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Economic reform and aggregate cropping patterns for Egypt

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Abstract

Beginning in the early 1980s, the government of Egypt embarked on an aggressive initiative to progressively change its centrally planned economy to a system more dependent on domestic and international markets. The agriculture and food sectors have taken the lead in the economic reforms. This paper investigates changes in Egyptian cropping patterns as an indicator of the 'success' of the transition toward a more market-oriented economy. First, trends in cultivated area and gross margins during the economic reforms are described. Responses of cropping patterns to changes in gross margins are then evaluated. A random effect distributed lag model with pooled cross-sectional time-series methods is used to examine the relationship for individual crops. Canonical correlation analysis provides a more general assessment of responsiveness of the overall cropping pattern. © 1997 Elsevier Science B.V.

1. Introduction

Beginning in the early 1980s, the government of Egypt embarked on an aggressive initiative to progressively change its centrally planned economy to a system more dependent on domestic and international markets. The agriculture and food sectors have taken the lead in the economic reforms. Important measures gradually adapted include: eliminating government crop procurement, eliminating farm input subsidies, reducing food subsidies by freeing domestic prices, limiting agricultural administrative controls, reducing tariffs and other protection measures, and modifying the agricultural credit system.

The general rationale articulated for the reform was that a more market-oriented economy with associated input and output price signals should spur local areas to grow crops in which they posses a comparative advantage. The relatively less profitable crops, previously grown through government control, should be replaced by more profitable crops reflecting market forces and local environmental conditions. The improved allocation of resources should increase efficiency, production, and growth in the agricultural sector.

Egypt, however, has not fully experienced the expected benefits from the reforms. Only modest growth rates occurred in the agricultural sector during the 1980s (World Bank, 1993). Also, selected studies of the transition indicate that further changes could increase the impact of the economic reforms. For example, wider adoption of improved technologies and additional changes in cropping patterns could increase yields and agricultural value added (World Bank, 1993). The impact of the economic reforms has been positive, but even the leaders of the

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transition have indicated, much remains to be done if the Egyptian agricultural sector is to reach its potential. (Wally, 1996).

There are many possible explanations for the positive but less than expected outcomes from the reforms. First, the Egyptian agricultural asset market remains fettered. Inefficient farmers cannot liquidate their assets (mainly land) and be replaced by more efficient farmers. Second, there is a lack of an agricultural extension service in Egypt that can aid the decision making of farmers in the newly created market environment. Third, subsistence farmers may find that changing cropping patterns and practices to be very risky. Fourth, changes in local cropping patterns may have implications for processing operations (lower local income and employment). Many Egyptian processing facilities are largely state owned and the responsibility of the local administration. Administrators have incentives to insulate the local economy from the negative impacts of the reforms. For these and other reasons, aggregate cropping patterns responded more slowly to the market signals.

Economic implications of the formal centrally planned system for Egyptian agriculture are well documented (de Janvry et al., 1983; Levy, 1983; Antle and Aitah, 1983; Abdou et al., 1986; Monke et al., 1987). Research on the implications of the gradual reform for Egyptian agriculture has been more limited (Fletcher, 1996; Ministry of Agriculture and Land Reclamation, 1995). This paper investigates changes in cropping patterns as an indicator of the 'success' of the transition toward a more market-oriented economy. If the economy was, in fact, distorted as suggested by the available research, the reforms should have led to different cropping patterns. First, trends in cultivated area and gross margins during the economic reforms are described. Response of cropping patterns to changes in gross margins are then evaluated. Individual crop responses and the overall response of cultivated area are then more systematically and statistically tested. A random effect distributed lag model with pooled cross-sectional time-series methods is used to examine the relationship for individual crops. Canonical correlation analysis provides a more general assessment of responsiveness of the overall cropping pattern. Implications and conclusions on the reforms are then reviewed.

2. Cropping pattern and gross margin trends

The analysis uses yearly data on cultivated area, yield, farm price, and production cost for 17 major crops. Gross margins, defined as gross farmer receipts less production expenses, are calculated for

