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THE EGYPTIAN RICE MARKET: A MODEL ANALYSIS OF THE EFFECTS OF GOVERNMENT INTERVENTIONS AND SUBSIDIES

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THE EGYPTIAN RICE MARKET: A MODEL ANALYSIS OF THE EFFECTS OF GOVERNMENT INTERVENTIONS AND SUBSIDIES

by

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FOREWORD

Studies of food subsidies are an important part of IFPRI's research portfolio. Their primary purpose is to help governments of developing countries assess how current and alternative subsidy policies affect human nutrition, food consumption, income growth and distribution, fiscal costs, agricultural production, and foreign trade. Results from studies in several countries have been published as IFPRI's research reports. This working paper series was initiated to meet requests for additional information on the nature, implementation, and effects of subsidies in various countries. The food subsidy papers complement IFPRI's research reports on the subject by providing detailed descriptive analyses of operational and implementation issues and impact.

Control of food marketing has remained a major element of government food policies in many countries. It is only with a detailed analysis of these policies that effective guidance can be provided to policymakers when there is a need to modify existing policies. This paper provides an illustration of such an approach. It analyses the various facets and productivity implications of price- and nonprice-oriented rice policies in Egypt and suggests policy modifications that will raise rice productivity in the country.

Shubh Kumar
Project Director

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1. SUMMARY

The area planted to rice in Egypt decreased from a record high of 1.2 million feddans in the late 1960s to 985,000 feddans in the 1980s. Rice yield increases also slowed down during the same period. Stagnating rice production was the result of these developments. At the same time, domestic demand for rice grew rapidly as a result of population growth and improved incomes, especially after 1973.

Developing policies that would induce an expansion of rice production to meet growing domestic consumption and possibly provide foreign exchange from exports is a matter of great importance to the Egyptian economy in both the short and the long run.

The major objective of this study is to develop an econometric model of the Egyptian rice market and apply it to policy analysis. Model simulations could provide decisionmakers with information about different market outcomes based on alternative policies and courses of action.

The major rice-producing group of governorates, with a share of about 99 percent of total rice area in Egypt, has always included Domyat, Elbahira, Eldakahlia, Elfayom, Elgharbia, Elsharkia, and Kafr Elsheikh. In general, cotton, maize, and summer vegetables are the most important alternative crops for rice growers in Egypt.

About half the domestic rice production is marketed through government channels. The General Authority for Supply of Commodities (GASC) obtains paddy rice through a group of receiving agents. The milled rice is then distributed through government as well as authorized private retail stores for ration cardholders at fixed prices.

Per capita consumption of paddy rice ranged between 58.3 kilograms and 43.6 kilograms in 1968 and 1987, respectively. This negative trend is the result of a high population growth rate, stagnant paddy production, and government trade policies in the rice and wheat markets.

Typically the exercise of rice policy has involved the following policy instruments: (1) procurement of rice by the government; (2) provision of subsidies for important inputs, such as irrigation and fertilizers; (3) area and water control; (4) distribution of rice to consumers at a price lower than the market price; (5) foreign trade control; and (6) fixed prices on quota rice for rice producers.

The procurement of rice by the government depends on a set of policy instruments that includes a quota system, zonal restrictions, and a two-price system.

Since 1970 the quota has been set at 1.5 tons of paddy rice per feddan for most rice-producing areas. The actual delivery rate has always been lower than the government target.

According to government regulations, the movement of rice into and out of a governorate is prohibited, except with the permission of the government.

A two-price scheme was implemented in some years. This implies the use of two price levels--one for the quota amount and one for quantities delivered above the required quota.

The area to be planted to rice is decided on by a government committee. Although regulations on area and water control have a significant effect on the patterns of production, violations occur widely and persistently.

From 1979 until 1987, Egypt was facing a water shortage and the water level of Lake Nasser was falling as a result of below-normal rainfall in the catchment area of the Nile. Consequently, the Egyptian government decided to reduce its rice area for 1988 by 13.3 percent from its area in 1987.

Quota-rice farm prices have been set by an interministerial committee since World War II. In setting farm prices, this committee mainly considers the cost of production. Quota-rice farm prices (real) show a statistically significant negative trend throughout the period from 1967 to 1987. Furthermore, a large gap exists between the prices prevailing in the rural free market for rice and the average price received for quota rice.

The ratios of domestic price to international price of rice in Egypt suggest that rice exports were implicitly taxed for most of the period between 1967 and 1987.

In the early 1960s, the Egyptian government assumed total control over the foreign trade of rice. Rice exports reached a record high of about 772,000 tons in 1969. A decreasing trend can be seen during the next decade, and by 1985 Egypt's rice exports were at their lowest amount of only 16,000 tons. Rice imports were insignificant during most of that period. However, changes in Egypt's trade policy in 1986 made it possible for private importers to import rice into the duty-free zone.

In Egypt, rice exports are valued at the official (Central Bank) rate. With this overvalued exchange rate, exporters receive less in local currency for exported crops than they would otherwise. The ratio of the government price to the border price corrected for overvaluation of the currency indicates that rice producers were taxed throughout the period from 1967 to 1987.

Policy discrimination against agriculture had a significant negative effect on Egypt's agricultural production and exports. Therefore, re-evaluating the agricultural policy has been the subject of discussion in Egypt for some time, and different proposals for policy reform have been presented. Liberalizing the agricultural sector is one of the options being discussed.

Given the nature of government intervention at the regional level, an econometric model of the Egyptian rice market is specified and applied for analysis in which each rice-producing governorate is modeled by a block of equations. The model at the regional level includes a planted area equation, a yield per feddan equation, a production identity, a forced delivery equation, a free market sales equation, a total supply of rice identity, a free market price equation, and a private demand identity. The final product is a dynamic simultaneous equations model.

Thus relationships were estimated in seven major rice-producing governorates in Egypt--Domyat, Elbahira, Eldakahlia, Elfayom, Elgharbia, Elsharkia, and Kafr Elsheikh.

The results support the view that area planted to rice varies directly with lagged area planted to rice and with lagged free market price of rice, and inversely with lagged prices of competing products.

The short-run elasticity coefficients of the area planted to rice with respect to the free market price of rice and cotton price ranged between 0.12 and 0.45 and -0.28 and -0.88, respectively.

In general, comparing long-run price elasticities of area planted to rice in Egypt with similar estimates from different countries shows that the response of Egyptian rice farmers to prices is elastic.

In most of the yield equations, the estimated coefficients of planted area are negative. This means that planting more land to rice would lead farmers to use marginal land, thus lowering rice yields. However, this negative impact of area planted to rice was found to be statistically significant in only two governorates, Domyat and Kafr Elsheikh. Rice varieties were also found to have significant effects on rice yields. For example, rice variety Giza 159 had a positive and statistically significant effect on yields in Domyat, Eldakahlia, and Kafr Elsheikh.

Quantities of rice delivered to the government under the forced delivery program were found to vary directly with rice production and with the ratio of government price to free market price.

In all governorates, the results support the hypothesis that the free market price varies directly with the government price for rice and inversely with the per capita quantity of rice available for sale in the free market. For the first variable, the results show statistically significant flexibility coefficients that ranged between 0.9 and 2.4, which indicates that the free market price is highly responsive to changes in the government price.

The analysis shows a statistically significant negative effect of subsidized rice distribution on rice production because this distribution depresses the free market price in the respective governorates.

Wheat is a substitute for rice in consumption, and per capita consumption of wheat was found to be a statistically significant variable in the rice demand equation in all governorates except Elbahira. The free market price flexibility with respect to this variable ranged between -0.5 and -1.3. This indicates that a 10 percent reduction in the quantities of wheat consumed per capita would be associated with an increase between 5 and 13 percent in the price of rice in the free market.

The significance of this result is clear under Egypt's current conditions. Moreover, it confirms the conclusion of previous studies that changes in wheat policy will affect the rice market.

To estimate the impact of some of the policy instruments that were used to influence the Egyptian rice economy during the period of this study, simulation experiments were performed.

This analysis is based on partial equilibrium models for rice in segregated markets. The limitations of such an approach for analyzing far-reaching policy changes are obvious; however, the partial equilibrium model was chosen here to explain and analyze the current system of the rice market.

The first simulation examined the effect of the public distribution of subsidized rice in the rice-producing areas. The results show that setting public distribution quantities to zero for the 1969-82 period results in an increase of about 5.4 percent in the area planted to rice, 4.0 percent in rice production, and 3.3 percent in quantities of rice delivered to the government. These increases are mainly the result of the effect of public rice distribution on prices.

A second simulation assumed a 40 percent reduction in per capita wheat consumption as a result of a change in the wheat subsidy policy. On the national level, the effect of this simulation on rice area is shown to be 5.3 percent above the base run. Under this simulation, rice production increased about 4.1 percent and quantities of rice delivered to the government were about 3.0 percent above the base run on the average.

In the third simulation, it was assumed that the Egyptian government followed an active price policy since 1970 by adjusting nominal prices of rice quota in order to keep it constant in real terms at the 1969 levels. All other variables are assumed to remain at their actual levels. On the national levels, area planted to rice would have been 10 percent higher than the base run. Also, production and forced deliveries were 8.8 and 9.4 percent above that for the base run.

Implementing all policy changes discussed thus far at the same time was shown, in the fourth simulation, to cause the largest increases in area planted to rice (21 percent), rice production (15 percent), and quantities of rice delivered to the government (14 percent). Improved prices and higher production levels led to higher gross revenue per feddan of rice in almost all regions.

In the fifth simulation, introducing high-yielding varieties of rice (in Egypt, referred to as Filipino rice) in all rice-producing areas reduced free market prices when current procurement and trade regulations remained in place. However, gross revenue per feddan of rice in most regions should improve because increases in production more than compensate the price reductions. Still, this simulation stresses that current government interventions in the regionally segregated rice market are not conducive to adopting technological improvements in rice production.

The liberalization of the Egyptian rice market is assumed to produce an environment in which there would be no farm price control by the government, no area control, no crop procurement quotas, no restrictions on rice transportation, and no government constraints on private sector processing and marketing of rice. Under these conditions, a price of rice equal to the international price (the border price equivalent at the farmgate) would prevail. In the six simulation, it was assumed that these changes had taken place in 1981.

The results of this simulation suggest that the total area planted to rice in Egypt would have been about 16.4 percent higher than the base. The effect ranges between 7.4 and 64.3 percent in the Elgharbia and the Elfayom governorates, respectively. Rice production in Egypt would have been about 15.4 percent higher than the base run. In all regions the gross revenues per feddan are higher than in the base run. In Kafr Elsheikh governorate, the gross revenue per feddan was about 275 percent above that of the base run.

In Egypt, a disproportionate amount of government attention has been devoted to nonprice policy issues--forced delivery programs, restrictions on intergovernorate movement, and many such interferences. This research demonstrated, however, that the free market prices of rice are significantly influenced by changes in government prices of rice quota. Furthermore, rice farmers are price responsive in their production and allocation decisions. Consequently, even under the current system of interventions, changes in government prices for rice quota would influence farmers' decisions and a price regime closely oriented to the higher international price of rice would stimulate adoption of yield-increasing technology even in the short run.

2. INTRODUCTION

In developing countries, government intervention in agriculture through the use of price and trade policies is widespread. Yet the effects of these policies have received insufficient attention.

In Egypt, agriculture remains the largest sector of the economy, contributing about 20 percent of the gross domestic product (GDP) and 40 percent of total employment (World Bank 1984). However, the price, trade, and exchange rate policies followed by the Egyptian government over the past two decades have significantly and negatively affected agricultural production and exports. Furthermore, government policies have contributed to the flow of resources out of agriculture and created inefficiencies in the allocation of scarce resources.

An important part of Egypt's agricultural sector, the rice industry has experienced problems similar to those observed in the sector as a whole. During the 1970s and early 1980s, the area allocated for rice has been decreasing at a rate of 10,500 feddans a year (feddan = 1.038 acres). This reduction in acreage and a slowdown in yield increases caused rice production to stagnate. At the same time, demand for rice (and food products in general) grew rapidly, reflecting population growth as well as improved incomes. Consequently, rice exports eroded during the same period, which implies that the Egyptian economy is losing an important source of foreign exchange.

At a time when Egypt is facing a significant decline in its major sources of foreign exchange--oil revenue, Suez Canal earnings, and the remittances of Egyptians working in the Gulf states--the decline in rice exports in particular and problems in the rice industry in general have direct and significant policy implications.

The major objective of this study is to develop an econometric model of the Egyptian rice market and apply it to policy analysis. Studying the effects of government policies is needed for formulating future policies. Future policies could induce an expansion of rice production to meet growing domestic consumption and produce foreign exchange from exports.

Chapter 3 discusses the historical background of major variables in the Egyptian rice market. Chapter 4 presents the institutional framework of government intervention within which the Egyptian rice market functions as well as policy goals and instruments. The need for policy reform and different proposals for this reform are also discussed.

Chapter 5 formulates an econometric model of the Egyptian rice market and discusses the econometric method used in this study and the results of this estimation process.

The final chapter covers some simulation experiments in order to estimate the historical impact of some of the policy instruments that were used to influence the Egyptian rice economy during the study period.

3. THE EGYPTIAN RICE MARKET

The rice industry is one of the most important industries in Egyptian agriculture. Rice area represents more than 9 percent of Egypt's total cropped area, and the total value of rice produced in 1984 was about LE 292 million.[1] Approximately 50 percent of that rice was sold to the government, and the rest was either consumed on the farms where it was grown or sold in the free market. Another aspect of great importance to the Egyptian economy is the role rice plays in foreign exchange. In 1969, rice's share of all exports and of agricultural exports was 17 and 26 percent, respectively. By 1984, this share had declined to only 0.9 and 3.2 percent, respectively. The main factors behind this deterioration of the relative (and absolute) importance of rice as an export in Egypt were: (1) the increase in domestic rice consumption, which made less rice available for export, and (2) the increase in exports of petroleum and petroleum products in the second half of the 1970s.

This chapter discusses the historical background of the following major variables in the Egyptian rice market: production, consumption, and marketing channels.

Developments in Rice Production

In the course of the last seven decades, area planted, yields, and production of rice have changed considerably. The area planted to rice in Egypt has varied from a low of 0.259 million feddans in 1919-34 to a high of 1.048 million feddans in 1967-82 (see Table 1). From 1919 to 1934, rice area expanded rapidly with an annual growth rate of about 7.6 percent. In the period 1967-82, this annual growth rate dropped to less than 1 percent and came close to 0 in the 1980s.

[1] The Egyptian pound (LE) equals 100 piasters. In 1987, US$0.47 equalled LE 1.00.

Table 1--Growth rates of rice area, yield, and production in Egypt, 1919-87

Item	1919-34	1935-50	1951-66	1967-82	1983-87
Area					
Average (1,000 feddans)	258.750	584.170	678.040	1,047.600	985.302
Coefficient of variation	50.500	23.700	26.800	7.030	3.646
Growth rate	7.597	2.504	2.737	0.837	0.002
Yield					
Average (ton per feddan)	1.239	1.474	1.988	2.250	2.388
Coefficient of variation	10.060	12.408	16.445	4.729	3.687
Growth rate	0.841	1.142	2.262	0.041	-0.004
Production					
Average (1,000 tons)	327.380	869.040	1,388.800	2,406.200	2,352.034
Coefficient of variation	51.252	30.795	37.420	5.422	3.803
Growth rate	8.448	3.617	5.079	0.980	-0.002

Sources: Calculated on the basis of the data provided by the following sources: P. Singh, *The rice report, commodity analysis project* (Cairo: Ministry of Agriculture, 1959), for the period 1919-57; Arab Republic of Egypt, Production statistics, unpublished data, Ministry of Agriculture, Agricultural Statistics Division, Cairo, for the period 1958-87.

An explanation of this phenomenon is closely related to the availability and distribution of irrigation water. With the completion of major irrigation projects, such as the Barrages and the Mahmudiya canal, the total cultivated area rose from 4.16 million feddans in 1852 to 5.18 million feddans in 1913 (Elkheshan et al. 1983). The construction of the Aswan Dam, completed in 1933, and other irrigation projects outside the Egyptian border, such as the Gable Elawlia Dam in Sudan, helped to control water supplies in Egypt. The latest addition to the system was the Aswan High Dam that became operational in 1964. The dam and further irrigation network developments thus added an estimated 1.0 million feddans to the area planted. These projects in general, and the Aswan High Dam in particular, made more water available in Egypt and brought the water supply under more control. Rice area and production had been greatly affected by fluctuating water supply, but since the mid-1960s, the regulated water supply has permitted stable expansion of the rice area. Changing economic incentives and government intervention policies have mainly been responsible for shifting land use in or out of rice production.

Egypt's rice yields increased slowly from a low of about 0.851 ton per feddan in 1922 to a high of about 2.46 tons per feddan in 1962. The highest rate of growth in yield occurred during the years 1951-66. This increase in yield was brought about by a variety of factors; most important among them being improved varieties and seeds, general improvements in cultural methods and practices, and better pest and disease control. Some high-yielding varieties were introduced in limited areas in the late 1970s and early 1980s. The 1983-87 period shows a slightly higher average yield per feddan, but it is also characterized by the first negative growth rate of yield during the seven decades. Difficulty in obtaining adequate irrigation water at crucial times and problems with pest control could be the cause of this negative growth rate (Parker 1988).

Rice yields in Egypt are among the highest in the world. Only Australia, North Korea, South Korea, Japan, and the United States rank ahead of Egypt, and even the highest national yields are only 20 percent greater than Egypt's (Herdt 1987). Thus Herdt concludes that "this does not indicate that there is an obvious opportunity to exploit technology from other places"; in other words, "there appears to be a small exploitable yield gap in Egypt."

During most of the period 1919-87, rice production expanded dramatically: from a low of about 0.041 million tons of paddy in 1922 to a high of about 2.604 million tons in 1970. Growth in production is mainly due to growth in the area planted to rice, with the possible exception of the third period, 1951-66, when the growth rate of yield was at its highest level. As a result of a 5.9 percent decline in area planted to rice, average paddy production was reduced in the final period, 1983-87, by about 2.3 percent (see Table 1).

Major Rice-Producing Regions

The geographical pattern of Egypt's rice industry has not changed significantly during the last two decades for which consistent regional data are available. For example, the Eldakahlia governorate has always been the most important rice-producing region in Egypt in terms of both area and production. The major rice-producing group of governorates has always included Domyat, Eldakahlia, Elfayom, Elgharbia, Elsharkia, and Kafr Elsheikh. This group collectively planted more than 97 percent of the total rice area during 1965-70. This share increased to about 99 percent during the second period, 1977-82 (see Table 2 and Figure 1).

Table 2--Geographical pattern of rice production in Egypt, various periods

Region	1965-70		1977-82		1986	
	(1,000 feddans)	(percent)	(1,000 feddans)	(percent)	(1,000 feddans)	(percent)
Eldakahlia	277.040	26.370	277.950	26.765	280.217	27.800
Kafr Elsheikh	234.020	22.270	220.250	22.127	218.832	21.700
Elbahira	195.260	18.580	179.050	17.988	171.132	16.980
Elsharkia	165.030	15.700	159.680	16.042	163.465	16.220
Elgharbia	80.480	7.660	93.650	9.408	95.036	9.430
Domyat	52.330	4.980	43.550	4.375	53.135	5.270
Elfayom	20.580	1.960	17.350	1.743	12.315	1.222
Others	26.059	2.480	6.968	0.700	13.662	1.356
Total Egypt	1,050.780	100.000	1,038.500	100.000	1,007.794	100.000

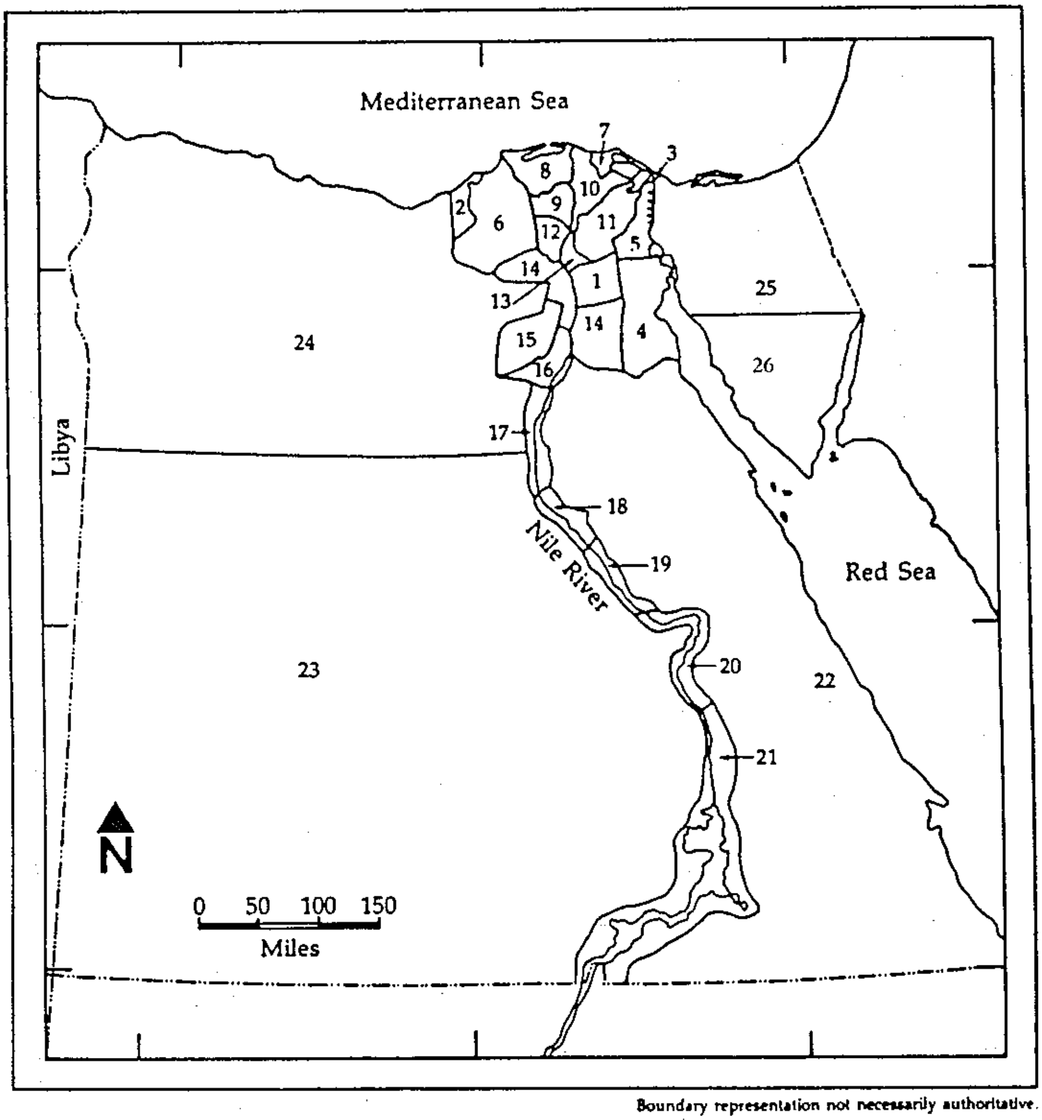
Source: Arab Republic of Egypt, Production statistics, unpublished data, Ministry of Agriculture, Agricultural Statistics Division, Cairo.

Rice in the Cropping Pattern of Egyptian Agriculture

Rice is cultivated during two seasons in Egypt, summer and *nili* (August-September). In recent years the *nili* production has been almost negligible, occupying less than 1 percent of the total rice area. In general, cotton, maize, and summer vegetables are the three most important alternatives to rice growing in Egypt. In the rice belt (the northern part of the Nile delta), rice is usually the summer crop, following wheat or full-term berseem. In the southern delta region, maize is the main summer crop, following winter cereals and legumes (see Figure 2).