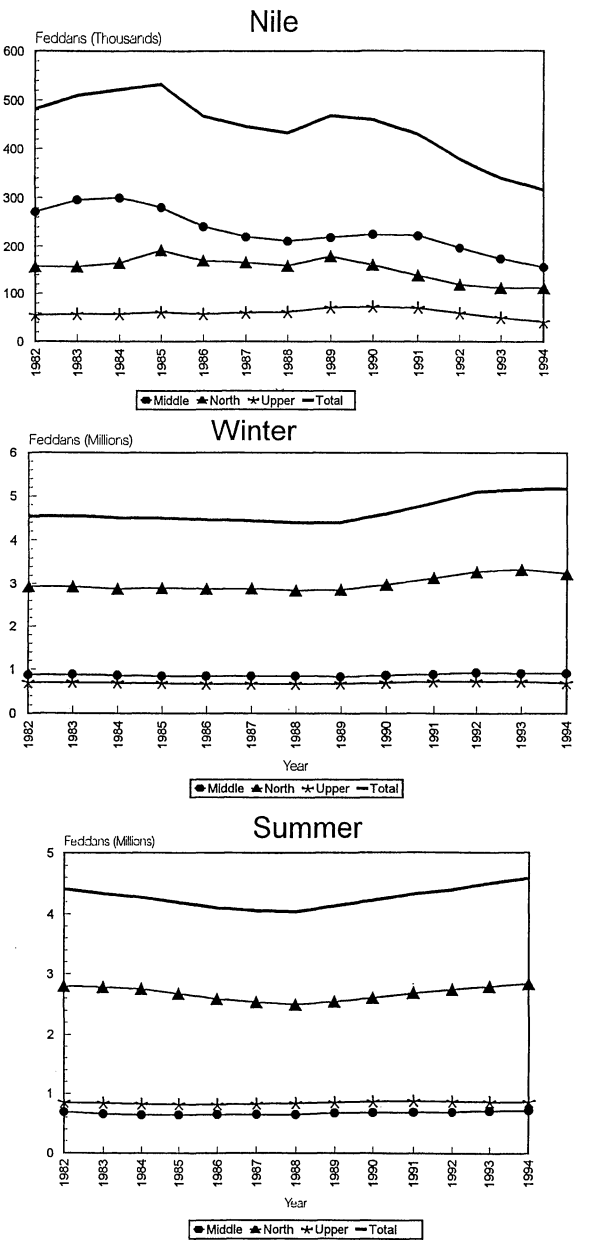

Fig. 1. Total cultivated area—3-yr moving average.

each crop. Eight are summer crops, one is a Nile or fall crop, and eight are winter crops. The analysis is for various levels of aggregation; national, regional, and governorate levels. The three regions are Middle, North, and Upper Egypt. Each region includes local areas called governorates; four in Middle Egypt, nine in North Egypt, and four in Upper Egypt. The 15 years (1980–1994) of data cover the period of the gradual reform.

2.1. Cultivated area

Fig. 1 shows a three-year moving average of the total cultivated area for major crops in each region during the three growing seasons. The summer and winter seasons have a much larger role in crop production than the Nile season, which is mainly for fruits and vegetables. An increase in land for orchards caused the declining trend in cultivated area for major crops during the Nile season. In 1983, there were 404,000 feddans of orchard lands with major cropland at 808,000 feddans. By 1994, the orchard cropland was about one-third larger than major cropland, 941,000 feddans to 570,000 feddans.

The total cultivated area trend for the winter and summer crops during the 1980s was nearly constant. Land reclamation is the main reason for the slight upward trend in cultivated area during the 1990s. The Egyptian land reclamation strategy for 1992–1997 is increasing agricultural land by 872,000 feddans (Khedr et al., 1996). The majority of the land reclamation has occurred in North Egypt as indicated by the upward trend in cultivated area for the summer and winter crops. For example, in 1994, 88% of the 363,000 feddans of reclaimed land producing major crops was in North Egypt, while 11% was in Upper Egypt and one percent in Middle Egypt.

Figs. 2 and 3 present the trends in cultivated area for six major crops; wheat, bean, summer maize, sugar cane, cotton, and rice. The trends during the

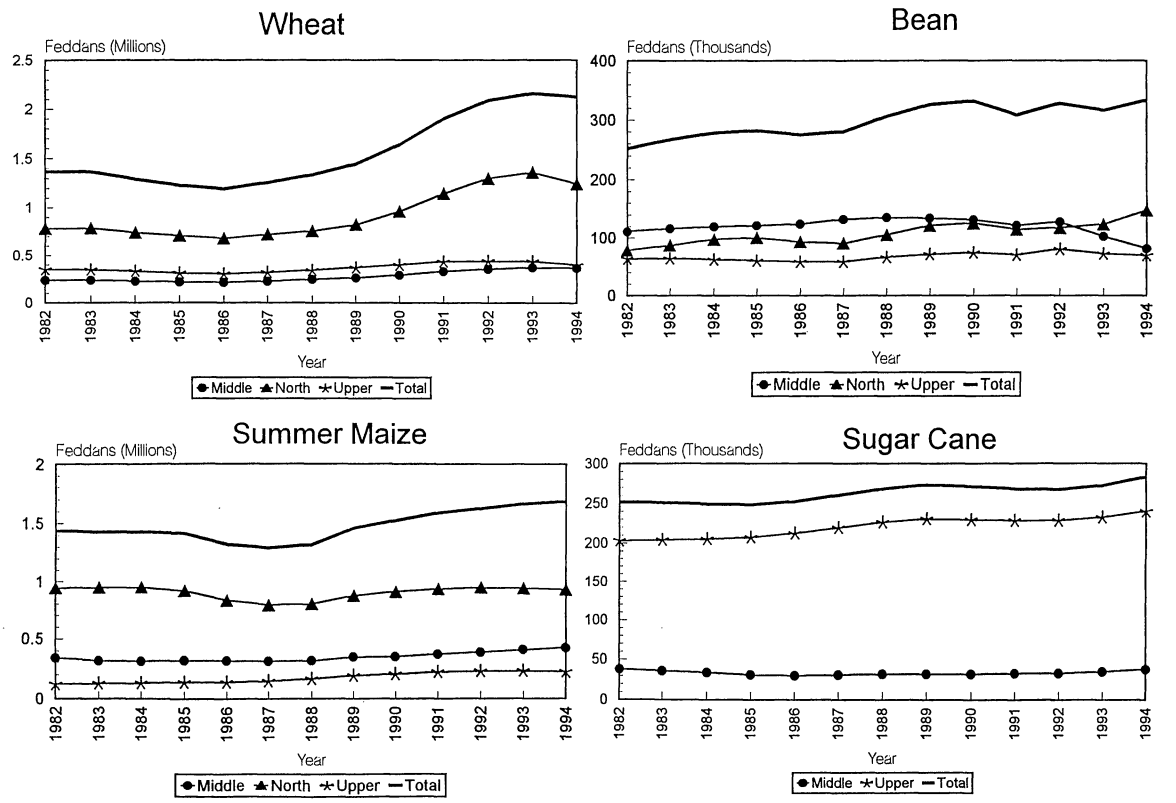

Fig. 2. Crop cultivated area—3-yr moving average.

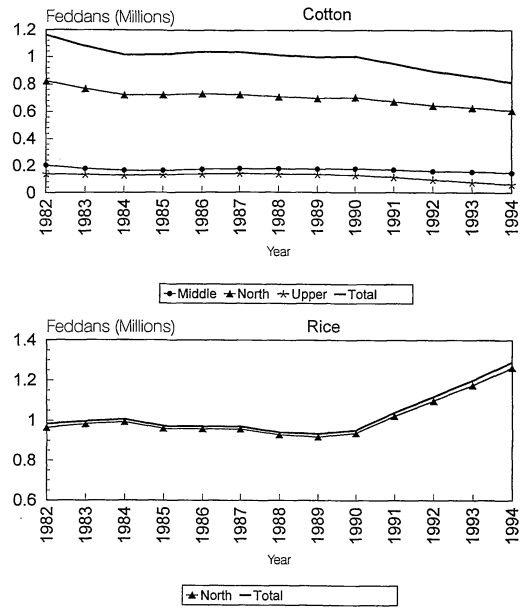

Fig. 3. Crop cultivated area - 3 year moving average.

beginning of the reforms were relatively constant for each crop. The cultivated area for wheat began to increase slightly in 1986. During the 1990s, land reclamation and development programs significantly increased the cultivated area in wheat. By 1988, these projects had brought slightly less than 15,000 feddans into wheat production. However, by 1994, these projects had increased the cultivated area in wheat by slightly more than 342,000 feddans, with the majority in North Egypt. Summer maize, bean, and sugar cane have very slight increasing trends in cultivated area. In 1994, land reclamation added 69,000 feddans of summer maize, 50,000 feddans of beans, and only 4,000 feddans of sugar cane.

Fig. 3 shows the cultivated area for cotton and rice. Cotton is one of the few main crops with a decreasing trend in cultivated area. A combination of an overvalued exchange rate and subsidies to domestic mills associated with low farm-gate prices kept the gross margin of cotton low from 1981–1988 (Khedr et al., 1996). Both of these policies lead to the decrease in cotton production and trade. In 1989, the government began relaxing its control on cotton by increasing procurement prices relative to border prices and decreasing the amount procured.

In 1992 and 1993, the Egyptian farm procurement prices for cotton were above border prices due to the declining world price of cotton. Eventually, the Egyptian government found itself unable to pay farmers a price 30% above the world price. After a substantial delay, the government honored its commitment (Khedr et al., 1996). Farmers may have been reluctant to grow cotton during this period due to the uncertainty in payments and other potential or actual government intervention.

Fig. 3 also shows the increasing trend in cultivated area for rice during the 1990s. Rice cultivated area is relatively unaffected by land reclamation and development programs. However, the reduction in the overvaluation of the exchange rate and artificially low farm procurement prices coupled with water and nitrogen subsidies increased rice cultivated area dramatically in the 1990s (Khedr et al., 1996).