Nassar and Mansour (1987) discuss developments in the Egyptian agricultural cropping pattern from 1970 to 1984. During that period the area planted to crops subject to direct government intervention decreased. Cotton area, for example, decreased at an average annual rate of 42,900 feddans, and rice area decreased at a rate of 10,500 feddans a year. At the same time, area planted to crops with little or no government intervention, such as maize, vegetables, and fruits, increased significantly. Maize area, for example, increased at an annual rate of 31,400 feddans during the 15-year

Figure 1--Major rice-producing regions in Egypt



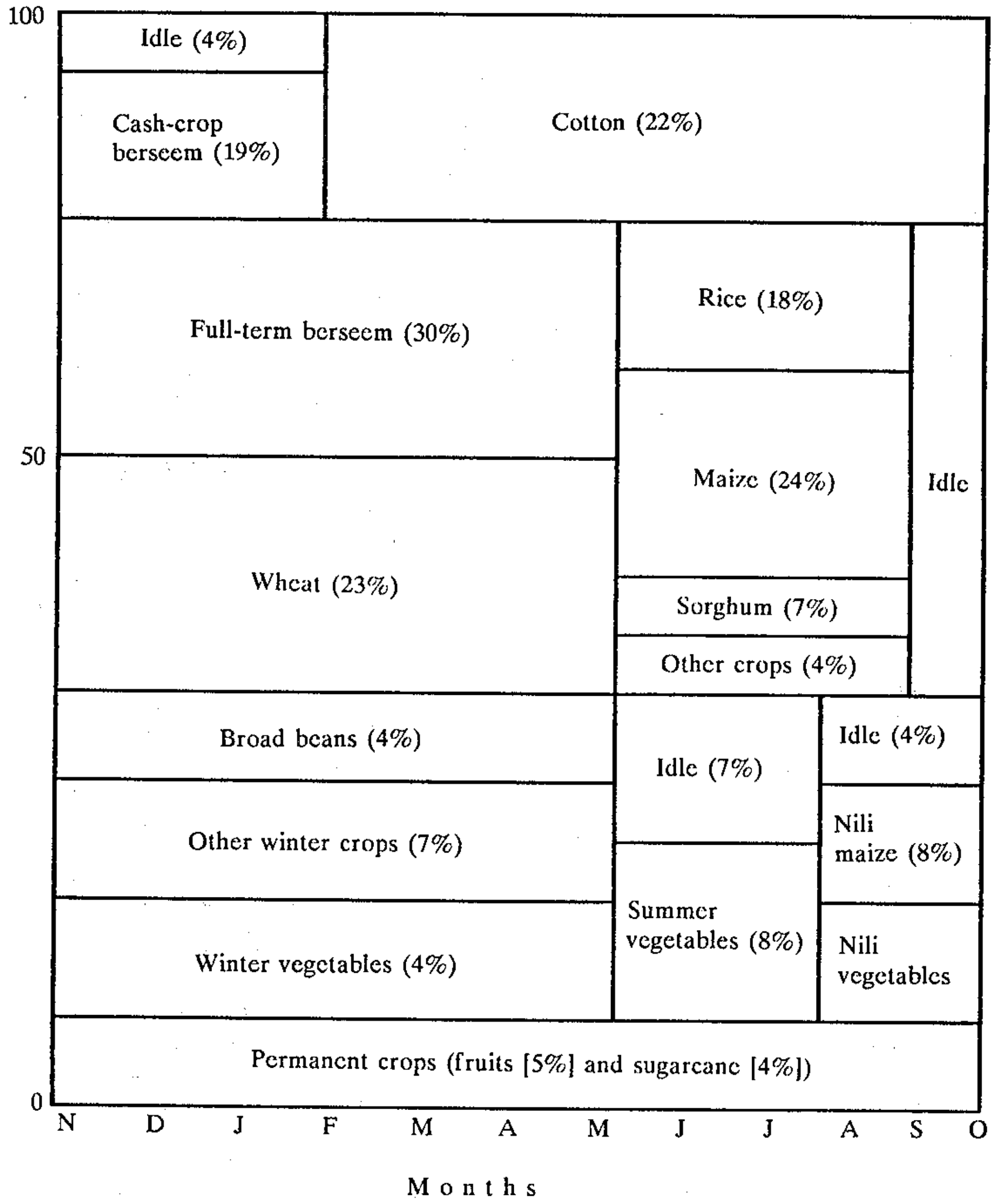
Urban governorates
1. Cairo
2. Alexandria
3. Port-Said
4. El Suez

Lower Egypt
5. El Ismailia
6. Elbahira (rice)
7. Domyat (rice)
8. Kafr Elsheikh (rice)
9. Elgharbia (rice)
10. Eldakahlia (rice)
11. Elsharkia (rice)
12. El Munufia
13. El Kalyubia

Upper Egypt
14. El Giza
15. Elfayom (rice)
16. Beni-Suef
17. El Menia
18. Asyut
19. Suhag
20. Qena
21. Aswan

Frontier governorates
22. Red Sea
23. New Valley
24. Matruh
25. North Sinai
26. South Sinai

Figure 2--The cropping pattern in Egypt, 1977-79



Source: J. von Braun and H. de Haen, *The effects of food price and subsidy policies on Egyptian agriculture*, Research report 42 (Washington, D.C.: International Food Policy Research Institute, 1983).

period,[2] and the area planted with fruits and vegetables increased at a rate of 17,500 feddans a year.

Rice Varieties

Many varieties of rice are grown in Egypt. Singh (1959) reported that the amount of land planted with the rice variety Yabani (Nahda) ranged between 93 and 97 percent of the total area in the period 1948-57. But by 1968 this variety's share of rice production had declined to only 75 percent, with the then-new variety Giza 159 accounting for the remaining 25 percent (Arab Republic of Egypt 1972).

In 1986 the main varieties of rice were Giza 172 and Giza 171, which had a total area of about 889,000 feddans, or 87.4 percent of the total area planted to rice. The other less important variety was Filipino rice (IRRI 28), which had 10.1 percent.

Table 3 shows the distribution of these varieties in the seven major rice-producing governorates in Egypt. Farmers in each of these governorates clearly specialize in one variety of rice and devote only small areas, or none at all, to the others. This specialization raises serious questions about studies that treat the whole rice area as a homogeneous unit. At the same time, it lends some support to disaggregated studies that use the governorate as a unit. Moreover, the continuous change in rice varieties used in Egypt could be a potential source of yield variations. The selection and distribution of seeds are decided by the government. The Agricultural Research Center (ARC) is responsible for the varieties being considered for multiplication. Once the variety is increased beyond the stage called basic or "foundation" seed, the responsibility to multiply it further becomes that of the Central Administration for Seed (CAS) which other carries out this multiplication on government lands or otherwise on farmers' fields under contract (World Bank 1984).

Rice Marketing Channels in Egypt

About half of domestic production is marketed through government channels (Figure 3) (Alderman, von Braun, and Sakr 1982). The General

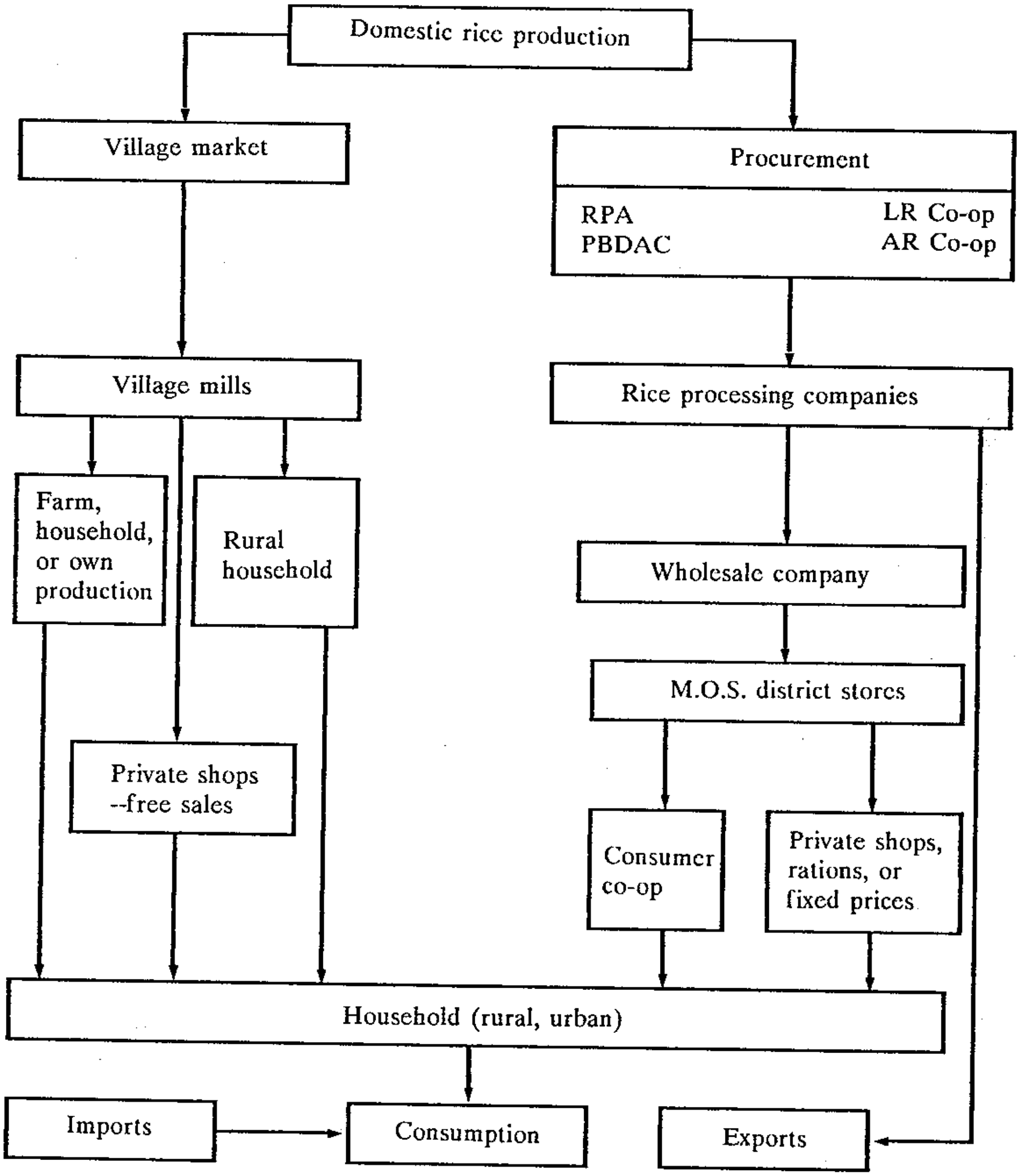
[2] This upward trend in area planted to maize is due largely to developments in the livestock sector during the same period. See von Braun and de Haen (1983) for a discussion of this issue.

Table 3--Distribution of rice varieties in Egypt, by region, 1982 and 1986

		Rice varieties					
Region	**Year**	**Yabani**	**Giza 159**	**Giza 171**	**Giza 172**	**Filipino rice (IRRI 28)**	**Others**
		(percent of total rice area)					
Domyat	1982	...	...	...	100.000	...	...
	1986	...	...	...	78.479	8.290	13.230
Elbahira	1982	...	0.568	99.377	...	...	0.055
	1986	...	...	84.400	...	15.598	...
Eldakahlia	1982	1.860	2.900	...	94.900	...	0.337
	1986	...	...	19.016	72.224	6.429	...
Elfayom	1982	100.000	...	...	...	...	...
	1986	...	...	...	97.660	2.340	...
Elgharbia	1982	...	...	100.000	...	...	...
	1986	...	...	85.511	...	14.140	0.348
Elsharkia	1982	...	6.940	93.058	...	...	...
	1986	...	...	91.949	...	7.529	0.521
Kafr Elsheikh	1982	...	7.430	0.798	91.420	...	0.358
	1986	...	...	19.892	67.130	12.460	0.520
Total	1982	2.910	3.667	43.640	49.610	...	0.176
	1986	0.862	...	47.410	39.990	10.161	1.576

Source: Arab Republic of Egypt, Production statistics, unpublished data, Ministry of Agriculture, Agricultural Statistics Division, Cairo.

Figure 3--Rice marketing channels in Egypt



Source: Adapted from H. Alderman, J. von Braun, and S. A. Sakr, *Egypt food subsidy and rationing system: A description*, Research report 34 (Washington, D.C.: International Food Policy Research Institute, 1982).

Authority for Supply of Commodities (GASC) obtains paddy rice through a group of receiving agents. The Rice Producers Association (RPA) is in charge of this process in most rice-producing areas, with less important roles played by the Agrarian Reform Co-op (ARCO-OP), Land Reclamation Co-op (LR CO-OP) and the Principal Bank for Development and Agricultural Credit (PBDAC) (Arab Republic of Egypt 1988b). The PBDAC was the principal receiving agent until the early 1980s, when it started to concentrate more on its financial role and to minimize its participation in activities outside that realm. Regional milling companies husk the rice and perform some marketing functions, although they do not handle bulk sales. The milled rice is then distributed through the government and authorized, private retail stores for local consumption. These outlets provide milled rice for ration cardholders and also sell rice outside the ration-card system at a higher fixed price. Their stocks, however, are seldom sufficient to meet demand.

Rice that is not delivered under the quota is mostly milled in private mills. Antiquated private mills produce more than half of Egypt's milled rice.

Production Costs

Table 4 shows the major cost items in two representative rice-producing governorates in Egypt in 1979 and 1986. About half the total cost of production goes to labor: 46.3 percent in Eldakahlia and 45.3 percent in Elgharbia in 1986.

Excluding the cost of renting land would increase labor's share to 53.3 and 52.9 percent in these two governorates, respectively. These high percentages are common in all rice-producing regions and are the result of high and increasing wage rates for hired labor. The increase in wage rates is attributed to labor shortages, which become critical during the peak labor seasons of May-June, when winter crops are harvested and summer crops are planted, and of September-October, when summer crops are harvested and winter crops are sown. This labor shortage is due to rural-urban migration and to the emigration of more than one million Egyptians who are working overseas (World Bank 1984).

The average cost of producing paddy in 1986 was LE 278 per feddan in Elgharbia and LE 246 in Eldakahlia. Based on the average yield per feddan, the average cost per ton of paddy rice was LE 96.2 and LE 118.1 in these two governorates, respectively.

Table 4--Cost of producing rice in Elgharbia and Eldakahlia governorates, 1979 and 1986

Cost item	Elgharbia				Eldakahlia			
	1979		1986		1979		1986	
	(LE)	(percent)	(LE)	(percent)	(LE)	(percent)	(LE)	(percent)
Labor	65.58	41.51	125.97	45.30	38.19	32.60	114.30	46.30
Draft animals	13.13	8.31	11.16	4.00	6.70	5.80	13.70	5.50
Machinery	21.95	13.89	54.00	19.40	16.97	14.50	33.00	13.40
Seeds	11.26	7.13	20.47	7.40	8.15	7.00	19.10	7.80
Manure	5.26	3.33	0.00	0.00	7.00	5.90	10.00	4.00
Fertilizer	6.94	4.39	15.40	5.50	7.85	6.67	12.10	4.90
Miscellaneous	3.88	2.46	11.00	4.00	2.18	1.86	11.80	4.80
Rent	30.00	18.98	40.00	14.40	30.00	25.60	32.70	13.30
Cost per feddan	158.00	100.00	278.00	100.00	117.10	100.00	246.70	100.00
Cost per ton[a]	65.05	...	96.20	...	47.80	...	118.10	...

Source: Arab Republic of Egypt, Cost records, unpublished data, Ministry of Agriculture, Agricultural Statistics Division, Cairo.

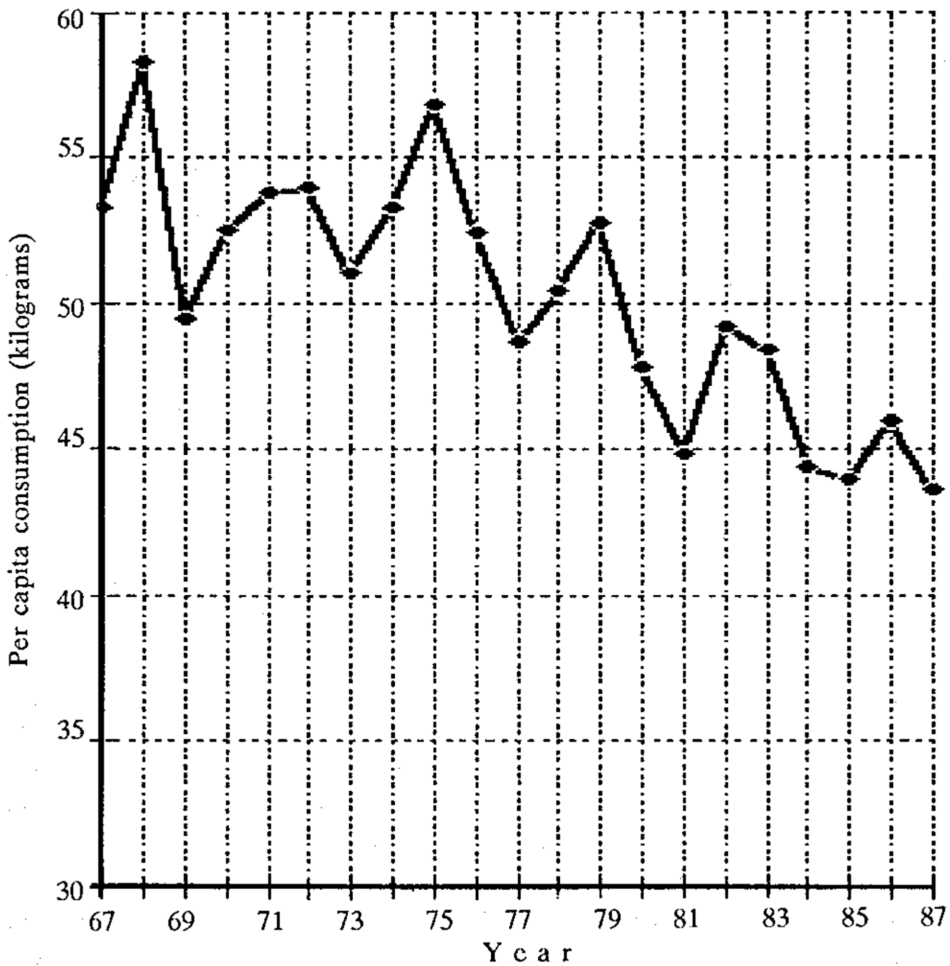
[a] Based on average yield per feddan.

Rice Consumption

As shown in Figure 4, per capita consumption of paddy rice has changed significantly during the period 1967-87. The per capita consumption of rice was at its peak of 58.3 kilograms in 1968 and continued to exceed 50 kilograms during most of the 1970s. In 1987, however, it reached its lowest per capita level in two decades, about 43.6 kilograms.

This significant negative trend is the result of three forces--high rate of population growth, stagnant paddy production, especially in the 1980s, and trade restrictions brought about by the government's policy of expanding the distribution of wheat relative to rice in the public system.

Figure 4--Per capita consumption of paddy rice in Egypt, 1967-87



Source: Annex B, Table 24.

4. GOVERNMENT POLICIES AND THE EGYPTIAN RICE MARKET

Government intervention in Egyptian agriculture is designed to achieve the following objectives: (1) promote self-sufficiency in food; (2) provide incentives to increase production and improve productivity; (3) stabilize prices; (4) generate government revenue; (5) distribute income; and (6) promote exports or provide surplus products for export (Goueli and Elrasoul 1987).

Developments in the political environment in which the formation of policy takes place will affect the choice and ranking of these objectives. Therefore, as the political environment changes, so will the ranking of the objectives. For example, the 1960s and early 1970s were characterized by a shortage of foreign exchange so that the objective of promoting exports to provide foreign exchange was emphasized. And in the early 1980s, inflation was causing great concern among Egyptian policymakers, who accordingly assigned the objective of stabilizing prices high priority.

Many types of government economic policies affect the Egyptian rice market. General fiscal and monetary and exchange rate policies affect a broad spectrum of economic activities that concern rice producers, consumers, and marketing firms. Here, the concern is only with those forms of policy interventions that have a direct effect on economic agents involved in the rice market.

Typically, the exercise of rice policy involves the following policy instruments: (1) government procurement of rice; (2) subsidies for important inputs such as irrigation and fertilizers; (3) area and water control; (4) distribution of rice to consumers at prices lower than market prices; (5) foreign trade control; and (6) fixed prices for quota rice.

This chapter briefly discusses the most important policy instruments as background for the discussion of model specification and simulations that follows.

Government Procurement of Rice

With rice, as with some other agricultural crops, the Egyptian government operates a system of compulsory deliveries at fixed prices. At the aggregate level, the volume of procured rice amounts to about half of total production. Shares of production that are procured at these low fixed prices vary, however, among governorates and over time.

The percentage of total production procured by the government in 1969 and 1974 was 52.5 to 38.7 percent, respectively (see Figure 5). In fact, all rice-producing governorates delivered a smaller percentage of their rice to the government through the forced delivery program during 1972-74 than before or after that period. This was clearly linked to a reduction in the government's price for rice in those years. The government procurement of rice depends on a set of policy instruments that includes a quota system, movement or zonal restrictions, and a two-price system.

The Quota System

In the period from 1944 until 1964, rice producers planting over two feddans were required to sell the government between one- and three-fourths of a *dariba* (*dariba* = 0.945 metric ton) per feddan. Farmers who planted less than two feddans of rice were allowed to keep all their rice production. The quota system changed over the period from 1965 until 1970, when farmers with two feddans or less were also obligated to deliver an assigned portion of their production. In addition to being dependent on the amount of area planted to rice, the quota varied according to land productivity, from 1.17 to 1.65 metric tons of paddy rice per feddan.

Since 1970 the quota has been based on land productivity alone, and the quota set at 1.5 tons of paddy rice per feddan for most rice-producing areas. A maximum of approximately 1.377 tons per feddan was achieved by Elgharbia rice farmers in 1979, and the delivery rate has always been lower than the government's target of 1.5 tons per feddan.[3] In 1971 it reached a low of 0.618 tons per feddan in Elfayom governorate (see Table 5).

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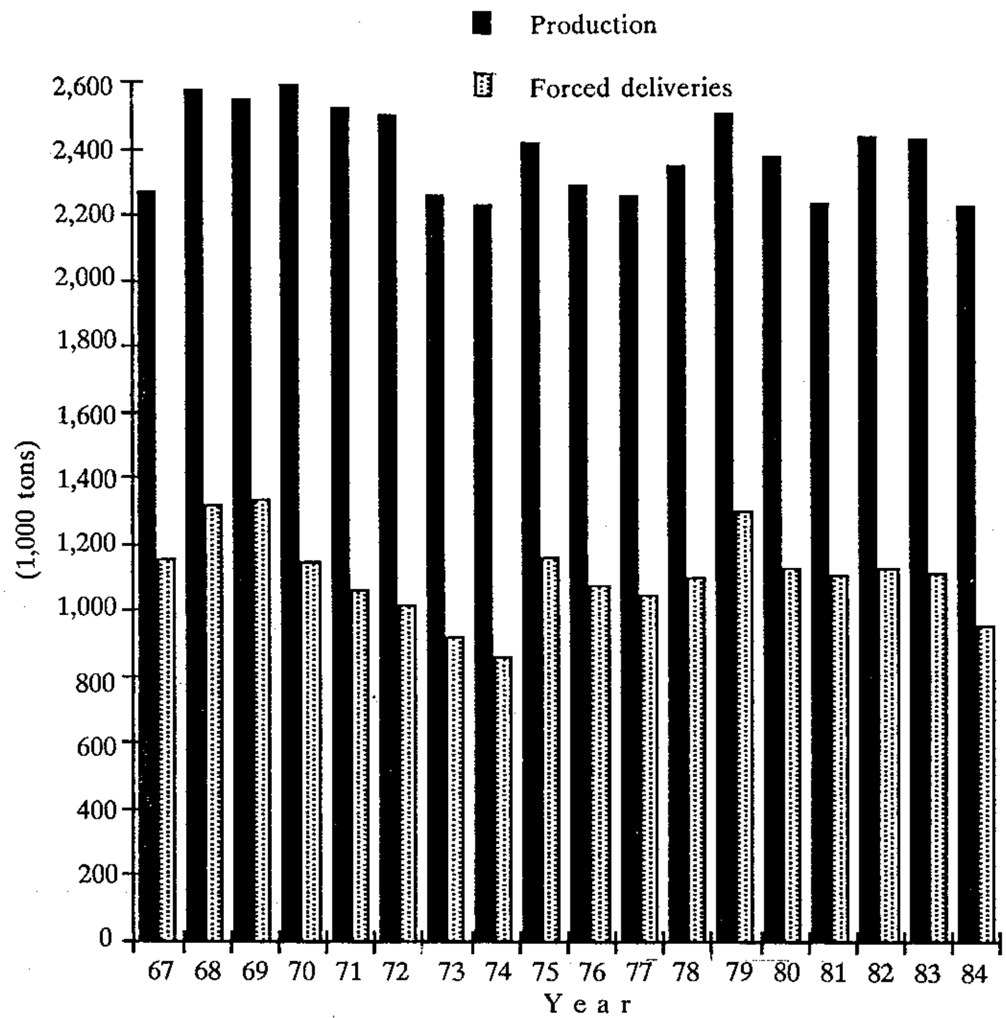
[3] Adams (1986, 80) makes the following observation based on his study of a village in the rice-growing area: "Peasants regularly ignore state controls designed to make them sell a portion of their rice crop to the cooperatives at government-mandated prices. Instead they prefer to consume their rice domestically, or sell it at higher prices on the open market." In another study, Abdou, Gardner, and Green (1986) examine rice and cotton quotas and find that the probability of violating the law increases as the size of the landholding grows, decreases as the distance from the market lengthens, and decreases (by about 10 to 20 percent) as government prices increase by LE 1 per *qantar* of cotton.

Figure 5--Total production and quantities of paddy rice delivered to the Egyptian government, 1967-84



Source: Annex B, Table 25.

Table 5--Average delivery rate per feddan in selected governorates of Egypt, various years

Governorate	1967	1971	1975	1979	1982
			(tons per feddan)		
Domyat	1.135	0.965	1.129	1.224	1.085
Elbahira	1.224	1.105	1.084	1.317	1.224
Eldakahlia	1.058	0.830	0.982	1.119	1.026
Elfayom	0.758	0.618	0.899	1.094	1.206
Elgharbia	1.202	1.126	1.329	1.377	1.309
Elsharkia	1.060	0.773	1.099	1.218	1.005
Kafr Elsheikh	1.138	0.925	1.057	1.095	0.986

Sources: Arab Republic of Egypt, Production statistics, unpublished data, Ministry of Agriculture, Agricultural Statistics Division, Cairo, and *Processing and actual production in rice mills: Annual report* (Cairo: Ministry of Supply and Home Trade, 1983).

Regional Movement Restrictions

The imposition of restrictions on the movement of rice among governorates has been one ingredient of the Egyptian government's procurement policy. According to these restrictions, the movement of rice inside governorates is unrestricted, but any movement into or out of a governorate is prohibited except with permission from the government. The responsibility for the movement of rice from one governorate to another is assumed entirely by the government.

These restrictions facilitate procurement. First, they bottle up surpluses in the surplus areas, and second, they lower the open market prices and reduce the gap between the free market price and the procurement price.

Two-Price System

A plan for paying bonus incentives to rice farmers, which was related to the targets set for them through the quota system, was implemented in 1967 and 1974. According to this plan, bonuses on a per ton basis were to be paid for the quantity of rice delivered to the government over and above the target fixed for the farm. This implies the use of two price levels--one for quota and one for quantities delivered above the quota. The objective of this system is to increase delivery of rice to the government.

De Janvry, Siam, and Gad (1983) address the question of whether government procurement of rice through the forced delivery system is needed to ensure a sufficient supply of rice. Their empirical case study of rice, using data taken from a sample of farms in 1976, concludes that compulsory deliveries are irrelevant to food security in Egypt and that sales in the free market would increase more than proportionately if forced deliveries were halted. Moreover, the authors suggest that the dominant effect of this policy is to tax farm income.

Distribution of Subsidized Wheat and Rice

Food subsidies represented about 8 percent of the Egyptian gross domestic product (GDP) in 1979 (Alderman, von Braun, and Sakr 1982). Wheat is the largest component of the national food subsidy, and unlimited quantities of flour and bread are allowed at a fixed price.

Rice was also sold to consumers by the government and private authorized shops at a fixed low price for the years 1967-87. Rationing, however, was only used during the 1970s and 1980s.

The distribution of subsidized rice was limited mainly to areas that do not produce rice. In the early 1970s, however, that distribution was expanded to include rice-producing areas. Available data show a significant trend toward increased distribution of subsidized rice per capita in the seven major rice-producing governorates in Egypt throughout the 1967-82 period (Elminiawy 1987).

The cost of public distribution of subsidized rice in 1970 was LE 16 million. By 1985 the cost had increased to LE 103 million (Parker 1988). In May 1987 concern over losses from consumer subsidies for rice caused the General Authority for the Supply of Commodities to increase retail prices. Nevertheless, a considerable subsidy remains for those buying rice with their ration cards.

Area and Water Control

The area to be planted with rice, as well as with some other major crops, is decided on by a committee composed of representatives of various ministries--among them, the Ministry of Agriculture, the Ministry of Supply and Home Trade, the Ministry of Planning, the Ministry of Foreign Trade, and the Ministry of Public Works and Water Resources. After deciding on the total area of rice to be planted nationally, the committee distributes the total area among various rice-producing governorates, districts, and villages.

This allocation is supported by the Ministry of Public Works and Water Resources, which issues "irrigation licenses" each year before the cultivation season. These licenses, which authorize the irrigation of rice areas, are important because rice has special irrigation requirements. These consist, in part, of systematically alternating "wet" and "dry" periods in the irrigation canals by fixing the flow into the canals and controlling the size of the flow into the field according to the area of each farmer's property.

Although the area control regulation significantly affects the patterns of production, violations occur widely and persistently (Singh 1959; Grouch and Siam 1983; von Braun and de Haen 1983).

In recent years, and during most of the period under examination, planting less land with rice than the amount prescribed by the government is the most common form of violating the land control regulation. Planting more rice than the government requests also takes place in some regions and in areas not covered by irrigation licenses. This is not a new problem.

One Egyptian agricultural expert admits, ". . . The fact is that there is a discrepancy between what the irrigation law stipulates and what is actually occurring. . . . For example, section 35 of Law No. 74 of 1971 charges the Ministry of Irrigation (now the Ministry of Public Works and Water Resources) to direct how the rotation periods are to be established in delivering water throughout the system. However, field observations in some areas have demonstrated that farmers do irrigate during the 'off' periods" (Sallam 1984).

A more detailed observation is included in the following quotation, which appeared in a draft copy of a U.S. Department of Agriculture report (1976) and is cited in Adams (1986, 95): "farmers manage [the irrigation system] more than the Irrigation Department. Unauthorized canal outlets exceed authorized outlets by at least three times, unauthorized pumps are used, laterals and outlets on the main canals use water out of turn, turns on laterals are extended to reduce farmer complaints."

Concern over Water Shortage and the Egyptian Rice Area

The Nile valley and delta in Egypt are among the oldest agricultural areas in the world. For thousands of years, their fertile soil has been cultivated. Before the construction of the Aswan High Dam, the agricultural lands used to be flooded in late summer during the high tide of the Nile. An artificial lake (Lake Nasser) was created as a result of the construction of the high dam.

The 1959 agreement between Egypt and the Sudan determined Egypt's share of the Nile's water to be 55.5 billion cubic meters a year. However, Egypt's water needs for agricultural and nonagricultural uses are estimated at 59.5 billion cubic meters a year--that is, Egypt needs an additional 4 billion cubic meters of water each year. This gap is filled by ground water.[4]

From 1979 through 1987, the water level of Lake Nasser continued to fall as a result of below-normal rainfall in Ethiopia. As a result, in 1987, Egypt received only 42 billion cubic meters of water (Parker 1988). Some experts argue that this water crisis is a cycle in the long life of the river and cite four similar shortage periods (1911-15, 1918-22, 1939-45, and 1968-73) to support their argument. Annual water discharge was below average during these periods, but recovered afterward (Rady 1987a).

A different theory is presented by Waterbury (1979, 253), who argues that this reduction in the water discharge of the Nile is part of a long-term negative trend. The average annual discharge of the Nile for the period 1901-87 (see Table 6) does not indicate a significant trend toward reduced discharge.

The water shortage persisted, however, and Egyptian irrigation experts presented a set of recommendations for dealing with it (Rady 1987a). Among these were the following:

1. Set a maximum level of 700,000 feddans for area planted to rice in any given year, which means a reduction of about 30 percent in rice area.

2. Expand the area planted to new high-yielding varieties (HYV) that use less water and reduce the area of other rice varieties.

The Egyptian government's response to the water problem was, as explained in the Five-Year (1987/88-1991/92) Social and Economic Develop-

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[4] A comprehensive discussion of Egypt's water resources and distribution systems can be found in Waterbury (1979).

Table 6--Average annual discharge of the Nile, 1901-87

Time period	Average annual discharge
	(billion m^3)
1901-10	86.3
1911-20	82.8
1921-30	82.3
1931-40	85.2
1941-50	82.4
1951-60	89.3
1961-70	91.4
1971-80	85.4
1981-87	66.1

Sources: J. Waterbury, *Hydropolitics of the Nile valley* (New York: Syracuse University Press, 1979), Table 33, p. 253, for 1901-75; and Arab Republic of Egypt, unpublished statistics, Ministry of Public Works and Water Resources, Cairo, for 1976-87.

ment Plan Document (1988), to reduce the planned rice area for 1988 by about 13.3 percent from its level in 1987.[5]

Input Prices and Subsidies

Several inputs used in rice production, including fertilizer, irrigation, seeds, and credit, are provided at subsidized prices. All of Egypt's rice area is under irrigation, and water is supplied to farmers free of charge. In general, energy prices are also very low. For example, in 1983 gasoline was being sold at US$0.20/gallon compared with the international price of US$0.80/gallon.

The Principal Bank for Development and Agricultural Credit (PBDAC) finances the subsidized production credit program. Thus most agricultural loans receive concessional interest rates (World Bank 1984).

[5] The plan also calls for reducing the area planted with other crops that need a lot of water. At the same time, the area planted with summer crops that have low water needs is expanded; the plan allocates about 22.0 per cent more land for maize, including yellow maize.

Fertilizer, especially nitrogen, is an input of increasing importance in rice production in Egypt because the new high-yielding varieties demand greater use of fertilizers.

The farm-level prices of various types of fertilizer are set by the government, and the Agricultural Prices Stabilization Fund (APSF) imposes a tax on imported fertilizer or pays a subsidy in order to keep prices fixed at the level set by the government. Cuddihy (1980) estimated the tax rate imposed on imported fertilizer in 1971 to be 87 percent. As international prices rose in 1975, the APSF paid a subsidy of 60 percent for imported fertilizer.

Table 7 shows the price ratio of nitrogen (ammonium sulfate) to paddy rice in Egypt for 1967-87. This ratio was relatively high throughout the 1960s and most of the 1970s. In 1972, for example, the relative price of nitrogen in the form of ammonium sulfate was 4.85 units of rice using the government procurement price, or 4.1 units of rice using the free market price.The upward trend in the nominal prices for both quota and free market rice that began in the second half of the 1970s helped to reduce this ratio. By 1987, the ratio had dropped to 1.42:1, or about 0.74:1 when the free market price is used.

This reduction in the amount of rice needed to buy fertilizer--lowering the price ratio--normally leads to increased fertilizer use and higher yields. However, the Egyptian government interventions in the fertilizer market in the form of price fixing and quantity restrictions prevent rice farmers from using fertilizer more intensively and thus keep rice yield low.

Rice Price and Implicit Taxation

The farm prices of quota rice have been set by an interministerial committee since World War II. In setting farm prices, this committee considers mainly the cost of production (Nassar and Mansour 1987).[6]

Quota rice farm prices deflated by the Wholesale Price Index (WPI 1975 = 100) show a statistically significant negative trend throughout the period from 1967 through 1987.

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[6] Farm prices for main crops are determined using the following formula:

$$\text{Farm price} = \frac{\text{Cost per feddan + land rent - value of byproducts}}{\text{Average yield per feddan}}$$

Table 7--Ratio of the price of nitrogen to that of government and free market rice in Egypt, 1967-87

Year	Ratio of nitrogen price to Government price	Ratio of nitrogen price to Free market price
1967	4.32	2.73
1968	4.11	2.26
1969	4.19	3.05
1970	4.58	3.58
1971	4.73	3.77
1972	4.85	4.01
1973	4.59	3.54
1974	3.58	2.82
1975	3.20	2.90
1976	2.54	2.44
1977	2.58	2.24
1978	2.00	1.87
1979	2.85	2.51
1980	2.77	2.51
1981	2.87	2.15
1982	2.92	1.68
1983	2.64	2.13
1984	2.64	1.85
1985	2.22	1.02
1986	1.68	0.87
1987	1.42	0.74

Sources: Calculated on the basis of data provided by the Egyptian Ministry of Agriculture on government and free market prices; W. Cuddihy, *Agricultural price management in Egypt*, Staff working paper 388 (Washington, D.C.: World Bank, 1980); and Food and Agriculture Organization of the United Nations, *Trade yearbook*, various issues (Rome: FAO) on ammonium sulfate price.

$$RGP = 46.839 - \underset{(-4.958)}{0.6658}\ Time \qquad (1)$$

$$R^2 = 0.564,$$

where

RGP = real government price for rice quota,
Time = 1, . . ., n   n = 21; and
the t-ratio is in parentheses.

Data in Table 8 show that a large gap exists between the prices prevailing in the rural free market for rice and the average price received for quota rice.

Table 8--Relationship of the government and free market price of rice to the international price and the effect of currency overvaluation, 1967-87

			International price not corrected for overvaluation		International price corrected for overvaluation	
Year	Government price	Free market price	Government procurement price	Open market producer price	Government procurement price	Open market producer price
	..........(LE/ton)..........		................(percent of border price).................			
1967	30.11	47.65	77.46	122.59	35.98	56.93
1968	31.58	57.41	68.85	125.16	33.56	61.01
1969	31.00	42.58	76.22	104.07	33.44	45.93
1970	28.41	36.29	102.67	131.15	42.79	54.65
1971	27.54	34.47	112.87	141.27	51.48	64.43
1972	26.83	32.40	107.88	130.28	51.20	61.80
1973	28.09	36.43	56.26	72.96	30.57	39.64
1974	36.00	45.69	19.49	24.73	11.73	14.89
1975	40.24	44.46	27.49	30.37	14.70	16.24
1976	50.00	52.19	58.00	60.55	28.82	30.08
1977	50.40	58.13	88.11	101.63	43.56	50.24
1978	65.00	69.59	83.47	89.37	42.07	45.07
1979	65.11	73.90	46.58	52.96	43.09	48.91
1980	75.74	83.68	51.11	57.03	42.34	46.77
1981	85.00	113.00	46.30	61.55	30.90	41.08
1982	95.00	165.00	48.54	84.30	28.81	50.03
1983	105.00	130.00	79.87	98.88	45.08	55.82
1984	105.00	150.00	92.49	132.12	45.67	65.25
1985	125.00	272.00	110.69	240.86	43.01	93.60
1986	165.00	319.00	171.04	330.67	49.56	95.82
1987	195.00	375.00	154.43	296.98	39.88	76.69

Sources: Estimated on the basis of data provided by the Egyptian Ministry of Agriculture on quota and free market prices of rice; the Egyptian Ministry of Supply and Home Trade on marketing and milling costs; J. Parker, *Market fundamentals, Egypt: Rice* (Washington, D.C.: U.S. Department of Agriculture, 1988) for average export value; and Table 10 for relative exchange rate bias. The border price is reported in Appendix 2, Table 26.

In 1982 the price farmers received for rice in the free market (LE 165 per ton) was 73 percent higher than the average price they received in sales to the government, LE 95 per ton.

The gap in 1987 was even larger--the market price of LE 375 per ton was 92 percent higher than the procurement price. This large gap reflects the burden of taxation implicit in the procurement system.

The ratios of the domestic price to the international price of rice in Egypt for 1967-87 are presented in Table 8, which suggests an implicit tax or negative protection. Whenever the domestic price is below the border price, the ratio is less than unity. A ratio of domestic to border price that exceeds unity implies positive protection for domestic production of the crop. Thus rice exports were implicitly taxed during the period 1967-87, and the tax rate was particularly high during 1974-75. In the early 1980s, Egypt's exports declined, and the implicit tax on rice exports dropped to its lowest level.

During 1970-72 and 1985-87 rice enjoyed an implicit subsidy when evaluated at the official exchange rate. However, before coming to any conclusion, one should correct for the overvaluation of the exchange rate (see the discussion on page 34).

Foreign Trade in Rice as an Instrument of Government Policy

The Egyptian government began intervening in the rice trade in 1884 when it imposed an export tax on rice exports. This tax was increased twice in the 1940s and continued to be in effect until the mid-1950s (Singh 1959).

In the early 1960s, the Egyptian government assumed total control over the foreign trade of rice. The foreign trade organization, which is a government agency, became the sole exporter of rice in Egypt, and an export committee was charged with determining the volume of exports by calculating production minus the quantity to be used domestically. Thus rice exports since 1962, with the possible exception of 1968 and 1969, may be viewed as a residual effect of rather than a response to international prices.

Studies that lend strong support to this view include Siamwalla and Haykin's study (1983) of the international rice market. They consider Egypt to be one of the small price-taking participants in the world rice market and estimate the net Egyptian rice export equation for the period 1962-80. The most significant factor affecting the export decision, as seen from this estimated equation, is the expected surplus of rice in the domestic market.

Since the international price of rice is not found to be statistically significant, it is excluded from the equation.

Rice exports reached a record high of about 772,000 tons in 1969. A trend toward fewer exports took place during the next decade, and by 1985 Egypt's rice exports were at their lowest level of only 16,000 tons.

Rice imports were insignificant during most of the period 1967-87 (see Table 9). As an element in the Egyptian government's policy of monopolizing the foreign trade in rice, private firms were not allowed to import rice into Egypt. In 1986 changes in Egypt's trade policy allowed private importers to import rice, especially into Egypt's duty-free zone.

Table 9--Exports, imports, total export value, and average export price of rice in Egypt, 1967-87

Year	Exports	Export average price	Total export value	Imports	Net exports
	(1,000 mt)	($/ton)	(million $)	(1,000 mt)	
1967	434	157.47	68.50	0	+ 434
1968	570	181.40	103.40	0	+ 570
1969	772	164.64	127.10	0	+ 772
1970	654	120.18	78.60	0	+ 654
1971	514	109.73	56.40	0	+ 514
1972	456	118.18	50.70	5	+ 451
1973	298	221.48	66.00	0	+ 298
1974	136	745.59	101.40	11	+ 125
1975	104	600.96	62.50	4	+ 100
1976	211	374.88	79.10	5	+ 206
1977	223	267.71	59.70	4	+ 219
1978	153	350.34	50.80	7	+ 146
1979	123	331.58	31.50	11	+ 112
1980	184	359.18	35.20	7	+ 177
1981	135	441.94	41.10	7	+ 128
1982	25	473.91	10.90	8	+ 17
1983	21	338.10	7.10	9	+ 12
1984	52	316.90	22.50	3	+ 49
1985	16	317.65	5.40	7	+ 9
1986	92	298.91	27.50	45	+ 47
1987	105	380.95	40.00	20	+ 85

Source: J. Parker, *Market fundamentals, Egypt: Rice* (Washington, D.C.: U.S. Department of Agriculture, 1988).

One might expect rice exports to decrease in 1986 when the export price was low. Rice exports increased, however, to 92,000 tons in 1986 and to 105,000 tons in 1987. One explanation could be that the export contracts designated through trade agreements caused rice exports to remain considerable.

The leading markets during 1985-87 were Austria, Czechoslovakia, Finland, and the Soviet Union (Parker 1988).

Exchange Rate Overvaluation: Another Implicit Tax on Rice Exports

The real exchange rate is the ratio of the domestic price of tradable goods to the price of nontradable goods (Dethier 1987). Thus it plays an important role in the allocation of resources among tradable and non-tradable, agricultural, and nonagricultural sectors.

Exchange rate overvaluation is most often the result of an expansionary fiscal and monetary policy directed at maximizing economic growth. This expansionary policy leads to price inflation, which, when it is more rapid than that of the country's principal trading partners, causes the real exchange rate to appreciate. Furthermore, restrictive trade policies lead to domestic prices of industrial goods that are higher than world prices. Under this condition, the official exchange rate will overvalue the real purchasing power of the local currency relative to that of the foreign currency.

The exchange rate determines how much local currency an exporter receives in return for foreign currency earnings. With an overvalued exchange rate, the exporter receives less local currency for exported crops than would otherwise be the case. Hence an overvalued exchange rate in effect maintains artificially low producer prices, which is equivalent to the imposing an implicit export tax.

In Egypt, rice exports, like most agricultural exports and imports, are valued at the official (Central Bank) rate. Dethier (1987) explains the effect of this policy: "By valuing tradeable goods at an overvalued nominal exchange rate, the government has artificially cheapened wheat imports, thus saving on foreign exchange reserves, raising demand for wheat and bread. By not paying exporters the opportunity cost of their product, it has also accentuated the taxation of the sector and contributed to its declining performance."

The exchange rate bias is a measure of exchange rate overvaluation (see Table 10). During the period 1967-87 the Egyptian pound was

Table 10--Official (Central Bank) rates, black market exchange rates, real exchange rates, and relative foreign exchange bias in Egypt, 1967-87

Year	Official rate	Real exchange rate[a]	Black market rate	Relative bias[b]
	..........................US$/LE................................			
1967	2.30	2.33	1.16	0.982
1968	2.30	2.38	1.20	0.916
1969	2.30	2.38	1.10	1.090
1970	2.30	2.33	1.09	1.110
1971	2.30	2.27	1.20	0.916
1972	2.30	2.27	1.24	0.854
1973	2.56	2.56	1.48	0.729
1974	2.56	2.38	1.57	0.630
1975	2.56	2.27	1.41	0.815
1976	2.56	2.38	1.35	0.896
1977	2.56	2.44	1.39	0.841
1978	2.56	2.50	1.39	0.841
1979	1.43	1.37	1.33	0.075
1980	1.43	1.47	1.22	0.172
1981	1.43	1.41	0.99	0.444
1982	1.43	1.56	0.89	0.607
1983	1.43	1.72	0.87	0.644
1984	1.43	2.27	0.80	0.788
1985	1.43	...	0.65	1.200
1986	1.43	...	0.53	1.698
1987	1.43	...	0.47	2.043

Source: Joachim von Braun and Hartwig de Haen, *The effects of food price and subsidy policies on Egyptian agriculture*, Research report 42 (Washington, D.C.: International Food Policy Research Institute, 1983) for the period 1967-80; International Monetary Fund, *International financial statistics* (Washington, D.C.: IMF, 1988) for the period 1981-87; and Arab Republic of Egypt, *The political economy of agricultural pricing policies: The case of Egypt*, World Bank research project 673-64 final report (Washington, D.C.: World Bank, 1988c). (Table A-9 for the real exchange rate).

[a] The real equilibrium exchange rate assumes external balance and free trade (E*) deflated by the CPI, which is corrected for the impact of overvaluation in its tradable component and multiplied by the wholesale price index of major trading partners (U.S. WPI).

[b] Overvaluation of the currency is estimated as the relative deviation B of the black market rate

where:

B is $W_o/W_b - 1$,

W_b is in LE/US$ from the official rate, and

W_o is in LE/US$.

consistently overvalued relative to the dollar exchange rate. The nominal exchange rate adjustment in 1979 apparently reduced the exchange rate overvaluation. With an annual inflation rate above 20 percent, a massive trade deficit, and rapid terms-of-trade deterioration, this foreign exchange bias increased rapidly during the following years and achieved its highest level in 1987.

Table 8 shows the ratio of government price to the border price equivalent corrected for the overvaluation of the currency. It is clear that rice producers have been taxed throughout the period 1967-87. Moreover, this implicit tax, which was the result of an overvalued exchange rate, was large enough to transform what sometimes looks like a subsidy into a tax.

Policy Reform

Government policies that keep farm prices low are considered to be one of the causes of low agricultural productivity in many developing countries.[7] Moreover, price policies can distort the relative price structure among various commodities and inputs and lead to inefficiencies in production and consumption.

In Egypt, the government's price, trade, and exchange rate policies over the past two decades have significantly and negatively affected Egypt's agricultural production and exports. Policy discrimination imposed a substantial burden on the agricultural sector.

Von Braun and de Haen (1983) estimate this burden in terms of the aggregate gains and losses of producers in agricultural commodity markets during 1965-80. Their analysis shows that the total burden peaked in 1974 to about 2,000 (1975 LE million), and it ranged between LE 500 million and LE 1,000 million for most of the period.

These government policies have also contributed to the flow of resources out of agriculture. Workers have been leaving the agricultural labor force in great numbers and moving to urban areas in Egypt and elsewhere, creating a labor shortage, especially during critical periods in the agricultural production process. Similar trends have been observed in both land and capital markets (El-Kholei and Khedr 1987).

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[7] Several studies on the effects of government disincentives to agriculture in developing countries can be found in Schultz (1978).

Some experts argue that taxing agriculture with price and subsidy instruments has created black markets for inputs, thus diverting subsidized inputs to profitable crops and creating policy-generated rents for a few farmers. This is the case with fertilizer. By protecting certain sectors (livestock and berseem) and taxing others (cotton and rice), government intervention creates inefficiencies in the allocation of scarce resources. Furthermore, the Egyptian government's exchange rate and trade policies that encouraged imports--that is, wheat and wheat products--and led to a relative decline in agricultural exports contributed to a significant decline in the country's self-sufficiency ratios in foods.[8] The agricultural trade balance that showed a surplus of $300 million in 1970 recorded a deficit of $2.6 billion in 1983/84 (Dethier 1987).

Dethier shows that the impact of government intervention policies on agricultural output has been strong (Dethier 1987, 47). The index of gross agricultural output has fallen consistently since 1970, and agricultural output has stagnated since 1980/81.

In the early 1980s, Egypt also experienced a significant decline in its major sources of foreign exchange--oil revenue, Suez Canal earnings, and remittances from Egyptians working in the Gulf states.

Therefore, Egyptian policymakers recognized that economic and agricultural policy reform should be given high priority. Reevaluating agricultural policy has been the subject of discussion in Egypt for some time, and different proposals and recommendations for policy reform have been presented by the groups involved in this discussion.

The following is one set of recommendations: (a) remove the government's control of farm prices on all crops except cotton, rice, and sugarcane; (b) remove the government's area control except on cotton, sugarcane, and rice; (c) remove the government's crop procurement quotas except on cotton, sugarcane, and rice; (d) remove the government's constraints on private sector processing and marketing of farm products and inputs, including imports and exports, and continue to restrict rice transportation by private traders for the three months during the harvest; (e) eliminate subsidies on farm inputs, and, as a first step, keep the nominal

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[8] For studies that represent this view, see Abu-Ali (1987) and Dethier (1987).

value of farm input subsidies constant for 1987; and (f) limit state ownership of land.[9]

Another proposal calls for the Egyptian government to raise its direct agricultural tax on land enough to replace all the revenue generated indirectly through the system of procurement at fixed prices, while simultaneously raising farmgate prices of cotton and rice to their international levels. The same proposal also includes abolishing forced deliveries and area control for all crops, without exception, within three years. It is argued that setting the price of cotton and rice at their international level would create a new set of relative prices. This new set would encourage fewer resources to be allocated to the production of feed crops such as berseem, thus making more land available for food production (Nassar and Mansour 1987).

Dethier (1987) presents a comprehensive policy reform package with three major components: (1) unify the exchange rate, (2) liberalize trade, and (3) liberalize price controls. All currency transactions would be moved to a "unified pool" at a rate close to the free market rate. This implied devaluation of the effective exchange rate will raise the domestic currency price of tradables in relation to nontradables and shift resources and production into exportables and importables. The new real exchange rate would be protected from appreciating by a series of minidevaluations.

Dethier also recommends that subsidies on all nonbasic food items be limited and that a mechanism for adjusting the prices of all subsidized goods to reflect cost increases be put in place. The system of procurement prices and quotas would be abolished and replaced by a system of support prices for all important crops, and protection of the livestock sector would be gradually reduced.

This would mean that farmers would be free to respond to the world prices that represent the true opportunity cost of their crops and that economic efficiency and national income would probably increase. Agricultural production for domestic consumption and for export would be stimulated in proportions reflecting the country's comparative advantage and depending on the magnitude of supply elasticities. Exports would increase and imports decline as a result of exchange rate management and fiscal and monetary policies designed to keep the exchange rate from appreciating.

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[9] Recommendations included in the Agricultural Production and Credit Project 2630202, USAID, 1986.

Employment would increase, and the rate of rural-urban migration would possibly decline as a result of higher relative income in rural areas.

On the other side of this policy debate, it is claimed that the impact of these policy reform measures may not be as great as suggested above. Removing all forms of price control by the government, for example, would lead to higher prices and higher inflation. And it is argued that production of most agricultural crops would not expand significantly given low supply elasticities. The result would be that low-income households who spend a large percentage of their income on food would suffer the most without a reasonable increase in the supply of food. Consequently, social and political pressure to reverse such a policy would result, at least in the short run. Accordingly, it is proposed that current policies (forced deliveries, farm input subsidies, determined prices) should continue with only minor changes. For example, prices would be flexible rather than fixed for a long period of time.[10]

It is also argued that setting farm prices equal to world prices is not a viable option in the long run. Had such a policy been followed in the past, the Egyptian government would have lost much of its revenue, and government expenditure based on these revenues could not have been sustained.

Policy reform measures will always involve political costs, and governments will differ in their willingness to pay those costs. The choice and implementation of any agricultural policy will not depend only on the quality of the technical arguments presented in support of or against it. Political or social constraints often reduce the flexibility that governments have in implementing a full range of policy reform measures. The adoption of an optimal package will rarely be possible.

The future of the Egyptian rice sector is clearly linked with the outcome of the debate presented above.

In looking at Egypt's serious problem of stagnating rice production, this study attempts to contribute to the debate by answering the following policy questions:

1. What will be the effect of a change in the price of rice on the output of paddy?

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[10] Most of the elements of this proposal are discussed by Obeid in Al-Ahram (1988).

2. What will be the effect of a change in the price of rice (for quota) on the free market price of rice?

3. What will be the effect of a change in the price paid by the government for quota rice on the quantities of rice delivered to the government?

4. Did the Egyptian government's policy of distributing subsidized rice and wheat in rice-producing areas have a negative effect on rice production?

5. What is the expected impact of expanding the area planted with new high-yielding varieties of rice on production of rice, farmers' revenue, and prices?[11]

6. What would be the impact of a total liberalization policy on the major elements of the Egyptian rice market: production, farmers' revenue, and prices?

[11] This issue is discussed by Behrman and Murty (1985) in a different setting. They explained that "some experts have expressed the fear that technological innovations for sorghum in SAT India would depress sorghum prices to such an extent that farmers would shift away from sorghum production enough so that there would be little output gain."

5. MODEL SPECIFICATION AND ESTIMATION

The objective of this chapter is to formulate a dynamic econometric model of the Egyptian rice market and estimate its parameters. There were several important changes in this model specification due to factors involved in the empirical estimation of the model.

The chapter starts with a brief description of the underlying economic structure of the rice market in Egypt, which discusses the data limitations and considerations of policy and statistics that influenced the specification process. Then, the regional market structure is presented, and supply, allocation, and demand at the same level are brought together to form a model that portrays the Egyptian rice market. The model's characteristics and variables and the nature of the data set are also discussed, and the econometric methodology followed in this study outlined. Finally, the results of this estimation process are presented and discussed.

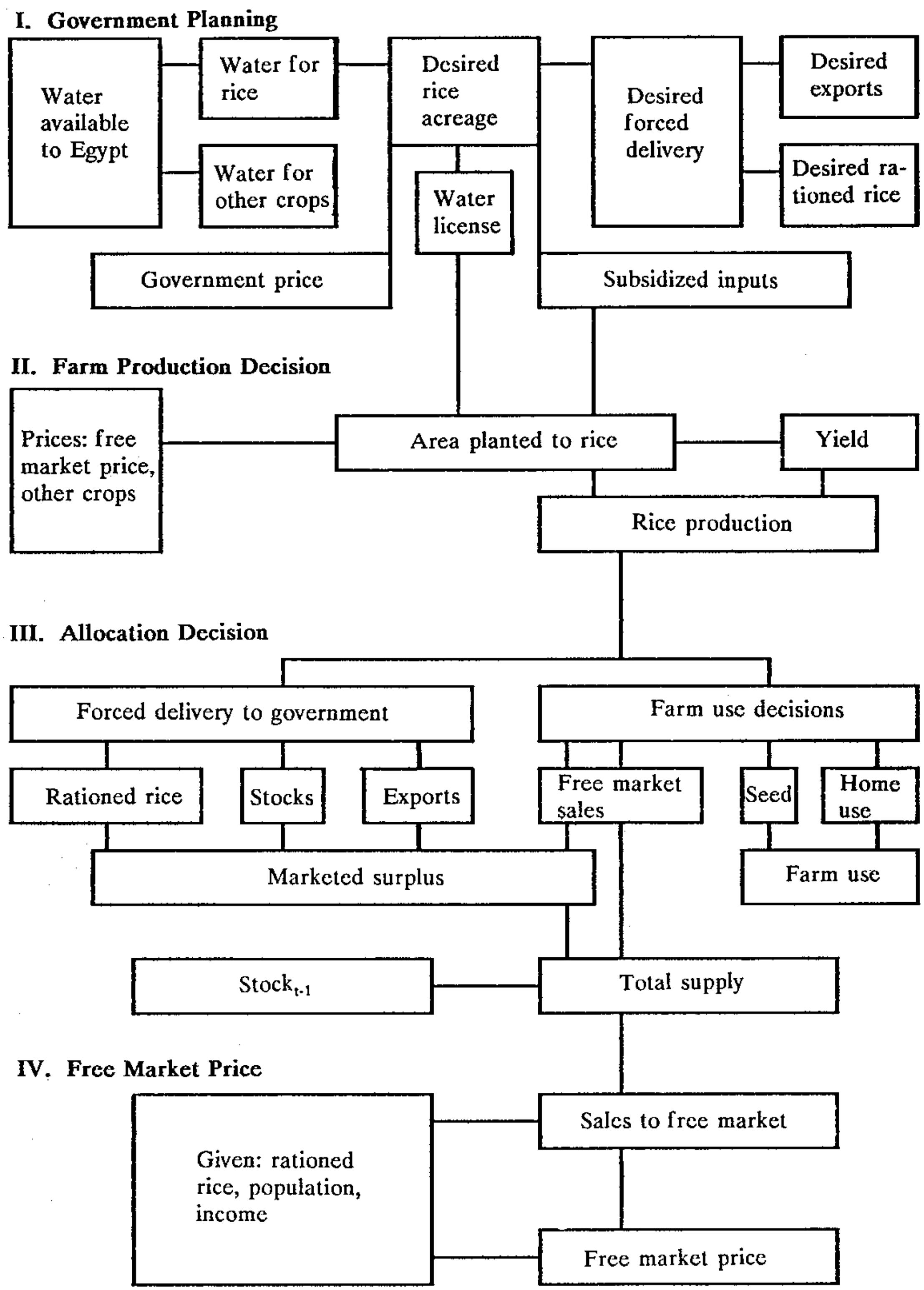
Economic Structure of the Egyptian Rice Market

Despite the substantial involvement of the Egyptian government, the economic structure of the rice market has a relatively simple framework.

The principal economic relationships and variables involved in this market are illustrated in the flow chart given in Figure 6, the upper part of which represents the government planning process.

The quantities that the government wants to acquire from rice producers through the forced delivery program will be approximately equal to the sum of desired exports and quantities expected to be distributed domestically through the public distribution channels. Given a quota system that requires rice producers to deliver a certain quantity per feddan to the government, the desired forced delivery quantities are related to desired rice area.

Figure 6--Representation of the Egyptian rice economy



At the same time, the total supply of water available to Egypt represents another dimension of the process. The planning body must determine how much water to provide rice farmers on the aggregate level, taking into account the needs of other crops. Thus water allocated to rice and the amount of desired forced deliveries determine what the government considers to be a desired rice area. This government decision is communicated to rice farmers through a set of instruments--water licenses and the government price for rice quota being the most important.

The second component of Figure 6 is the farm production decision. At the top of this part, area planted to rice is influenced by a set of expected prices--the free market price and the prices of competing crops. Also, rice area is expected to be affected by government prices for quota rice, water available to rice, and costs of production. In addition to rice area, yield per feddan is expected to be influenced by economic and noneconomic factors, such as area planted to rice, insects, diseases, technological change, and prices of rice and inputs. The area planted with rice and the average yield per feddan will determine the annual rice production.

The allocation process is represented by the third block in Figure 6. Rice farmers have to divide the rice produced between quantities to be delivered to the government and quantities to be kept for their own use. The latter is allocated further between farm use and sales to the free market. Rice kept on the farm where it is grown covers the farmer's home consumption and seeds needed for the next year. Rice delivered to the government through the forced delivery program is allocated by the government among three outlets--quantities to be distributed domestically as subsidized rice, government stocks, and government exports.

Adding forced deliveries to free market sales of rice gives rise to a definitional equation for quantities of rice available for sale in the market, either through government or private outlets; namely, the marketed surplus (MKS).

Adding the previous year's ending stocks to this year's production will determine the supply of rice. The available quantities of rice in the market, in addition to some exogenous variables such as population, personal disposable income, and supply of other food items, will determine the free market price of rice. This farm price affects the farmer's decision about how much area to plant with rice the next year.

Model Specification Process: Limitations and Assumptions

The preceding discussion can be a basis for identifying major structural relations in a model representing the Egyptian rice market. Data limitations and policy and statistical considerations are factors of great importance in this model specification process.

A rice farmer is expected to allocate a portion of this year's production to seeds for next year's crop. But the rice varieties used in Egypt have changed frequently during the period 1967-82 (see Chapter 4). These changes mean that, at least in the year a new variety is introduced, rice farmers cannot depend on their own production of seeds in the previous year. Furthermore, farmers produce a large portion of rice seeds under special contracts with the Ministry of Agriculture. Usually rice produced for seed use is included in data on forced delivery.[12] The next year these quantities of certified rice seed are sold to rice farmers through the village agricultural cooperatives. Unfortunately, reliable time-series data were not available for these sales. Some farmers may use sources other than the government to satisfy their need for rice seeds, but this use is assumed to be limited.

The lack of appropriate time-series data on a farmer's home consumption represents another unfortunate limitation. Therefore, it is not possible to distinguish between a farmer's home consumption and the quantities he delivers to the free market. Consequently, free market sales are assumed to be augmented by quantities consumed in the rice farmer's home, and home consumption is expected to be influenced by the same variables as the free market sales. The exclusion of both rice seed and home consumption from the data reduces the farmer's allocation decision to only two choices--delivering rice to the government under the forced delivery program or selling rice in the free market. The second direct result of this modification is that the concept of marketed surplus (MKS) must be dropped because it depends on the distinction between sales in the free market and home consumption.

Stocks, exports, and subsidized rice are regarded as being exogenously determined rather than jointly determined. This assumption is defensible in the context of available information.

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[12] This is confirmed by unpublished data provided by the Egyptian Rice Marketing Company in 1984.

Time-series data on rice stocks held by the private sector do not exist in Egypt. Available data on rice stocks primarily represent stocks held by the government or public sector companies. Consequently, all the accumulation or depletion of stocks can be regarded as reflecting government decisions. Another important point is that these stocks represent a very small percentage of the annual rice production delivered to the government. For these reasons, stock changes are best regarded as exogenous in this model.

Foreign trade that is in the hands of private firms and subject only to taxes or subsidies might be modeled as that of individuals who arbitrage between domestic and world markets. But the situation is different when foreign trade is completely under the control of the government, as is the case with the Egyptian rice exports (see Chapter 4). An interesting question is, to what extent does the government agency controlling the rice trade take explicit account of conditions in domestic and world rice markets? The answer will determine whether rice exports are classified as an exogenous or an endogenous variable in this model. This specification does not accept the notion that policymaking behavior in the field of rice exports is explicitly influenced by the characteristics of the rice market, whether domestic or international.

The fact that the government fixes consumer prices and determines quantities per capita for subsidized rice makes estimating a demand function meaningless. In fact, what is being estimated under these conditions is the policymaker's allocation behavior, which is not assumed to be an endogenous variable in this model.

A few additional remarks may also be useful on the subject of treating government policy variables as exogenous. This assumption does not suggest that government actions are inconsistent with rational behavior, but rather that these government policies are formulated, processed, and implemented in an environment that includes many elements. All of these elements influence the decision in some way and to some degree. It is only claimed here that the factors that influence the government's decision about the Egyptian rice market, though important, do not warrant endogenizing government policy variables in this model. In other words, it is assumed that other elements are far more important to and exert more influence on the policymaking process than those related to the rice market.

In the present analysis, as is usually the case with market-level studies, the main concern is not with the actions of individual firms, but rather with the behavior of broad aggregates of firms or economic agents. Moreover, available time-series data are in the form of regional or national aggregates. The choice between these two levels of aggregation can be based on institutional or statistical considerations. As explained in Chapter 4, the government imposes restrictions on the intergovernorate movement of the private rice trade, and different governorates specialize in different varieties of rice. These and other considerations support the use of the governorate as a unit of observation in this study.

In other words, given these considerations, it is expected that disaggregation of the analysis from the national to the regional level will reduce the potential aggregation bias.

And using governorates as the unit of observation will lend strong support to this model's assumption of exogenous government behavior at this level of aggregation.

An important question is, to what extent do parameters vary among governorates? The importance of this issue is obvious: if governorates have the same structure, then much greater efficiency can generally be gained by pooling, since fewer parameters must be estimated in the pooled model. This possibility can be considered statistically through hypothesis testing. The results of the F-test performed using 1967-82 data for the seven major governorates show that rice markets in these regions are not the same and that imposing such constraints in pooled estimations would produce erroneous results.[13]

The Regional Market Structure

Taking the considerations discussed above into account greatly simplifies the model specification.

Building an econometric model at the regional level means adding another variable (namely, water licenses) to the list of variables that have to be omitted because reliable time-series data are lacking. Data on this variable can only be used at the national aggregate level. At the regional level a discrepancy exists between the administrative borders of governorates, which represent the basis for all the data used in this study, and the borders of irrigation districts, which are reported in the water licenses annual decree issued by the Ministry of Public Works and Water Resources. Attempts to

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[13] For a detailed discussion of these tests and results, see Elminiawy (1987, 102-109).

reconcile these differences in order to produce a consistent data set were not successful.

Testing the structural differences among governorates reveals differences that are statistically significant. Furthermore, private traders are not allowed to move rice between governorates. Both these considerations support, at least to some degree, the treatment of each governorate as a different segment of the market. An even stronger approach would treat rice-producing governorates in Egypt as independent and totally separate markets. Under this specification each governorate is represented by a block of equations, and the structural equations in any one block do not involve current nor lagged endogenous variables from any other block. This kind of dynamic nonintegrated structure implies that not only the current value but also the path through time of an endogenous variable are determined entirely by the equations of the block in which the variable in question appears (Kmenta 1971).

The following discussion describes the market structure at the regional level, in particular the structural relationships in the rice market of a representative governorate.

Figure 7 diagrams the sources of current supply of and the types of demand for rice in a representative governorate (i). The total current supply of rice (TR_t^i) is composed of current governorate production (PRO_t^i) and subsidized rice that the government provides to rice consumers in the governorate (RSR_t^i). The subsidized rice is seen as an import to the regional market.

This supply of rice satisfies two major sources of demand: private or individual demand and government demand. The latter is assumed to equal the amount that farmers deliver to the government under the forced delivery program. The individual demand is satisfied by the amount of rice that consumers get from the free market (FMS_t^i) and from government distribution.[14] Because the amount of private stocks at the regional level is negligible and reliable time-series data do not exist, this variable was excluded. Accordingly, the specification of the model in governorate (i) is presented in Table 11 and discussed in the following section.

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[14] Available information supports the treatment of RSR_t^i as an independent component in this market. Rationed subsidized rice (RSR_t^i) cannot be used to satisfy forced delivery quota requirements simply because it comes to consumers as milled rice, while FDV_t^i is delivered as paddy rice. Because it represents small per capita quantities, it is not expected to be resold in the free market.

Figure 7--Structure of the regional rice market in a representative governorate

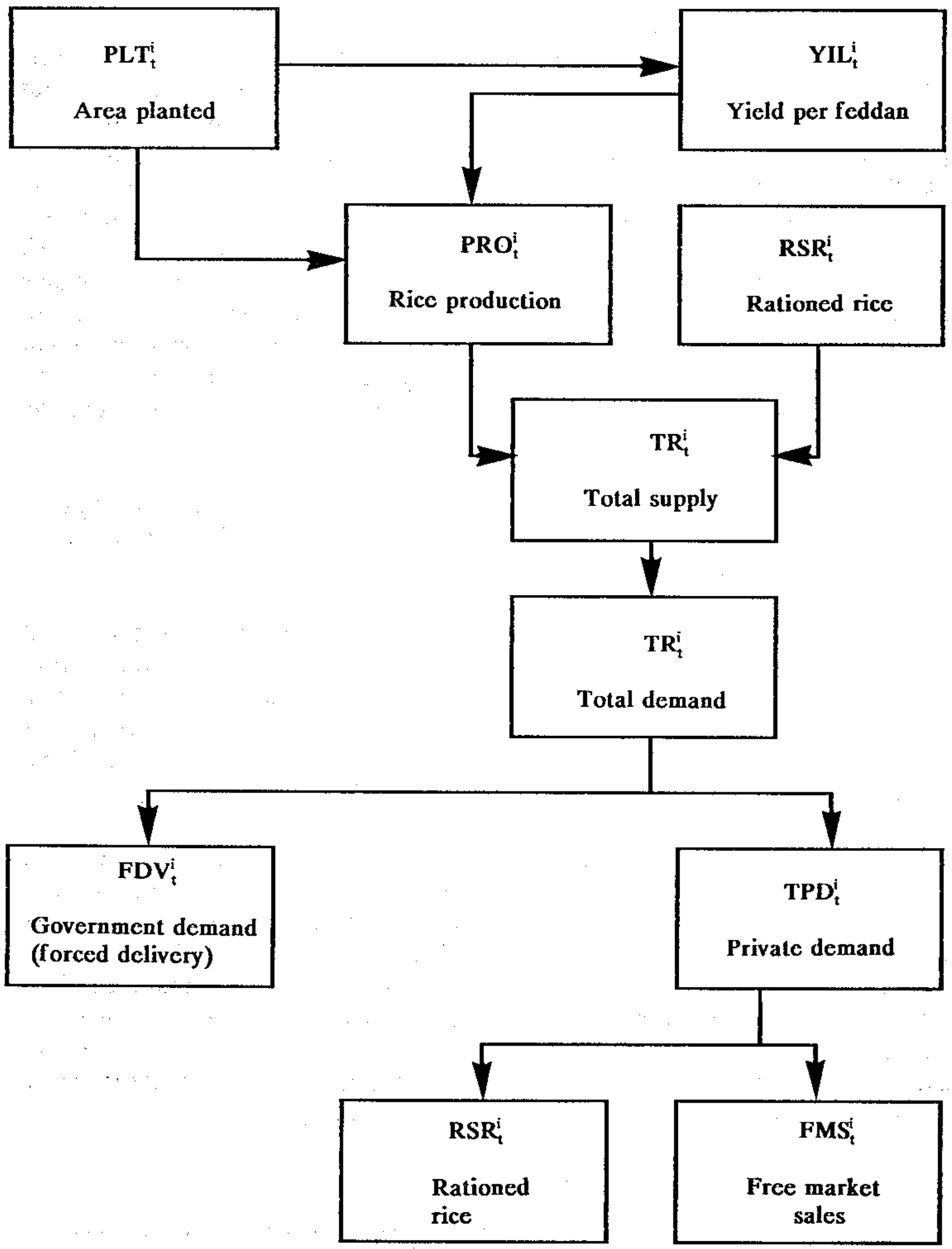

Table 11--Structural model of the Egyptian rice market

Area planted to rice equation

$$PLT_t^i \;=\; f_i\,(FMP_{t-1}^i,\ PLT_{t-1}^i,\ AGP_t^i,\ INP_{t-1}^i,\ COP_{t-1}^i,\ PSP_{t-1}^i,\ BMP_{t-1}^i) \qquad (1)$$

Yield per feddan equation

$$YIL_t^i \;=\; f_i\,(PLT_t^i,\ RWR_t^i,\ YABANI_t^i,\ GZ159_t^i,\ GZ170_t^i,\ GZ171_t^i,\ GZ172_t^i,\ AMSP_t^i,\ TIME_t^i \qquad (2)$$

Production identity

$$PRO_t^i \;=\; (PLT_t^i)\ X\ (YIL_t^i) \qquad (3)$$

Forced delivery equation

$$FDV_t^i \;=\; f_i\,(AGP_t^i/FMP_t^i),\ TWPS_t^i,\ CHQS_t^i,\ ARR_t^i,\ D82_t^i) \qquad (4)$$

Free market sales equation

$$FMS_t^i \;=\; f_i\,(AGP_t^i/FMP_t^i),\ TWPS_t^i,\ CHQS_t^i,\ ARR_t^i,\ D82_t^i) \qquad (5)$$

Total supply of rice in governorate (i) identity

$$TR_t^i \;=\; PRO_t^i + RSR_t^i \qquad (6)$$

Free market price equation

$$FMP_t^i \;=\; f_i\,(FMS1_t^i,\ RSR1_t^i,\ AGP_t^i,\ PDM_t^i,\ PCW_t^i,\ PCP_t^i) \qquad (7)$$

Total private demand in governorate (i) identity

$$TPD_t^i \;=\; (PRO_t^i + RSR_t^i) - FDV_t^i \qquad (8)$$

To show why identity (8) is in fact a market clearing condition, consider the following:

Total demand for rice in governorate (i) = Total supply of rice in governorate (i)

or

$$(TPD_t^i) + (FDV_t^i) = (PRO_t^i + RSR_t^i)$$

Private demand + government demand = total supply

(continued)

Table 11 (continued)

Endogenous variables

1. PLT_t^i = area planted to rice in governorate (i), year (t).
2. YIL_t^i = yield per feddan of rice in governorate (i), year (t).
3. PRO_t^i = rice production in governorate (i), year (t).
4. FDV_t^i = quantity of rice allocated to forced delivery in governorate (i), year (t).
5. FMS_t^i = quantity of rice allocated to free market in governorate (i), year (t).
6. TR_t^i = total supply of rice in governorate (i), year (t).
7. FMP_t^i = free market price of rice in governorate (i), year (t).
8. TPD_t^i = total private demand for rice in governorate (i), year (t).

Predetermined variables

1. FMP_{t-1}^i = free market price of rice in governorate (i), year (t-1).
2. PLT_{t-1}^i = area planted to rice in governorate (i), year (t-1).
3. AGP_t^i = government price for rice quota in governorate (i), year (t).
4. INP_t^i = input price index in governorate (i), year (t).
5. COP_{t-1}^i = cotton price in governorate (i), year (t-1).
6. PSP_{t-1}^i = potato price in governorate (i), year (t-1).
7. BMP_t^i = berseem price in governorate (i), year (t).
8. RWR_t^i = rural wage rate in governorate (i), year (t).
9. $YABANI_t^i$ = dummy variable that takes the value of 1 in years when Yabani variety is planted in governorate (i), and 0 otherwise.
10. $GZ159_t^i$ = dummy variable that takes the value of 1 in years when rice variety "Giza 159" is planted in governorate (i), and 0 otherwise.
11. $GZ170_t^i$ = dummy variable that takes the value of 1 in years when rice variety "Giza 170" is planted in governorate (i), and 0 otherwise.
12. $GZ171_t^i$ = dummy variable that takes the value of 1 in years when rice variety "Giza 171" is planted in governorate (i), and 0 otherwise.

(continued)

Table 11 (continued)

13.	$GZ172^i_t$	=	dummy variable that takes the value of 1 in years when rice variety "Giza 172" is planted in governorate (i), and 0 otherwise.
14.	$AMSP^i_t$	=	fertilizer price in governorate (i), year (t).
15.	$TIME_t$	=	time trend variable 1967 = 67,...,1982 = 82).
16.	$TWPS_t$	=	dummy variable 1967, 1974 = 1, 0 otherwise.
17.	$CHQS_t$	=	dummy variable after 1970 = 1, 0 otherwise.
18.	ARR^i_t	=	agrarian reform ratio in governorate (i), year (t).
19.	$D82^i_t$	=	dummy variable 1982 = 1, 0 otherwise.
20.	RSR^i_t	=	subsidized/rationed rice distributed in governorate (i), year (t).
21.	$RSR1^i_t$	=	per capita personal disposable income in governorate (i), year (t).
22.	PCW^i_t	=	per capita wheat consumption in governorate (i), year (t).
23.	PCP^i_t	=	per capita potato consumption in governorate (i), year (t).
24.	$D75^i_t$	=	dummy variable that takes the value of 1 in years before 1975 in governorate (i), and 0 otherwise.

The Determinants of Planted Rice Area

Production decisions in the rice market are assumed to reflect profit-maximizing behavior. Furthermore, policy variables are introduced to represent the effect of government involvement in the rice economy. Farmers are assumed to form expectations about future prices using an adaptive expectations approach.

The Nerlovian adaptive expectations approach was chosen for this study because of its compatibility with the relevant decision environment and its proven usefulness in numerous studies under similar conditions. In addition, one could argue that the loss resulting from not using a rational expectations approach would be minimized by using the Nerlovian adaptive expectations approach, hence the latter is an approximation of the former under certain conditions. Eckstein (1985) explains this point as follows:

> This rational expectations equilibrium model and the Nerlovian supply response (with adaptive expectations) model are equally good at fitting any stable patterns in time-series data because

each is sufficiently flexible to explain any reduced form derived from the other property known as observational equivalence.[15]

With all these considerations, the planted rice area equation is hypothesized to be as equation (1) in Table 11.

The assumption that rice farmers use the Nerlovian adaptive expectations approach to form their expectations about future prices has led to the inclusion of both free market price of rice lagged one year (FMP_{t-1}) and area planted to rice lagged one year (PLT_{t-1}). The free market price of rice is expected to be the most important of the variables influencing the area planted to rice. Because of government interventions, only a certain proportion of the area planted to rice adjusts to the desired area within a given year. Thus the variable of the area planted to rice lagged one year helps to clarify the adjustment process.

Government price for rice (AGP_{t-1}) is expected to affect the area planted to rice positively because when prices are set or guaranteed for all or part of the output, producers have an incentive to increase output to improve their total income.

Previous studies indicate that the prices of cotton (COP_{t-1}), potato (PSP_{t-1}), and berseem (BMP_t) are significant factors in the rice response function in Egypt. The direction of their impact on rice area is expected to be consistent with conventional theory.

Another important variable in this equation is the input price index during the given year (INP_t). This variable is hypothesized to have a negative relationship with area planted to rice, other things being equal.

The Rice Yield Equation

In addition to the area planted to rice, total rice production also depends on yields. To link rice area with its total production requires an equation describing the behavior of yield per feddan. In Egypt, the timing of different crops and the government's area control measures induce certain rigidities in the allocation of land among crops. Under these conditions, the allocation of other inputs and, therefore, the yield response become very important.

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[15] Two models are observationally equivalent if the given specifications of two models are such that the reduced forms of both models are identical. The two models are strictly observationally equivalent if both specifications are just or underidentified (Eckstein 1985).

Yield per feddan is influenced by several factors: the area planted, labor supply, rice variety, fertilizer price index, and time.[16]

A planted area variable is included in the yield equation to investigate the possibility that variations in rice area may be accompanied by an inverse response in rice yield.

Dummy variables (Yabani, GZ159, GZ170, GZ171, GZ172) are incorporated to capture the qualitative impact of rice varieties.

Rural wage rate (RWR_t) and nitrogen fertilizer price ($AMSP_t$) are included in this yield equation and are expected to have a negative impact on rice yield.

The time variable (Time) is included to indicate any technological changes that have not been reflected in the variety variables.

Accordingly, yield of rice per feddan may be specified as shown by equation (2) in Table 11.

The Allocation Decision

After harvest, rice producers face an allocation problem. They must allocate their output between quantities to be delivered to the government under the forced delivery program (FDV) and quantities to be sold in the free market (FMS).

Higher free market prices will result in farmers allocating more quantities of rice to the free market and fewer quantities to the government centers, other things being constant. An increase in the government price for forced deliveries (AGP) will induce farmers to deliver more to the government and less to the free market. In other words, the ratio of these two prices (AGP_t/FMP_t) is an important determinant in the allocation process.

Variations in output obviously affect this decision directly; the larger the output, the larger the following quantities: quantities the government receives, quantities sold in the free market, and quantities consumed at home. Output also influences this choice indirectly through the open market price. In a bad crop year the market price tends to rise, making it more

[16] The exclusion of producer prices from this yield equation is based on previous studies that reported insignificant effects of rice prices on rice yields.

profitable for the producer to sell rice to the private trader. In a good crop year the market price is likely to fall (or rise less), and the resulting improved ratio of government price to market prices (AGP_t/FMP_t) would induce higher sales to the government.

Government policy variables affect the allocation decision. The two-price policy (TWPS) variable is a dummy factor that takes the value of 1 in years (such as 1967 and 1974) when the policy of a two-price scheme is used and 0 otherwise. The impact of this policy is expected to be positive on quantities delivered to the government under forced deliveries (FDV) and negative for quantities allocated to the other outlets. Changes in the rice quota system ($CHQS_t$) are another dummy variable that takes the value of 1 for years after 1970 when rice farmers with two feddans or less were required to participate in the FDV program and 0 otherwise. As a result of this change in the quota system, new participants were included in the program. Thus this variable is expected to have a positive impact on quantities delivered to the government.

Another variable in these equations is the agrarian reform ratio (ARR_t). Farmers in the land reform areas are hypothesized to deliver more rice to the government since they are under a more restricted environment than other farmers.

In 1982 rice farmers encountered unusual weather conditions (heavy rain) in some areas when rice was being delivered. The dummy variable (D82) is included to account for this phenomenon.

Based on this discussion, the rice allocation function is represented by equations (4) and (5) in Table 11.

The Demand for Rice in Rice-Producing Governorates

To specify the demand for rice in rice-producing governorates, the inverse demand function is used, where the free market price (FMP_t) is the dependent variable. The inverse demand function is considered a more realistic representation since rice consumers perceive the rice supply to be quite inelastic. Furthermore, using the inverse demand function with FMP as the dependent variable can be useful in forecasting prices. The free market price of rice (FMP) is hypothesized to depend on a set of variables. One of these is the free market per capita sales (FMS1) and another is per capita subsidized rice distributed by the government to rice-producing governorates (RSR1). It is expected, however, that the government price for quota rice (AGP) will also influence the free market price of rice. The government price is expected to play the role of a floor price in this market. Other variables include per capita personal disposable income and per capita quantities of wheat and potatoes consumed. The demand equation for rice in rice-producing areas is specified in equation (7) in Table 11.

Review of Structural Relations in the Model

The model presented above consists of eight equations and eight endogenous variables. Two of the endogenous variables also occur as lagged variables; namely, area planted to rice lagged one year (PLT^i_{t-1}) and free market price for paddy rice lagged one year (FMP^i_{t-1}). To complete the model, a set of identities is included. Total production (PRO^i_t) is expressed as the product of yield per feddan times planted area. Production is then augmented by the quantities of subsidized rice distributed by the government in the same governorate during the year to give total supply of rice in governorate (i) (TR^i_t). The final equation is the market clearing identity that postulates that total demand for rice in governorate (i) equals total supply of rice in the same governorate in the same year (t).

It is clear that all equations in the model are overidentified and that each has its own implications for choosing the appropriate estimation method.[17]

To complete the specification process, one must add to the previous discussion a description of the structural disturbances design matrix. This subject is discussed in detail in Elminiawy (1987), and Appendix 1 summarizes that discussion.

Model Characteristics

Model specification implies certain characteristics. Furthermore, the characteristics affect the choice of the appropriate estimation method. In fact, many characteristics of the model under study can be identified. The model as specified above is disaggregated, has autoregressive disturbances, and is dynamic.

A simultaneous equations model is considered dynamic when it contains either endogenous or exogenous lagged variables. In this case, a unit change in an exogenous variable at time (t) can lead to delayed as well

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[17] Many econometric texts discuss estimating an overidentified model (see, for example, Theil 1971; Kmenta 1971; and Dhrymes 1970).

as immediate changes in the joint dependent variables of the model. The adjustment process implied by the model is intertemporal rather than instantaneous. The intertemporal effects are easy to visualize when the only lags are those of exogenous variables. A one-unit change in an exogenous variable will result in a "one-shot" change in the joint dependent variables after a delay equal to the length of the lag. But when at least one of the predetermined variables is a lagged endogenous variable (as is the case here), a unit change of an exogenous variable causes changes in the joint dependent variables that continue to reverberate through the system infinitely.

The coexistence of autoregressive disturbances and lagged endogenous variables in this model rules out certain econometric methods and necessitates the use of others.

Nature of the Data Set

Whenever possible, the data used to estimate the model were collected from the Egyptian government's periodicals or unpublished records.[18]

The selection of the 1967-82 time period was based on the following considerations:

1. Total rice area in the rice zone in Egypt was near its peak by 1967, while prior to this year total rice area was varying significantly from year to year. These variations were mostly the result of variations in noneconomic factors; namely, water supply.

2. Many of the records and publications from which data were obtained were only available after 1967; data after 1982 were not available in 1984, when the data were collected.

3. Prior to 1967 some administrative borders changed; hence, the data for some governorates would have had to have been adjusted to take these changes into account if any year prior to 1967 had been included in the study time period.

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[18] A complete description of the data sources and the units of measurement is given in Elminiawy's (1987) Appendix A, Table A-1.

Econometric Methodology

Developing an econometric methodology for these kinds of models (simultaneous equations with autoregressive disturbances and lagged endogenous variables) has been the subject of several studies (Fair 1972; Jorgenson and Brundy 1974; Dhrymes and Taylor 1976).

Hatanaka (1976) and Dhrymes and Taylor (1976) have independently developed consistent and asymptotically efficient procedures (called HDT) for estimating systems of simultaneous equations,[19] which are characterized by both autoregressive disturbances and lagged endogenous variables.

In this study, the number of observations is less than the total number of predetermined variables in the system. This means that what is usually referred to as the problem of undersized sample exists. Therefore, the HDT method had to be modified by introducing the concept of principal components.[20]

The following discussion is devoted to the results of applying this estimation method to the Egyptian rice market.[21]

Estimation Results

Area Planted to Rice

Table 12 presents the results of the estimation of the first equation in the model; namely, area planted to rice in the seven governorates.

The estimates for all coefficients in all governorates are quite good. The signs of all coefficients are consistent with prior expectations, and with very few exceptions the estimated coefficients are large relative to their

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[19] Spencer (1979) was the first to refer to this estimation method as HDT. A complete description of the HDT method is given in Elminiawy (1987). The literature cited there includes Hatanaka (1976), Dhrymes and Taylor (1976), and Fomby, Hill, and Johnson (1984).

[20] For further details, see Elminiawy (1987).

[21] In some cases, the Durbin-Watson statistics fell in the inconclusive area. Therefore, the von Neumann ratio was also reported in all cases. Some difficulties were encountered in the estimation of forced delivery equations, and multicollinearity is perhaps the cause of these difficulties. As a result, different forms of the variable--the ratio of the free market price to the government's price (FMP/AGP)--were used in different governorates.

Table 12--Relationships of the estimated acreage planted in seven governorates of Egypt, 1967-82

Variable	Estimates	Domyat	Elba-hira	Elda-kahlia	Elfayom	Elghar-bia	Elshar-kia	Kafr Elsheikh
Lagged planted acreage	Coefficient	0.2926	0.4206	0.2051	0.4370	0.4013	0.3823	0.4564
	Standard errors	0.1197	0.0964	0.0987	0.1174	0.1161	0.1148	0.1190
	Short-run elasticities	0.2943	0.4224	0.2047	0.4389	0.3945	0.3806	0.4609
Lagged free market price	Coefficient	2.4732	6.1776	6.0497	1.6956	2.2893	7.6856	6.5049
	Standard errors	0.3420	0.8859	1.0094	0.1814	0.5553	1.4346	1.9702
	Short-run elasticities	0.2596	0.1801	0.1158	0.4527	0.1364	0.2415	0.1472
Berseem price	Coefficient	1.6756	2.2112	6.6485	...	4.9702	-10.6450	1.2009
	Standard errors	1.1339	2.7791	3.2577	...	1.9297	6.4398	5.0438
	Short-run elasticities	0.0982	0.0349	0.0704	...	0.1614	-0.0976	0.0152
Lagged potato price	Coefficient	-1.3427	-3.8923	-4.4008	-0.8872	-2.3026	...	-8.5704
	Standard errors	0.7643	1.9260	2.1838	0.3278	1.4745	...	3.4650
	Short-run elasticities	-0.0975	-0.0759	-0.0576	-0.1654	-0.0925	...	-0.1347
Lagged cotton price	Coefficient	-4.9488	...	...	-6.1725	...	-40.0850	...
	Standard errors	2.4388	...	...	1.8428	...	8.6325	...
	Short-run elasticities	-0.2756	...	...	-0.8786	...	-0.6009	...
Constant		36.9330	83.8510	190.0900	23.0590	37.1860	187.4600	121.3700
R^2		0.8861	0.8912	0.7050	0.9032	0.5557	0.7459	0.7119
Durbin-Watson statistic		1.9606	1.7610	2.1134	1.9838	1.6822	1.9616	1.9444
von Neumann ratio		2.1007	1.8868	2.2643	2.1255	1.8024	2.1017	2.0833

Note: The short-run elasticities are calculated at the mean of the respective variables.

Source: The results of computations made using the econometric model of the Egyptian rice market; for a description of the model, see A. Elminiawy, A dynamic autoregressive econometric model of the Egyptian rice market, Ph.D. dissertation, University of California, Davis, Calif., U.S.A. (1987).

asymptotic standard errors. Since only asymptotic standard errors are obtained, a regression coefficient is considered to be statistically significant at the 5 percent level if the absolute value of the asymptotic t-ratio is greater than 2 (1.96).

For the free market price, short-run elasticity coefficients ranged between 0.12 and 0.45 in Elfayom and Eldakahlia governorates, respectively. This indicates that a 10 percent increase in the free market price (lagged one year) would be associated with a 1.2 to 4.5 percent increase in the area planted to rice in these governorates, respectively. Thus Egyptian rice farmers do respond to price incentives.

Cotton competes with rice for production resources. Cross price effects for cotton were found to be statistically significant and negative in the three governorates that included cotton as an explanatory variable. Table 12 shows the highest value of these elasticities (-0.88) to be in the Elfayom governorate. In Domyat and Elsharkia governorates, the rice area elasticities with respect to cotton price were -0.28 and -0.60, respectively.

Potato, which represents summer vegetables, is another important substitute for rice. The elasticities associated with this variable ranged between -0.17 in Elfayom and -0.06 in Eldakahlia. Elasticities of these magnitudes imply that the area planted to rice responds relatively weakly to changes in potato prices.

Berseem was included as an explanatory variable in the area planted to rice equation in six of the seven governorates. It was statistically significant in two of these cases. The sign of this coefficient was positive in all governorates, except Elsharkia, where it was negative. Initially this may seem implausible; however, understanding the role played by this crop in Egyptian agriculture can provide some insights into this complex relationship.

In Egypt, berseem is an important field crop used almost exclusively to feed livestock during the winter. Some berseem is used as hay during the summer. According to the time of harvest, berseem is classified as long- or short-season berseem. Berseem planted before cotton is usually the short-season type that is harvested after only two cuttings. Long-season berseem is one that is kept for three or four cuttings. This berseem complements rice or maize since it conditions the soil. This complementarity turns into competition, however, when a fifth cutting is made. And as livestock prices increase, the practice of taking more and more cuttings becomes more common. This provides a possible explanation for the presence of both negative and positive responses of rice area to the price of berseem. A negative coefficient indicates a competitive relationship between berseem and rice area, which implies that at least five cuttings of berseem have been made. The positive relationship implies that no more than four cuttings have been taken from berseem planted before rice.

Rice Yield

Rice yield relationships are summarized in Table 13. The effects of technological change on rice yield are measured by more than one variable: dummy variables represent changes in rice varieties, and a time trend captures the remaining effects of technological change. With the exception of Elfayom governorate, where no change in rice variety took place during the study period, dummy variables representing rice varieties have many significant effects on rice yields. Rice variety Giza 159, for example, was found to have a positive and statistically significant effect on yields in three governorates--Domyat, Eldakahlia, and Kafr Elsheikh. The adoption of the rice varieties Yabani (Nahda) and Giza 172 has led to higher rice yields in Kafr Elsheikh and Elgharbia, respectively.

Differences in soil characteristics, among other factors, could explain why some rice varieties have a positive impact on yield in one region and a negative effect in another. For example, rice variety Giza 171 has a statistically significant positive effect on yield in Elgharbia and a statistically significant negative effect in Elsharkia.

The positive trend coefficient in Elfayom, Elbahira, and Elsharkia governorates is consistent with the expected relationship between trend and yield.

The estimated coefficients of planted area in the yield equations are negative in most cases (four out of seven). This is expected because planting more land to rice could lead farmers to use marginal land, which would lower rice yields. Furthermore, expanding the rice area would lead to more intense competition with a limited amount of resources such as water and labor. In only two governorates--Kafr Elsheikh and Domyat--was this negative impact of area planted to rice found to be statistically significant. One could argue that this is to be expected given that both governorates are located in the northern part of the delta where the Nile runs into the Mediterranean sea and where water is among the critical factors affecting rice yield.

Table 13--Relationships of the estimated yield in seven governorates of Egypt, 1967-82

Variable	Estimates	Domyat	Elba-hira	Elda-kahlia	Elfayom	Elghar-bia	Elshar-kia	Kafr Elsheikh
Lagged acre-age of rice	Coefficient	-30.6570	5.9264	-0.2331	8.0390	-0.0002	0.1499	-4.2878
	Standard errors	8.4826	3.2771	1.8036	15.8310	0.0042	1.7423	1.4008
	Short-run elasticities	-0.6520	0.4933	-0.0302	0.0905	-0.0080	0.0118	-0.4335
Time	Coefficient	...	73.6900	...	53.4720	...	45.6680	...
	Standard errors	...	16.3140	...	11.5590	...	8.6746	...
	Short-run elasticities	...	63.8220	...	59.7120	...	40.6570	...
Rice variety G159	Coefficient	293.1500	...	177.4100	...	...	...	70.5540
	Standard errors	106.2300	...	34.8770	...	...	...	23.1170
	Short-run elasticities	0.0162	...	0.0394	...	...	...	0.0181
Rice variety Yabani	Coefficient	...	...	...	...	...	...	294.3100
	Standard errors	...	...	...	...	...	...	59.4860
	Short-run elasticities	...	...	...	...	...	...	0.0629
Rice variety G170	Coefficient	...	...	-44.5480	...	...	...	...
	Standard errors	...	...	30.1020	...	...	...	...
	Short-run elasticities	...	...	-0.0041	...	...	...	...
Rice variety G171	Coefficient	...	-94.2960	...	...	0.1399	-200.6000	...
	Standard errors	...	81.2450	...	...	0.0553	72.5650	...
	Short-run elasticities	...	-0.0181	...	...	0.0238	-0.0428	...
Rice variety G171	Coefficient	-31.1800	...	...	...	0.2170	...	...
	Standard errors	63.9320	...	...	...	0.0709	...	...
	Short-run elasticities	-0.0043	...	...	...	0.0123	...	...
Fertilizer price	Coefficient	-11.6540	...	-16.9880	...	...	...	-1000.3000
	Standard errors	7.0510	...	2.9243	...	...	...	875.7100
	Short-run elasticities	-0.0721	...	-0.1181	...	...	...	-0.0597
Labor wage rate	Coefficient	-39.4750	...	...	...	...	...	...
	Standard errors	43.7680	...	...	...	...	...	...
	Short-run elasticities	-0.0414	...	...	...	...	...	...
Intercept		4236.5000	-144380.0	2446.3000	104010.0	2.2892	-87911.0	3302.6
R^2		0.4986	0.6772	0.8860	0.7890	0.6212	0.5766	0.6016
Durbin-Watson statistic		2.2431	2.1187	2.6481	2.0431	1.6103	1.8674	1.6786
von Neumann ratio		2.4033	2.2700	2.8372	2.1890	1.7253	2.0008	1.7986

Note: The short-run elasticities are calculated at the mean of the respective variables.

Source: The results of computations made using the econometric model of the Egyptian rice market; for a description of the model, see A. Elminiawy, A dynamic autoregressive econometric model of the Egyptian rice market, Ph.D. dissertation, University of California, Davis, Calif., U.S.A. (1987).

Only in the Eldakahlia governorate was the coefficient of fertilizer price statistically significant with a negative sign. The highest value for the elasticity of yield with respect to fertilizer price was found in Eldakahlia (-0.12).

Forced Delivery

Table 14 presents the estimated forced delivery relationships for the seven major rice-producing governorates. All coefficients have appropriate signs, and most are statistically significant. In all governorates the delivery of rice to the government varies directly with rice production and with the ratio of government price to free market price. For policy and other variables included in this equation, the signs varied among governorates.

Rice production elasticity coefficients ranged between 0.26 in Kafr Elsheikh and 1.29 in Domyat. This indicates that the quantities of rice delivered to the government are responsive to changes in total rice production.

Farmers in their allocation decisions do respond to economic incentives; namely, relative prices. In four of the seven governorates, the price coefficients were statistically different from 0 at the 10 percent level of significance. In the Elfayom governorate an elasticity coefficient of -0.37 was obtained. Thus a 10 percent increase in the free market price relative to the government price would induce a 3.7 percent decrease in the quantity of rice delivered to the government.

The government price has an elasticity of 0.16 and 0.34 in Elbahira and Domyat governorates, respectively (see Table 14).

In the Elgharbia governorate, the price variable used was the ratio of the government price to the free market price, and this variable has an elasticity coefficient of 0.08.

For Kafr Elsheikh and Elsharkia governorates, the price variables have proper signs and the numerical magnitudes of their elasticities are plausible. Their asymptotic standard errors are too large, however, for the hypothesis that they are not different from 0 at the 10 percent level of significance to be rejected.

The effect of the two-price scheme that was used in some years to encourage farmers to deliver more rice was tested by the inclusion of a dummy variable (TWPS) in the forced delivery equation (for a more detailed

Table 14--Relationships of the estimated forced delivery in seven governorates of Egypt, 1967-82

Variable	Estimates	Domyat	Elba-hira	Elda-kahlia	Elfayom	Elghar-bia	Elshar-kia	Kafr Elsheikh
Government price	Coefficient	4.67	8.25	...	...	...	11.98	13.84
	Standard errors	2.99	4.72	...	...	...	8.75	11.49
	Short-run elasticities	0.34	0.16	...	...	...	0.30	0.26
Free/government price ratio	Coefficient	...	...	...	-5.01	...	...	...
	Standard errors	...	...	...	2.37	...	...	...
	Short-run elasticities	...	...	...	-0.37	...	...	...
Government/ free price ratio	Coefficient	...	...	...	...	1091.50	...	...
	Standard errors	...	...	...	...	737.82	...	...
	Short-run elasticities	...	...	...	...	0.08	...	...
1982 variable	Coefficient	-3.08	...	39.62	4.88	...	...	-1.06
	Standard errors	4.57	...	19.01	2.18	...	...	18.31
	Short-run elasticities	0.00	...	0.01	0.02	...	...	0.00
Two-price system	Coefficient	7.61	-5.65	-28.75	0.15	-9.37	-39.05	-64.61
	Standard errors	4.50	9.26	15.36	1.58	6.04	12.84	18.16
	Short-run elasticities	0.01	0.00	-0.01	0.01	0.01	-0.02	-0.02
Rice production	Coefficient	0.57	0.24	0.30	0.32	0.35	0.18	0.11
	Standard errors	0.14	0.16	0.08	0.16	0.09	0.10	0.08
	Short-run elasticities	1.29	0.49	0.71	0.65	0.70	0.41	0.27
Changes in quota system	Coefficient	...	...	30.09	...	-18.82	8.28	-51.36
	Standard errors	...	...	9.51	...	4.52	13.17	19.42
	Short-run elasticities	...	...	0.10	...	-0.15	0.04	-0.20
Land reform ratio	Coefficient	...	-5.70	...	...	-3.22	...	...
	Standard errors	...	1.36	...	...	0.54	...	...
	Short-run elasticities	...	-0.71	...	...	-0.39	...	...
Time	Coefficient	0.67	...	...	...	...	...	...
	Standard errors	0.27	...	...	...	...	...	...
	Short-run elasticities	24.01	...	...	...	...	...	...
Intercept		-1348.30	223.38	49.18	11.86	85.67	45.66	156.95
R^2		0.60	0.79	0.60	0.28	0.92	0.44	0.79
Durbin-Watson statistic		1.65	1.11	1.33	1.70	2.05	2.18	1.89
von Neumann ratio		1.76	1.19	1.42	1.82	2.20	2.34	2.03

Note: The short-run elasticities are calculated at the mean of the respective variables.

Source: The results of computations made using the econometric model of the Egyptian rice market; for a description of the model, see A. Elminiawy, A dynamic autoregressive econometric model of the Egyptian rice market, Ph.D. dissertation, University of California, Davis, Calif., U.S.A. (1987).

description of this policy variable, see Chapter 3). Contrary to what was expected and to the purpose of that policy, the effect of this variable was negative and statistically significant in three governorates--Kafr Elsheikh, Eldakahlia, and Elsharkia. In Elfayom, Elbahira, and Elgharbia governorates, the TWPS coefficients were also negative, but statistically insignificant. Only in the Domyat governorate was the sign of this policy variable consistent with the expectations. What are some plausible explanations for this unexpected effect of the policy variable TWPS? In most cases, the flexibility coefficients of the government price in the free market price equation show a clear pattern. In the four governorates where TWPS is negative and statistically significant (including Elgharbia where it is almost significant), the flexibility of the free market price compared with the government price ranged between 1.6 and 2.4. In governorates with negative, but insignificant, coefficients the flexibility of the free market price compared with the same variable ranged between 0.4 and 1.0. Farmers apparently see this policy variable (TWPS) as an indication that a certain increase in the government price would lead to a certain increase in the free market price. In areas with high flexibilities in the free market price compared with the government price, the expected percentage increase of the free market price is about twice that of the government price. This leads farmers in these areas to deliver less to the government, not more.

Low flexibility coefficients indicate that a certain increase in government price, which is the result of direct or indirect policy decisions (such as TWPS), would be associated with an equal or smaller increase in the free market price. Therefore, a farmer's decision about how to allocate his rice production between free market and forced delivery may remain unchanged, or he might even choose to deliver more to the government.

The second policy variable included in the forced delivery equation is the dummy variable representing changes in the quota system (CHQS); namely, the change requiring all farmers with two feddans or less to participate in the forced delivery program. This change, which increases the number of farmers required to deliver rice, was expected to have a positive effect on forced delivery. This occurred in only one governorate, Eldakahlia. In two other governorates--Kafr Elsheikh and Elgharbia--the effect of CHQS was negative and significant. One explanation of this unintended effect could be that one would generally expect two different consequences from this change in policy. The first is a direct and positive one: as small farmers join other rice farmers in delivering rice to the government, the participation base widens and the quantities delivered increase. However, requiring small farmers to deliver a certain proportion of their production would mean that they would have to resort to the free market to satisfy part of their need for rice. The resultant increase in demand in the free market coupled with smaller quantities available for sale would push the free market price up. Rice farmers would be encouraged to deliver less to the government and more to the free market. According to this explanation, such a policy change could produce either a positive or a negative effect.

The agrarian reform ratio (ARR) was found to have statistically significant negative effects on forced deliveries in Elbahira and Elgharbia. This contradicts the view that agrarian reform farmers would deliver more rice per feddan than other farmers because they are in a more regulated environment. Consequently, as ARR goes up, so do forced deliveries, other things being constant. The negative effect of ARR on forced deliveries indicates unique problems that prevent agrarian reform farmers from delivering their rice quota at levels equal to those of other farmers. One explanation could be the accounting system of the agrarian reform co-op, but this would require further investigation beyond the scope of this study.

Free Market Sales

Table 15 shows the estimated free market sales relationships for the seven major rice-producing governorates. All coefficients have appropriate signs, most of which are statistically significant. In all governorates the estimated equations support the view that rice sales in the free market vary directly with rice production and inversely with the ratio of government price to free market price. As in the forced delivery equation, policy variables exhibit different signs in the governorates under study.

Rice production elasticity coefficients ranged between 0.68 in Elfayom and 1.70 in Kafr Elsheikh.

The results indicate that the price variable coefficients were statistically different from 0 at the 10 percent level of significance in the three governorates of Elfayom, Elbahira, and Elgharbia. For Kafr Elsheikh, Domyat, and Elsharkia the price variables show proper signs and plausible magnitudes, but they were not statistically significant at the 10 percent level.

The effect of the two-price scheme (TWPS) was positive and statistically significant in most areas, except in Eldakahlia and Domyat, where it was not statistically significant in the free market sales equations.

The dummy variable representing changes in the quota system (CHQS) had a significant effect on free market sales in two governorates--Kafr Elsheikh and Eldakahlia (see Table 15).

Table 15--Relationships of the estimated free market sales in seven governorates of Egypt, 1967-82

Variable	Estimates	Domyat	Elba-hira	Elda-kahlia	Elfayom	Elghar-bia	Elshar-kia	Kafr Elsheikh
Government price	Coefficient	-2.90	-14.73	...	...	...	-8.71	-9.80
	Standard errors	3.29	6.12	...	...	...	13.14	9.24
	Short-run elasticities	-0.17	-0.28	...	...	...	-0.16	-0.12
Free/govern-ment price ratio	Coefficient	...	...	...	4.91	...	...	...
	Standard errors	...	...	...	1.67	...	...	...
	Short-run elasticities	...	...	...	0.35	...	...	...
Government/free price ratio	Coefficient	...	...	...	...	-3454.60	...	...
	Standard errors	...	...	...	...	1336.90	...	...
	Short-run elasticities	...	...	...	...	-0.25	...	...
1982 variable	Coefficient	1.60	...	-53.17	-4.65	...	...	-33.08
	Standard errors	4.99	...	27.41	1.69	...	...	17.20
	Short-run elasticities	0.00	...	-0.01	-0.02	...	...	-0.01
Two-price system	Coefficient	-3.45	40.05	17.42	1.63	21.51	39.80	39.17
	Standard errors	5.05	15.09	21.54	1.10	8.42	19.38	13.65
	Short-run elasticities	0.00	0.01	0.00	0.00	0.01	0.01	0.01
Rice produc-tion	Coefficient	0.49	0.86	0.54	0.34	0.53	0.65	1.01
	Standard errors	0.15	0.23	0.10	0.12	0.16	0.16	0.06
	Short-run elasticities	0.89	1.68	0.92	0.68	1.07	1.15	1.70
Changes in quota system	Coefficient	...	...	-0.70	...	2.98	4.42	86.08
	Standard errors	...	...	0.31	...	7.53	18.26	13.47
	Short-run elasticities	...	...	-0.05	...	0.02	0.02	0.22
Land reform ratio	Coefficient	...	5.12	...	...	4.37	...	...
	Standard errors	...	1.69	...	...	1.05	...	...
	Short-run elasticities	...	0.62	...	...	0.54	...	...
Time	Coefficient	-0.51	...	...	...	...	...	...
	Standard errors	0.29	...	...	...	...	...	...
	Short-run elasticities	-14.74	...	...	...	...	...	...
Intercept		1032.60	223.59	47.78	-0.28	-42.23	-3.40	-266.95
R^2		0.56	0.39	0.63	0.55	0.60	0.58	0.92
Durbin-Watson statistic		2.01	1.28	1.20	1.47	2.31	1.66	1.95
von Neumann ratio		2.16	1.37	1.29	1.57	2.47	1.78	2.09

Note: The short-run elasticities are calculated at the mean of the respective variables.

Source: The results of computations made using the econometric model of the Egyptian rice market; for a description of the model, see A. Elminiawy, A dynamic autoregressive econometric model of the Egyptian rice market, Ph.D. dissertation, University of California, Davis, Calif., U.S.A. (1987).

Regional Market Demand

Table 16 presents the estimated regional market demand for rice in the seven major rice-producing governorates.

In all seven, the free market price varies directly with the government price for rice in a given year (AGP) and inversely with the per capita quantity of rice available for sale in the free market (FMS1). Furthermore, the estimated equations support the view that the free market price varies inversely with the per capita quantity of subsidized rice that the government provides to each governorate (RSR1) and with the per capita wheat consumption in a given year (PCWH).

In only three governorates--Elbahira, Elgharbia, and Elsharkia--did the dummy variable migration have a positive and statistically significant relationship with the free market price of rice. This variable included changes in population and migration of persons going from the Suez Canal to the delta area after the 1967 war and returning in 1975 after the reopening of the Suez Canal. The absence of this dummy variable resulted in different and inferior results in all three of these cases.

Statistically significant flexibility coefficients for the government price of rice (AGP) ranged between 1.0 in Elfayom and 2.4 in Kafr Elsheikh. The free market price is therefore highly responsive to changes in the government price (AGP).

The flexibility coefficients of the free market price of rice (FMP) with respect to the per capita free market sales of rice (FMS1) were statistically significant in five governorates and had magnitudes from -0.9 to -0.5. Elsharkia and Elgharbia were the exceptions.

The per capita quantity of subsidized rice (RSR1) has a statistically significant inverse relationship with the free market price in all regions, except Elgharbia and Elsharkia. The flexibility coefficients of the free market price with respect to this variable ranged from -0.20 to -0.68.

This last finding implies that the distribution of subsidized rice adversely affects rice production by depressing the free market price. This is consistent with the conclusions of previous studies of rural areas in Egypt. For example, Alderman and von Braun (1984) conclude that "the availability of subsidized cereals in farm households decreases grain production," and "if the amount of subsidized cereals acquired by the household increased by 10 percent, grain production dropped by 0.5 percent. These effects of the distribution of subsidized cereals on production turned out to be significant

Table 16--Relationships of the estimated demand in seven governorates of Egypt, 1967-82

Variable	Estimates	Domyat	Elba-hira	Elda-kahlia	Elfayom	Elghar-bia	Elshar-kia	Kafr Elsheikh
Government price	Coefficient	0.1288	0.0359	0.1588	0.0879	0.1468	0.1453	0.0024
	Standard errors	0.0383	0.0237	0.0249	0.0265	0.0298	0.0218	0.0005
	Short-run elasticities	1.4265	0.4093	1.7658	0.9948	1.6297	1.5873	2.3581
Rationed and subsidized price	Coefficient	-0.0058	-0.0157	-0.0129	-0.4100	0.0048	...	-0.0005
	Standard errors	0.0021	0.0061	0.0044	0.0107	0.0067	...	0.0002
	Short-run elasticities	-0.2985	-0.1999	-0.2419	-0.6816	0.1297	...	-0.5264
Free market sales	Coefficient	-1.3475	-3.7137	-2.1314	-14.2870	-1.2976	-0.1583	-0.0164
	Standard errors	0.6757	0.7436	0.5046	7.4856	1.0661	0.3869	0.0094
	Short-run elasticities	-0.4651	-0.8866	-0.7639	-0.6188	-0.1621	-0.0383	-0.9218
Wheat per capita	Coefficient	-0.0027	...	-0.0027	-0.0017	-0.0017	-0.0015	-0.0004
	Standard errors	0.0008	...	0.0005	0.0006	0.0007	0.0007	0.0002
	Short-run elasticities	-0.9241	...	-0.9258	-0.5788	-0.5620	-0.5043	-1.2879
Migration	Coefficient	...	0.1001	...	...	0.1179	0.1048	...
	Standard errors	...	0.0377	...	...	0.0361	0.0343	...
	Short-run elasticities	...	0.1243	...	...	0.1493	0.1335	...
Intercept		0.4588	0.5659	0.4294	0.6866	0.0690	-0.0671	0.0060
R^2		0.8344	0.7886	0.9356	0.9238	0.8528	0.8937	0.9101
Durbin-Watson statistic		1.4533	1.1119	1.7366	1.5362	1.2430	1.3120	1.3012
von Neumann ratio		1.5571	1.1913	1.8606	1.6459	1.3318	1.4057	1.3941

Note: The short-run elasticities are calculated at the mean of the respective variables. The free market price is the dependent variable.

Source: The results of computations made using the econometric model of the Egyptian rice market; for a description of the model, see A. Elminiawy, A dynamic autoregressive econometric model of the Egyptian rice market, Ph.D. dissertation, University of California, Davis, Calif., U.S.A. (1987).

after differences in farm size and the government area allotment for cash crops are accounted for."

Wheat is a substitute for rice in consumption, and the per capita quantity of wheat consumed was a statistically significant variable in the rice demand equation in six governorates, all except Elbahira. The flexibility of the free market price with respect to this variable ranged between -0.5 and -1.3. This indicates that a 10 percent reduction in the quantities of wheat consumed per capita would be associated with an increase in the free market price of rice between 5 and 13 percent.

The issue of reducing wheat subsidies has been of great importance in Egyptian food policy circles in recent years. A large portion of Egyptian wheat is imported, and a large and increasing share of the national budget is spent on subsidizing wheat and wheat products (Alderman, von Braun, and Sakr 1982). It is argued by some economists and supported by some empirical studies that raising wheat prices for consumers would decrease consumption. Shapouri and Soliman (1984) conclude that "freeing wheat prices from 60 LE/ton to the 1981 international price of 150 LE/ton would increase the relative wheat price by 150 percent" and that "such a price increase would decrease per capita wheat consumption in rural areas by about 45 to 75 percent."

A reduction in per capita wheat consumption, which could result from a change in wheat price policy, could thus have a significant impact on the rice market. Alderman and von Braun (1984) state that "a substantial cut in wheat subsidies would induce a rapid increase in rice consumption, even if rice were not subsidized. In one scenario, rice would be a major import crop with about a half million tonnes imported annually. Of course, rice trade may be constrained by government policy. Yet it is evident that under such a policy--restriction of rice imports and reduced wheat price subsidies--rice might end up as a protected subsector in agriculture. . . . Such a further distortion of farm prices would adversely affect resource allocation in agriculture in the long run (for example, land for cotton, the major competing summer crop)." Thus a change in wheat policy could affect different aspects of the rice industry in the same year or the following years and could have significant implications for broader national agricultural policy issues.

Long-Run Elasticities

Table 17 shows the adjustment coefficients and the long-run elasticities for rice area in the seven major governorates for 1967-82. (For a definition of these coefficients, see Table 17.)

Table 17--Long-run elasticities of area planted to rice in the seven major governorates of Egypt, 1967-82

Governorate	Adjustment coefficient[a]	Long-run elasticity[b]			
		Rice	Cotton	Berseem	Potato
Domyat	0.7074	0.3719	-0.3892	0.1390	-0.1378
Elbahira	0.5794	0.3109	...	0.0602	-0.1311
Eldakahlia	0.7949	0.1457	...	0.0885	-0.0725
Elfayom	0.5611	0.8066	-1.5658	...	-0.2947
Elgharbia	0.5987	0.2279	...	0.2696	-0.1545
Elsharkia	0.6194	0.3898	-0.9701	-0.1576	...
Kafr Elsheikh	0.5391	0.2730	...	0.2827	-0.2498

Source: Table 12.

[a] Adjustment coefficient = 1 - coefficient of the one-year lagged dependent variable.

[b] Long-run elasticity (LRE) = long-run elasticity of area planted to rice with respect to the free market price of rice, cotton price, berseem price, or potato price.

LRE = (short-run elasticity / adjustment coefficient).

The results indicate wide regional differences in the adjustment coefficients, which ranged between 0.539 and 0.795 in Kafr Elsheikh and Eldakahlia governorates, respectively.

Long-run elasticities show similar regional differences. The highest value for long-run elasticities of area planted to rice with respect to the free market price is 0.81 in Elfayom governorate, and the lowest is 0.15 in Eldakahlia governorate. For the long-run cross elasticities, cotton shows the strongest competition for rice, with elasticity coefficients between -0.39 and -1.566. Potato followed with elasticity coefficients that ranged between -0.07 in Eldakahlia and -0.30 in Kafr Elsheikh. These wide regional differences in long-run elasticities may be explained by differences in the conditions of production. In Elfayom governorate, for example, only 4.9 percent of the agricultural land was used for producing rice in 1977. As many other crops competed for the land, higher price responsiveness in that region became justifiable. Of the total 609,000 feddans in Eldakahlia governorate in 1977, rice area accounted for as much as 45.5 percent, or 276,800 feddans. For few alternative crops a low price elasticity is expected in this governorate.

Comparing long-run price elasticities of area planted to rice in Egypt with those in different countries shows that the response of Egyptian rice farmers to prices is, in general, elastic (Askari and Cummings 1977).

6. MODEL SIMULATION

This chapter is concerned primarily with verification and applications of the model. Naylor (1971) outlines two general approaches to model verification--verification by forecasting and historical verification.

Verification by forecasting has the disadvantage of requiring either a great length of time before validation can be checked or use of only part of the sample information that is available when estimating the model.

In this study, because of the small sample size, only one observation (1983) was not used in estimating the model, and it will be used to check the model's ability to forecast beyond the sample period.

Historical verification examines how well the set of equations explains historical movements of the model's endogenous variables. One problem with this approach is that it uses the same data from which the model was developed. For examining the consequences of policy choices, however, the historical simulation approach offers several advantages over either an examination of the structural equation properties or an assessment of the derivatives of the model's endogenous variables with respect to predetermined variables. No single structural equation can be used to assess the total effects of changing policy instruments when supply, demand, and prices are determined interdependently. Furthermore, the market model as specified and estimated in Chapter 5 has a dynamic character. The result is that the values of policy instruments specified for any given year have effects in several succeeding years.

This chapter (1) provides an ordered model of the Egyptian rice market, (2) discusses the model's historical and dynamic simulation results, (3) provides forecasts for the endogenous variables in 1983, one period beyond that of the sample, (4) compares actual and simulated values, and (5) shows the model's applications by discussing six simulation experiments.

The Complete Model

The system of equations, when put together in a consistent way, includes 96 equations as well as the identities needed to close the system. Many of these identities are clearly statements that a whole is a sum of its component parts. Egyptian rice production on the national level, for example, is defined as the sum of rice production in all rice-producing governorates in Egypt and is represented by an identity.[22] Several approaches can solve such a system at a given point in time for the values of the predetermined variables. In this case, the Fletcher-Powell algorithm is used (Fletcher and Powell 1963).

Each individual equation has acceptable economic and statistical properties (see Chapter 5). Some problems can develop, however, when one is simulating the behavior of the whole system. In fact, attempts to simulate this model produced unrealistic and unacceptable results for two of the seven governorates, Elfayom and Kafr Elsheikh. The problem in both cases existed in the free market price equation. The real source of the problem, however, was the allocation block in both governorates. Accordingly, the model in these two governorates was respecified to exclude the allocation block. In order to complete the system, a simple assumption about the allocation of paddy rice was made. It was assumed that rice is allocated in these two governorates in the same proportions as it was actually allocated over the 1967-82 period. Modifying the model in this fashion clearly improved the simulation results.

Static and Dynamic Simulation

In a simulation exercise, one could use the actual values of both exogenous and lagged endogenous variables or the generated solution values for the lagged endogenous variables while retaining the actual values of exogenous variables. The former option is generally referred to as a one-period or static simulation and the latter as a dynamic simulation. Both involve solving the model and using the same set of exogenous variables. In the former case, however, lagged variables always assume their actual historical values, while in the latter, they assume the values solved for by the model when they fall within the model-solution period.

As Klein and Young (1980) explain, historical values for the lagged variables are used in a dynamic simulation until the number of solution

[22] For a complete description of the model used in this simulation exercise, see Elminiawy (1987).

periods exceeds the lag period. In the first solution period, all lagged endogenous variables assume their historical values. In the second, lags of one length have the values solved in the first solution period; all variables with lags of two or more periods have historical values. In the third solution, lags of one and two lengths have values from the solution, while greater lags have historical values. In a static simulation, lagged variables always assume historical values.

Quantitative measures used in evaluating both simulation results include the mean square error (MSE), the root mean square error (RMSE), the average absolute percentage error (AAPE), the MSE and RMSE measured in percentages, the number of turning-point errors, the correlation or regression analysis of simulated versus actual values, Theil's (1978) inequality coefficients (U), and many other measures.

U coefficients were calculated for the model during the 1969-82 period. Appendix B (Table 27) shows the results of these calculations for some major variables. In general, the U coefficients are remarkably low for most variables and in most governorates, which indicates high predictive ability. With the exception of the free market price equation and the yield equation for Domyat, the U coefficients of all equations in Appendix B (Table 27) are lower than 0.13.

Post-Sample Simulation

Data were obtained for 1983, one year beyond the sample period, and the model was simulated to cover this year.

The absolute percentage errors were used to assess the overall relationship between simulated and actual values and are reported in Appendix B (Table 28). The absolute percentage error is defined as the absolute values of the deviations between actual and simulated values, divided by the actual values.

The estimates for 1983 are not as accurate as they had been in the sample period. This result is to be expected in any post-sample simulation. With the exception of the equations for Elfayom governorate, the model appears to yield fairly good forecasts of the endogenous variables.

The error in forecasting the free market price for 1983 in Elfayom governorate is considerable (-66.3 percent). Since this governorate plays a relatively minor role in rice production in Egypt (Elfayom governorate produced less than 1.4 percent of total paddy rice produced in Egypt in

1982), the effect of this error on the overall model's predictive ability is almost negligible.

Policy Simulations

One of the most important uses of an econometric model is to evaluate alternative policies. The rice market model is used in this section to estimate the historical impact of some of the policy instruments that have influenced the Egyptian rice economy. To make these estimates, the historical operation of the Egyptian economy is reconstructed as it might have been had the government intervened in a different fashion than it actually did. A variety of alternative historical scenarios is reconstructed, each intended to measure results that might have been realized under a certain policy regime or a combination of regimes. Except for the policy instrument in question, all exogenous variables appearing in the model take on the values actually observed during the 1969-82 period. Then for each simulation experiment, a time series of values other than those actually observed is specified for a selected policy variable or for a specified combination of instruments.

Using hypothetical data for selected policy variables, actual data for all other exogenous variables, and previously calculated solution values for lagged endogenous variables, the model is then used to find solutions for each endogenous variable in each of the 14 years from 1969 through 1982.

Solution values for the endogenous variables calculated under these hypothetical conditions are then compared with solution values computed with the full set of actual historical data on all exogenous variables, including policy variables (dynamic simulation), or what is referred to as the "base run." This basic scenario assumes that the policies described in the previous chapters of this study continue. These comparisons then measure the effects of the policy changes under consideration. This base simulation is a better reference point than actual values for the endogenous variables because it clarifies the systematic impact of hypothesized changes without the confusing effects of stochastic terms.

Using such a long simulation period allows the dynamic effects of initial exogenous changes to work their way through the system. Furthermore, the long simulation period permits exploration of whether or not errors exist in the model.

Before discussing these simulations, several points should be clarified. To simulate the effects of changes in government policies on the Egyptian rice market, this study uses partial equilibrium models, the limitations of which are well known. When the government intervenes in a certain sector, the substitution in production and consumption, or input-output relations, may affect other sectors. Therefore, to analyze the effects of government policy changes, the various indirect effects, including those arising from interactions with other sectors, should be taken into account.[23]

Previous studies can provide some understanding of the interactions between the rice sector and other sectors in Egyptian agriculture.

Using a linear programming model of Egyptian agriculture, von Braun and de Haen (1983) produced a set of scenarios. The results of their study are summarized as follows:

1. Under the assumption of rigid area allotment for cotton, no cross effects may appear, but price increases for rice and wheat reduce maize and berseem production. This is the result of increased cropping intensity and of changes in area allocation. Rice would increase mainly at the expense of maize, the other summer grain.

2. In another scenario, the expansion of rice area leads to a scarcity of water, and because wheat requires about 30 percent less water than berseem, wheat production increases.

3. Assuming that area allotment for all crops, except cotton, is no longer enforced and no quota is required, farmer quota prices are raised to equal domestic open market prices. This leads to increases in the production of wheat and maize and decreases in the production of pulses. Rice area, formerly enforced by area allotment, declines, but the intensity of its cultivation increases, and its production is almost unaffected. Most of the abandoned rice area is taken over by maize.

4. Another scenario uses international prices for all inputs and outputs. None of the crops are procured nor is their area restricted by the government. Under these conditions, production of maize, wheat, and beef decreases considerably. When the livestock market is no longer protected, production of crops for fodder, wheat, and maize also declines. On the other hand, cotton and rice production increases greatly, as does that of berseem.

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[23] Many authors discuss this issue. See, for example, Tolley et al. (1983).

As indicated by the discussion in Chapter 5, the policies dealing with prices, trade, and exchange rates followed by the Egyptian government during the past two decades significantly and negatively affected agricultural production and exports. A combination of low producer prices and government subsidies to maintain low food prices caused agricultural production, investment, and growth to decline.

Reexamining agricultural policies to find ways of maintaining producer incentives in order to increase agricultural production has been discussed in Egypt for some time. And, as explained above, different policy reforms have also been proposed. An optimal policy reform package may be impossible to implement because of social, economic, or political constraints, and as Alderman and von Braun (1984) state, "there is no need to consider [an] all-or-nothing approach to policy reformulation. It is surely possible to improve economic efficiency by modifying only some prices or quotas or both." With this in mind, some policy options are presented and examined in the following sections. Most of these options move toward an environment with less government intervention.

The first option is to eliminate subsidized rice from rice-producing areas. The negative impact of subsidies on rice production is statistically significant in most rice-producing areas (see Chapter 5).

The second option is to eliminate wheat subsidies and allow wheat prices to equal world prices. Previous studies indicate that "a substantial cut in wheat subsidies would lead to higher levels of demand for rice. And rice imports could reach about half a million tonnes annually under these conditions" (Alderman and von Braun 1986). The effect of this proposed change in wheat policy on the rice market is shown by the results of simulation (2).

One major objective of this policy reform process is "maintaining producer incentives," and one way to achieve this could be to keep rice prices constant in real terms. This option is examined in the third scenario.

The fourth simulation combines the three policy changes discussed in the previous three experiments.

The discussion in Chapter 5 provides a clear picture of the water shortage problem facing Egypt. One of the solutions adopted by the Egyptian government has been to reduce the area planted to rice. This leaves only one way to increase rice production: expand the area planted to high-yielding varieties. The impact of introducing these HYVs on major variables in the rice market is examined in the fifth simulation.

The final simulation examines the effects of liberalizing the rice market by eliminating all forms of government intervention. Table 18 summarizes the effects of the alternative policies discussed on rice area, rice production, and gross revenue per feddan for 1982. The fifth simulation is the only one that leads to decreasing the area planted to rice and reducing the gross revenue per feddan of rice in some governorates; it also provides the highest increase in production.

Simulation (1): Elimination of Subsidized Rice Policy

This experiment examines the effect of distributing subsidized rice in rice-producing areas. In this analysis, the per capita quantities of subsidized rice (RSR1) were assumed to be zero every year between 1969 and 1982 in every major rice-producing governorate. Moreover, all government regulations discussed above are unchanged in this case, including the forced delivery of rice in those areas. The estimated effects are shown in Figures 8-10 and in Tables 19-21.

The results of this simulation suggest that total area planted to rice in Egypt would have been about 5.4 percent higher than the base. In other words, the policy of distributing subsidized rice is responsible for a reduction of this magnitude in the area devoted to rice production. Although similar results are observed in most governorates, the effect ranges between 3.4 and 11.7 percent in Eldakahlia and Elfayom governorates, respectively.

This reduction in area planted to rice led, as expected, to a reduction in both rice production and quantities of rice delivered to the government. In the absence of this policy, rice production and forced deliveries would have been 4.0 and 3.3 percent higher than the base simulation, respectively.

This simulation also shows that the gross revenue of rice growers is reduced by the subsidized rice policy.[24] For example, in Elfayom governorate the gross revenue per feddan was about 38 percent above that for the base run. Rice producers in other areas lost less gross revenue as a result

[24] The term gross revenue refers to the total value of rice produced. The quantities of rice delivered to the government are valued using the government price (AGP), while the rest of the production is valued using the free market price (FMP). In all cases prices are in real terms. Gross revenue per feddan is the result of dividing gross revenue by the area planted to rice.

Table 18--Effects of alternative agricultural policies and government interventions on rice area, production, and gross revenue per feddan in Egypt, 1982

	Base (1982)	Simulation 1 No subsidized rice in rice-producing areas	Simulation 2 No subsidized wheat; wheat prices to international level	Simulation 3 Constant real price for rice quota at 1969 level
		(percentage change)		
Area planted to rice, Egypt (1,000 feddans)	1,066.50	+5.4	+5.3	+10.0
Rice production, Egypt (1,000 tonnes)	2,561.20	+4.0	+4.1	+8.8
Gross revenue per feddan, Elbahira (LE/feddan)	104.79	+13.4	0.0	+24.8
Gross revenue per feddan, Eldakahlia (LE/feddan)	87.37	+19.3	+26.9	+57.1
Gross revenue per feddan, Domyat (LE/feddan)	88.87	+14.3	+16.4	+31.9

(continued)

	Base (1982)	Simulation 4 (1),(2), and (3) combined	Simulation 5 HYV with all government regulations	Simulation 6 Liberalization short-term effect
		(percentage change)		
Area planted to rice, Egypt (1,000 feddans)	1,066.50	+21.0	-6.9	+16.4
Rice production, Egypt (1,000 tonnes)	2,561.20	+15.0	+25.8	+15.4
Gross revenue per feddan, Elbahira (LE/feddan)	104.79	+38.5	+1.2	+268.7
Gross revenue per feddan, Eldakahlia (LE/feddan)	87.37	+104.8	-2.8	+228.1
Gross revenue per feddan, Domyat (LE/feddan)	88.87	+37.1	+18.7	+169.7

Source: The results of computations made using the simulation model of the Egyptian rice market; for a description of the model, see A. Elminiawy, A dynamic autoregressive econometric model of the Egyptian rice market, Ph.D. dissertation, University of California, Davis, Calif., U.S.A. (1987).

Figure 8--Rice production in Egypt, 1969-82

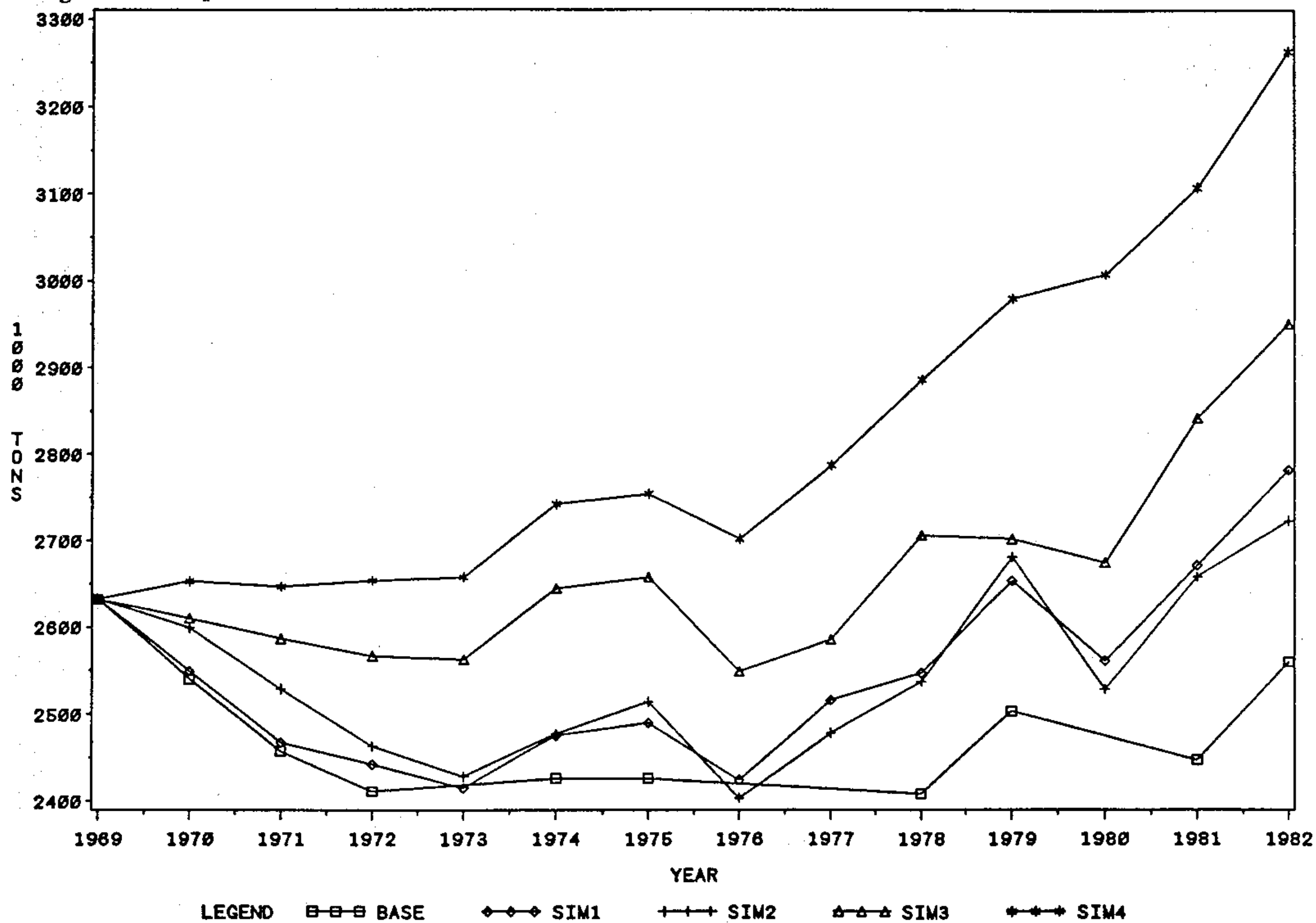

Figure 9--Free market price of rice, Eldakahlia governorate, 1969-82

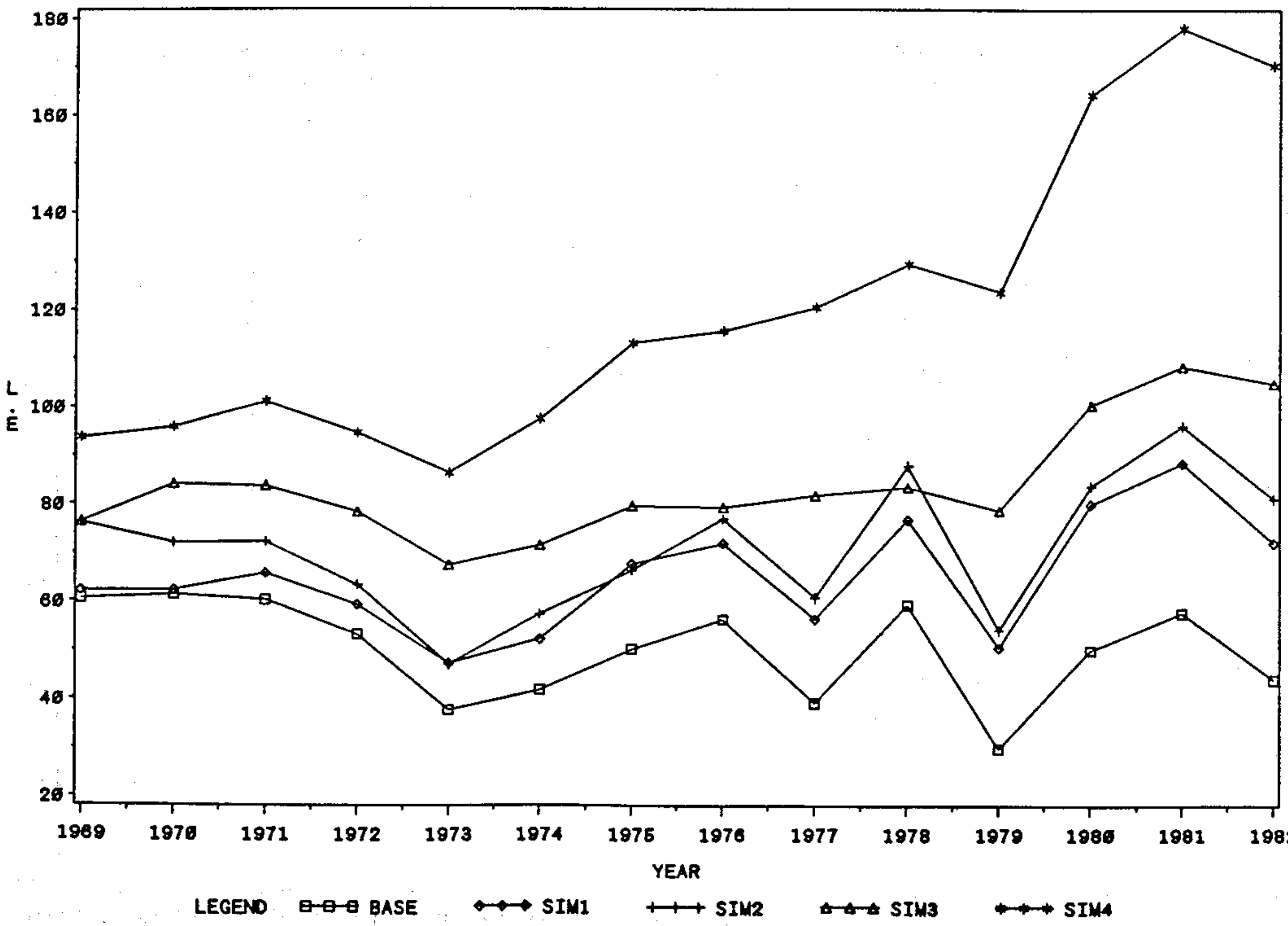

Figure 10--Gross revenue per feddan, Eldakahlia governorate, 1969-82

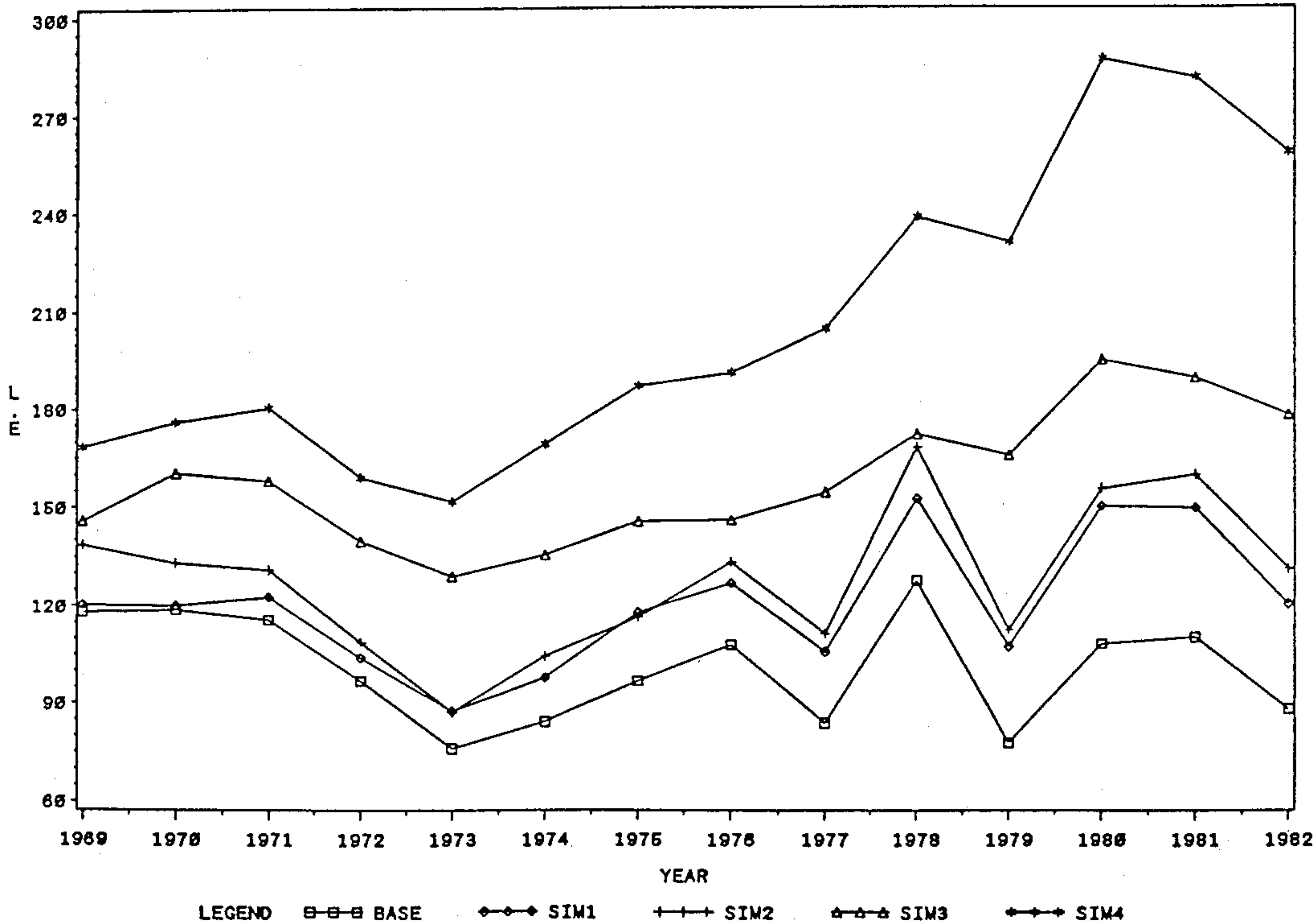

Table 19--Area planted to rice in Egypt, 1969-82

Year	Base	Simulation 1	Simulation 2	Simulation 3	Simulation 4
			(1,000 feddans)		
1969	1,232.792	1,232.792	1,232.792	1,232.792	1,232.792
1970	1,120.280	1,125.132	1,153.174	1,155.344	1,182.838
1971	1,077.206	1,082.710	1,116.841	1,141.878	1,178.734
1972	1,064.788	1,082.128	1,096.361	1,144.307	1,197.915
1973	1,021.604	1,044.133	1,052.330	1,114.473	1,170.358
1974	1,035.625	1,062.434	1,064.299	1,142.284	1,199.568
1975	1,032.283	1,065.517	1,078.956	1,144.251	1,205.217
1976	1,019.873	1,076.866	1,063.224	1,129.581	1,234.013
1977	1,011.249	1,089.158	1,067.024	1,110.358	1,243.733
1978	992.208	1,073.886	1,061.601	1,132.741	1,264.664
1979	1,018.847	1,107.349	1,113.264	1,116.489	1,298.070
1980	983.866	1,087.878	1,069.526	1,131.254	1,340.109
1981	1,025.945	1,159.740	1,141.929	1,219.521	1,439.479
1982	1,066.542	1,212.999	1,170.552	1,260.847	1,532.860
Mean	1,050.222	1,107.337	1,105.848	1,155.437	1,265.740

Table 20--Rice production in Egypt, 1969-82

Year	Base	Simulation 1	Simulation 2	Simulation 3	Simulation 4
			(1,000 tons)		
1969	2,631.544	2,631.544	2,631.544	2,631.544	2,631.544
1970	2,539.789	2,548.939	2,599.042	2,609.610	2,652.654
1971	2,457.065	2,467.320	2,529.376	2,586.967	2,647.262
1972	2,411.281	2,441.530	2,462.831	2,566.672	2,653.501
1973	2,373.068	2,414.860	2,428.272	2,562.828	2,658.266
1974	2,425.503	2,475.480	2,477.123	2,645.385	2,742.491
1975	2,426.102	2,490.100	2,513.652	2,657.575	2,754.132
1976	2,331.039	2,424.260	2,403.413	2,548.671	2,701.983
1977	2,382.347	2,515.739	2,477.581	2,586.172	2,787.365
1978	2,408.153	2,546.786	2,536.502	2,705.531	2,885.689
1979	2,503.236	2,653.803	2,680.614	2,702.355	2,980.304
1980	2,373.229	2,562.480	2,529.105	2,674.631	3,007.927
1981	2,447.151	2,671.545	2,658.922	2,841.778	3,108.270
1982	2,561.188	2,783.021	2,723.645	2,951.600	3,264.062
Mean	2,447.907	2,544.879	2,546.544	2,662.237	2,819.765

Source: The results of computations made using the econometric model of the Egyptian rice market; for a description of the model, see A. Elminiawy, A dynamic autoregressive econometric model of the Egyptian rice market (Ph.D. diss., University of California, Davis, Calif., U.S.A., 1987).

Table 21--Forced delivery in Egypt, 1969-82

Year	Base	Simulation 1	Simulation 2	Simulation 3	Simulation 4
			(1,000 tons)		
1969	1,295.983	1,295.984	1,295.979	1,314.777	1,314.785
1970	1,166.723	1,170.047	1,187.217	1,216.858	1,227.437
1971	1,109.937	1,113.516	1,135.854	1,182.869	1,200.844
1972	1,031.688	1,042.168	1,045.622	1,117.852	1,144.992
1973	1,020.567	1,035.124	1,037.002	1,131.751	1,162.029
1974	949.976	967.659	965.044	1,061.797	1,092.538
1975	1,129.684	1,155.819	1,161.638	1,242.119	1,271.091
1976	1,059.706	1,094.055	1,081.886	1,155.035	1,205.769
1977	1,085.846	1,137.057	1,115.866	1,200.975	1,268.667
1978	1,133.705	1,186.092	1,178.303	1,251.251	1,303.453
1979	1,214.343	1,275.311	1,281.399	1,326.230	1,427.180
1980	1,103.366	1,176.243	1,157.616	1,234.204	1,356.023
1981	1,146.961	1,236.855	1,226.588	1,312.154	1,391.967
1982	1,188.372	1,269.836	1,239.148	1,356.098	1,452.122
Mean	1,116.918	1,153.983	1,150.654	1,221.712	1,272.778

Source: The results of computations made using the econometric model of the Egyptian rice market; for a description of the model, see A. Elminiawy, A dynamic autoregressive econometric model of the Egyptian rice market (Ph.D. diss., University of California, Davis, Calif., U.S.A., 1987).

of this policy. Gross revenues per feddan of rice would be increased by eliminating subsidized rice from areas producing rice. Figure 10 shows the effect of this change in policy on rice growers' gross revenue per feddan in Eldakahlia governorate.

Simulation (2): 40 Percent Reduction in Per Capita Wheat Consumption

The Egyptian government's subsidy policy includes another important grain: wheat. Subsidized wheat is available in rice-producing areas, and Shapouri and Soliman (1984) estimate that raising wheat prices to international levels would reduce the per capita wheat consumption in rural areas about 45-75 percent. In this study, however, it is assumed that increasing wheat prices to their international levels would cause a 40 percent reduction in per capita wheat consumption. In other words, consumers would respond to that increase in wheat prices by lowering their consumption of wheat to 60 percent of the amount actually observed during the simulation period 1969-82. All other aspects of the Egyptian government's policies are left unchanged.

On the national level, the production and delivery effects of this second simulation almost equal those obtained by the first simulation (see Figures 8, 9, and 10). The positive effect of this change in policy on the revenue of rice farmers is obvious in Eldakahlia governorate, where gross revenue per feddan is 28 percent above the base run (see Figure 10). In Elbahira, gross revenue per feddan is the same as under the base run because per capita wheat consumption was excluded from the demand equation. In all other regions, gross revenue per feddan increased by at least 11 percent.

Simulation (3): Constant Real Prices for Rice Quota

This scenario assumes constant real prices for rice quota. In other words, it assumes that the Egyptian government, starting in 1970, increased nominal prices of rice quota (AGP) just enough to keep pace with inflation. All other variables are assumed to remain at their actual levels. Tables 19-21 show the results of this simulation for some major variables on the national level.

The adoption of this policy leads to significant increases in the area planted to rice and in the production and quantities of rice delivered to the government. On the national level, area planted to rice would have been 10 percent higher than the base run. Also, production and forced deliveries were 8.8 and 9.4 percent, respectively, above that for the base simulation. The highest increase in area planted to rice is observed in Elsharkia governorate (19.2 percent), while the highest increase in production and delivery to the government is in Elfayom governorate.

Previous chapters explained the relationship between the government price for rice quota and the free market price. Accordingly, the positive impact of this change in policy on the free market price is to be expected (see Figures 8, 9, and 10). Higher free market prices for rice lead to higher levels of production, which in turn lead to increases in gross revenue per feddan of rice that ranged between 25 and 58 percent above that for the base in Elbahira and Eldakahlia governorates, respectively.

Simulation (4): A Policy Package

The fourth simulation combines the three policy changes discussed in the previous three experiments; that is, (1) subsidized rice is absent in rice-producing areas; (2) wheat prices are set at the international levels, and consequently wheat consumption per capita drops to 60 percent of the values actually observed; and (3) government price for rice quota (AGP) is adjusted annually to keep up with inflation (fixed in real terms at 1969 levels).

The results of this simulation, which are shown in Tables 19-21, suggest that implementing all these changes at the same time would have caused substantial increases in almost all major variables. Comparing the results to those obtained under the previous three simulations indicates that this combination of policies provides the greatest increases in area planted to rice, rice production, and quantities of rice delivered to the government (21, 15, and 14 percent, respectively).

In all governorates, producers have more gross revenue per feddan than in the base run. This conclusion is also valid when the increases under this policy are compared with those under any of the other three alone, except in Elgharbia governorate.

One common feature of all the simulation experiments discussed thus far is that they use the same simulation model in its original form and only change exogenous variables.

In this section, two additional experiments are presented with some important changes to the model. The first examines the impact of adopting high-yielding varieties; in this case, Filipino rice. The final experiment examines the impact on the Egyptian rice market of adopting a policy of total liberalization.

Simulation (5): The Adoption of High-Yielding Varieties

In order to examine the impact of introducing Filipino rice, the yield per feddan is fixed at the 1982 average yield of Filipino rice reported in each governorate. Consequently, the yield function is deleted from the simulation model (yield is assumed to be exogenous in this case). The results are shown in Table 22.

In the first year, 1980, production of rice in Egypt increased about 35 percent above the base level. This increase is mainly the result of higher yields, since area planted to rice remained the same as its base run value. However, as production increased on the same amount of land, the price of

Table 22--Impact of introducing high-yielding varieties of rice on selected variables, 1980-82

Variable	Simulation	1980	1981	1982
Area planted to rice, Egypt	Base	981.23	1,033.95	1,068.89
(1,000 feddans)	Simulation 5	981.23	970.38	995.67
	Percentage	0.00	-6.15	-6.85
Rice production, Egypt	Base	2,365.05	2,476.68	2,567.05
(1,000 feddans)	Simulation 5	3,182.68	3,155.49	3,230.57
	Percentage	+34.60	+27.40	+25.80
Free market price	Base	55.99	42.79	38.24
Elbahira governorate	Simulation 5	34.02	38.16	33.46
(LE/ton)	Percentage	-9.00	+4.80	+1.20
Free market price	Base	45.27	58.85	43.75
Eldakahlia governorate	Simulation 5	22.41	34.61	20.74
(LE/ton)	Percentage	-50.50	-41.20	-52.60
Gross revenue per feddan	Base	100.66	111.59	87.37
Eldakahlia governorate	Simulation 5	88.00	113.12	84.89
(LE/ton)	Percentage	-12.60	+1.40	-2.80
Free market price	Base	57.25	61.66	41.07
Domyat governorate	Simulation 5	52.83	54.84	34.52
(LE/ton)	Percentage	-7.70	-11.10	-15.90
Gross revenue per feddan	Base	123.91	120.71	88.87
Domyat governorate	Simulation 5	137.25	142.19	105.51
(LE/ton)	Percentage	+10.80	+17.80	+18.70

rice had to decline to absorb the additional output.[25] In Elbahira governorate, for example, the free market price of rice decreased about 39 percent the first year. In the following years, these price declines discouraged rice production so that output did not increase as much as it would have if the downward price movement had not been induced. In the second year, area planted to rice declined about 6.2 percent, while production increased only 27.4 percent.

[25] All government regulations discussed above are unchanged in this case, including the restrictions on intergovernorate movement.

Area reduction continued in the third year, and the production percentage change is 25.8 percent above the base run.

In most cases, rice producers receive greater gross revenues per feddan since the production increase is much larger than the price decline. In Domyat governorate, gross revenue per feddan of rice is about 11, 18, and 19 percent above the base levels in 1980, 1981, and 1982, respectively. This is in contrast to frequent speculations that output would increase only slightly or even decline in response to the decrease in prices.[26]

However, the results obtained here would have been more encouraging if the Egyptian government had abolished its policy of restricting rice transportation. Without restrictions on moving rice from rice-producing (surplus) to rice-consuming (shortage) areas, the negative effects of introducing HYV of rice on the free market price would have been much smaller, and increases in rice output and farmers' gross revenue per feddan would have been greater than they were under this simulation.

Simulation (6): Liberalization of the Egyptian Rice Market

The liberalization of the Egyptian rice market is assumed to produce an environment in which there would be no farm price control by the government, no area control, no crop procurement quotas, no restrictions on rice transportation by private traders, and no government constraints on private sector processing and marketing of rice, including foreign trade activities. Under these conditions, one price of rice (the free market price) would prevail that would equal the international price (the border price equivalent at the farmgate).

Assuming that the liberalization package would also include management of the exchange rate to assure parity of the local currency's purchasing power with that of Egypt's major trading partners, the border price equivalent at the farmgate is corrected for the overvaluation of the currency.

In order to examine the impact of adopting this liberalization package on the Egyptian rice market, it was assumed that these changes had taken place in 1981. Therefore, the price used by rice farmers as a proxy for their 1982 rice price expectations was the 1981 border price equivalent at the farm gate deflated by the wholesale price index (WPI 1975 = 100), or about LE 132.29 per ton. The results of this simulation for 1982 are shown in Table 23.

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[26] For a discussion of this issue, see Behrman and Murty (1985).

Table 23--Impact of total liberalization of the Egyptian rice market on selected variables, 1982

Region	Simulation	Area	Production	Gross revenue/ feddan
		(1,000 feddans)	(1,000 tons)	(LE/feddan)
Domyat	Base	53.776	122.297	88.790
	Simulation 6	68.914	124.735	239.428
	Percentage change	28.150	1.994	169.656
Elbahira	Base	177.997	502.442	104.590
	Simulation 6	225.553	657.690	385.625
	Percentage change	26.717	30.899	268.702
Eldakahlia	Base	286.171	625.796	87.790
	Simulation 6	325.951	709.758	288.062
	Percentage change	13.900	13.417	228.126
Elfayom	Base	18.552	39.342	80.350
	Simulation 6	30.479	67.557	293.222
	Percentage change	64.290	71.720	264.931
Elgharbia	Base	103.355	271.359	129.270
	Simulation 6	110.994	291.237	347.116
	Percentage change	7.391	7.325	168.520
Elsharkia	Base	182.548	443.546	97.970
	Simulation 6	217.669	515.820	313.494
	Percentage change	19.239	16.295	219.990
Kafr Elsheikh	Base	228.446	522.821	79.490
	Simulation 6	261.633	588.935	297.824
	Percentage change	14.528	12.646	274.669
Total	Base	1066.542	2561.188	93.207
	Simulation 6	1241.193	2955.733	315.017
	Percentage change	16.375	15.405	237.976

The total area planted to rice in Egypt would have been about 16.4 percent higher than the base under this simulation. While similar results are observed in most governorates, the effect ranges between 7.4 and 64.3 percent in Elgharbia and Elfayom governorates, respectively.

Rice production in Egypt would have been about 15.4 percent higher than the base run. The most significant result of this simulation, however, is its effect on rice farmers' gross revenue per feddan. In all regions producers have more gross revenue per feddan than in the base run. In Kafr Elsheikh governorate, the gross revenue per feddan is about 275 percent above that in the base run.

The process of liberalization of the Egyptian rice market, or any other market for that matter, will involve more than the simple assumptions listed above. This change in the rice market will affect the markets of substitute commodities (either in consumption or in production). At the same time, the results of this change in the rice market will be determined, to some degree, by the nature and response of other markets.

Moreover, this simulation model depends on parameter estimates that were obtained using data for a time period during which the rice market was under government control. As one might expect, as this environment changes, so will the parameters.

APPENDIX 1:

THE PROPOSED STRUCTURAL DISTURBANCES DESIGN MATRIX

Autoregressive Disturbance Process

The assumption of serial independence over time of the structural disturbances is usually postulated in most simultaneous equation models, whether dynamic or not. In the present study, however, this assumption is relaxed to allow autocorrelated disturbances. For the purpose of this discussion consider the following simultaneous equations model:[27]

$$Y\Gamma + X\Delta + Y_{-1} H + E = 0 \qquad (2)$$

with disturbance specification

$$E = E_{-1} R + U , \qquad (3)$$

where $Eu'_t = 0$, $E\, u'_t u_t = \Sigma$ and $E\, u_s u_t = 0$ for $s \neq t$. To ensure that this model is dynamically stable, it is assumed that all the roots of $\det(\Gamma - Hx) = 0$ and $\det(I - Rx) = 0$ are outside the unit circle. The system of equations (2) and (3) represents a dynamic simultaneous equations model with a vector autoregressive disturbance process.

Up to this point the discussion has mainly described the subsystem for one market or one governorate. However, the whole system is composed of blocks representing one governorate each and has a dynamic non-integrated structure; that is, the structural equations in any one block do not involve current nor lagged endogenous variables from any other block or governorate. Furthermore, the autocorrelation matrix (R) is assumed to be diagonal. Thus the only stochastic specification still to be discussed is the contemporaneous correlation aspects of the model.

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[27] The discussion in this section basically follows that of Fomby, Hill, and Johnson (1984).

Contemporaneous Correlations

If the variance-covariance matrix of the structural disturbances Σ is not block diagonal, then these blocks only seem to be unrelated. In this case more efficient estimators can be obtained by considering the seven 5-equation governorate subsystems as a 35-equation simultaneous system.[28]

However, difficulties exist with this overall estimator. The overall system includes 35 behavioral equations to be estimated, but the data only consist of 16 observations. Under similar conditions, Theil (1971, 529) explains the problem as follows: "The matrix Σ consisting of mean squares and products of 2SLS residuals, which is used as an estimator of Σ is singular when $L > n$ (L = the total number of structural equations and n = the number of observations), so that 3SLS estimators fail to exist. This will happen when the model is large and the sample is not."

Therefore, any proposed structure should be able to produce a nonsingular estimate of Σ for the overall estimator of the whole system to exist. To attain this goal, several sets of covariance constraints could be imposed on this Σ matrix. For example, some particular covariances can be constrained to zero. In fact, some *a priori* information that can justify at least one set of these desired constraints.

The Covariance Structure

It is possible to assume that all covariances between equations equal zero, except in the case of similar equations. For example, the disturbances of the planted area equation are assumed to be contemporaneously correlated only with those in other governorates. A similar restriction is imposed on all other equations.

Thus the covariance matrix Σ for the whole system can be arranged to be block diagonal, with five blocks corresponding to the five behavioral equations. As Figure 11 shows, the dimensions of each block are the number of governorates included in this study (7 x 7). Equation (4) represents this covariance structure as follows:

$$E\, u_{ijT}\, u_{i\tau T} = \begin{cases} \sigma_{j\tau} & j,\tau = 1,2,\ldots,N \\ 0 & \text{otherwise} \end{cases} \qquad (4)$$

[28] Each subsystem includes eight equations, only five of which are behavioral relationships.

Figure 11--The proposed covariance structure

$$\begin{bmatrix} \underset{N \times N}{\Sigma^1} & & & & 0 \\ & \underset{N \times N}{\Sigma^2} & & & \\ & & \underset{N \times N}{\Sigma^3} & & \\ & & & \underset{N \times N}{\Sigma^4} & \\ 0 & & & & \underset{N \times N}{\Sigma^5} \end{bmatrix}$$

GN x GN

N = number of governorates, G = number of equations
(5 sets of 7 x 7 disturbances)

where i = the equation,
j = the region or governorate, and
T = time.

The rationale for this structure is as follows: similar equations in all rice markets represent activities that are taking place within the same time period and are influenced by similar factors. It also seems reasonable to assume that omitted variables influencing these activities are missing from the other equations that describe the same activity.

APPENDIX 2

SUPPLEMENTAL TABLES

Table 24--Per capita consumption of paddy rice in Egypt, 1967-87

Year	Per capita consumption
	(kilograms)
1967	53.3
1968	58.3
1969	49.5
1970	52.5
1971	53.8
1972	54.0
1973	51.0
1974	53.3
1975	56.9
1976	52.4
1977	48.7
1978	50.4
1979	52.8
1980	47.8
1981	44.9
1982	49.2
1983	48.4
1984	44.4
1985	44.0
1986	46.0
1987	43.6

Source: J. Parker, *Market fundamentals, Egypt: Rice* (Washington, D.C.: U.S. Department of Agriculture, 1988).

Table 25--Total production and quantities of paddy rice delivered to the Egyptian government, 1967-87

Year	Production	Forced deliveries	Percent
	........................(1,000 tons)........................		
1967	2,276	1,156	50.8
1968	2,583	1,322	51.2
1969	2,557	1,342	52.5
1970	2,603	1,154	44.3
1971	2,536	1,068	42.1
1972	2,512	1,021	40.6
1973	2,271	925	40.7
1974	2,239	866	38.7
1975	2,428	1,166	48.0
1976	2,300	1,086	47.2
1977	2,272	1,054	46.4
1978	2,358	1,108	46.9
1979	2,517	1,312	52.2
1980	2,392	1,134	47.4
1981	2,244	1,111	49.5
1982	2,450	1,139	46.5
1983	2,440	1,122	45.8
1984	2,235	961	42.8
1985	2,310	n.a.	n.a.
1986	2,444	n.a.	n.a.
1987	2,331	n.a.	n.a.

Source: Arab Republic of Egypt, *Marketing policies for some agricultural crops and their economic impacts,* Working paper 40 (Cairo: Institute of National Planning, 1988).

Table 26--Calculation of the price of rice corrected for overvaluation of the exchange rate, 1967-87

Year	(1) Marketing costs	(2) Processing costs	(3) Average Export Unit Value	(4) Average Export Unit Value	(5) Relative Foreign Exchange Bias	(6) Foreign Exchange Bias (5 x4)	(7) Border Price[a]
			($/ton)	(LE/ton)		(LE/ton)	(LE/ton)
1967	8.2	2.0	157.5	68.51	0.982	67.267	125.567
1968	8.1	2.0	181.4	78.91	0.916	72.272	141.072
1969	8.4	2.2	164.6	71.60	1.090	78.044	139.044
1970	8.7	2.1	120.2	52.29	1.110	58.053	99.553
1971	9.0	2.1	109.7	47.72	0.916	43.693	80.293
1972	9.1	2.0	111.2	48.37	0.854	41.334	78.634
1973	9.5	2.0	221.5	86.39	0.729	62.990	137.890
1974	10.6	3.1	745.6	290.78	0.630	183.204	460.304
1975	11.6	3.2	601.0	234.39	0.815	191.036	410.636
1976	12.8	4.1	374.9	146.21	0.896	130.995	260.295
1977	14.4	4.2	267.7	104.40	0.841	87.800	173.600
1978	16.0	3.8	350.3	136.62	0.841	114.880	231.680
1979	17.6	4.7	331.6	231.79	0.075	17.385	226.685
1980	21.6	9.4	359.2	251.11	0.172	43.189	263.289
1981	23.2	10.3	441.9	308.89	0.444	137.152	412.552
1982	26.1	11.6	473.9	331.26	0.607	201.099	494.699
1983	30.3	8.8	338.1	236.33	0.644	152.177	349.377
1984	40.4	10.8	316.9	221.51	0.788	174.542	344.842
1985	41.3	11.4	317.7	222.10	1.200	266.520	435.920
1986	50.7	13.5	298.9	208.90	1.698	354.712	499.412
1987	60.7	16.2	380.9	266.25	2.043	544.051	733.451

Sources: (1) and (2) are from the Arab Republic of Egypt, *Actual production and processing report* (Cairo: Ministry of Supply and Home Trade, 1983).
(3) is from J. Parker, *Market fundamentals, Egypt: Rice* (Washington, D.C.: U.S. Department of Agriculture, 1988).
(4) For the official exchange rate, see Table 10.

[a] The border price is corrected for the overvaluation of the exchange rate.

Table 27--Simulations of the Egyptian rice market, 1969-82

Variable/governorate	Theil's inequality coefficients (U) Static simulation	Dynamic simulation
Planted area		
Domyat	0.040	0.055
Elbahira	0.032	0.023
Eldakahlia	0.031	0.032
Elfayom	0.053	0.092
Elgharbia	0.045	0.051
Elsharkia	0.049	0.054
Kafr Elsheikh	0.052	0.059
Yield per feddan		
Domyat	0.045	0.451
Elbahira	0.060	0.075
Eldakahlia	0.026	0.031
Elfayom	0.054	0.053
Elgharbia	0.044	0.045
Elsharkia	0.041	0.041
Kafr Elsheikh	0.031	0.037
Forced delivery		
Domyat	0.079	0.077
Elbahira	0.041	0.046
Eldakahlia	0.078	0.080
Elfayom	0.074	0.115
Elgharbia	0.063	0.069
Elsharkia	0.099	0.099
Kafr Elsheikh	0.054	0.057
Free market price		
Domyat	0.174	0.178
Elbahira	0.167	0.162
Eldakahlia	0.155	0.170
Elfayom	0.137	0.173
Elgharbia	0.428	0.330
Elsharkia	0.155	0.164
Kafr Elsheikh	0.193	0.207

Table 28--Post-sample simulations of the Egyptian rice market, selected variables

Variable/governorate	1983 actual values	Percentage errors
Area planted (1,000 tons)		
Domyat	52.510	4.7
Elbahira	175.781	7.2
Eldakahlia	278.501	3.0
Elfayom	15.414	47.4
Elgharbia	95.381	1.1
Elsharkia	171.307	1.1
Kafr Elsheikh	212.908	9.3
Yield (ton/feddan)		
Domyat	2.444	-7.8
Elbahira	2.736	6.9
Eldakahlia	2.137	4.2
Elfayom	2.241	-1.4
Elgharbia	2.815	-6.6
Elsharkia	2.506	-1.1
Kafr Elsheikh	2.270	-4.8
Forced delivery (1,000 tons)		
Domyat	59.375	-4.9
Elbahira	238.512	-2.7
Eldakahlia	291.401	-6.3
Elfayom	14.598	82.1
Elgharbia	127.595	-5.9
Elsharkia	177.330	-5.1
Kafr Elsheikh	234.784	4.0
Free market price (LE/ton)		
Domyat	39.430	-16.7
Elbahira	39.510	-9.6
Eldakahlia	39.430	-31.9
Elfayom	39.430	-66.3
Elgharbia	41.010	0.1
Elsharkia	39.430	-16.5
Kafr Elsheikh	46.690	-14.6

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