Besides cotton, other crops with slight decreasing trends include: temporary clover, soybeans, and Nile maize. The cotton and temporary clover cultivated areas move together, since farmers, for agricultural reasons, grow these crops consecutively on a given tract of land. Soybeans are a relatively new crop to Egypt and accounts for less than 100,000 feddans. Land previously growing Nile maize has been shifted to the production of fruits and vegetables. Other crops experiencing slight upward trends in cultivated area during the 1990s from responses to land reclamation were: barley, sesame, peanut, and onion. Permanent clover, flax, and millet cultivated areas remained stable throughout the period.

2.2. Gross margins

Fig. 4 presents for each crop and growing season, a three-year moving average of the real gross margins per feddan. In each season, the real gross margin decreased in the initial stages of the reform, then increased through the late 1980s or early 1990s, and subsequently decreased through the end of the horizon. Real gross margins per feddan appeared to move closely with the levels of government subsidies for fertilizer, seed, and fuel.

Table 1 presents the results of the policy to gradually remove indirect and direct farm subsidies for fertilizer, seed, and fuel (Principal Bank for Development and Agricultural Credit, unpublished

data). The total level of these subsidies increased throughout the 1980s, and then began decreasing in 1990 with complete elimination in 1993. Indirect subsidies kept the exchange rate artificially low for

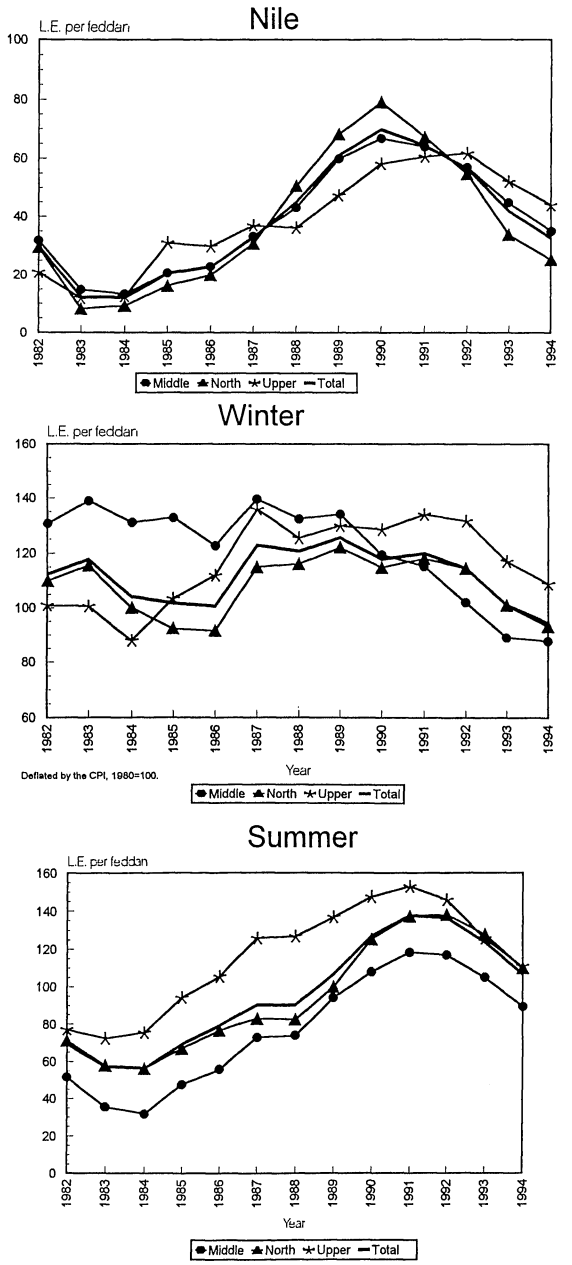

Fig. 4. Egypt gross margin—3-yr moving average.

Table 1
Total government agricultural input subsidy for fertilizer, seed, and fuel (million L.E.)

Year	1983	1984	1985	1986	1987	1988
Subsidy	63.9	61.7	74.6	82.3	91.5	105.3
Year	1989	1990	1991	1992	1993	1994
Subsidy	112.0	109.3	64.0	45.3	0.0	0.0

Source: Principal Bank for Development and Agricultural Credit (PBDAC), unpublished data.

imported agricultural inputs. For example, the exchange rate gradually increased to approximate market rate of 3.352 Egyptian pounds per U.S. dollar. In 1987, farmers faced the subsidized exchange rate of 0.7 Egyptian pounds per dollar. Direct subsidies reduced the farmer cost for inputs such as fertilizer, seeds, and herbicides by lowering the interest rate for loans below the commercial interest rate. For example, in 1987, farmers needing a loan for the purchase of fertilizer received a subsidized interest rate of 3.5%, while the commercial interest rate was 16%.

Figs. 5 and 6 present the gross margin trends for wheat, bean, summer maize, sugar cane, cotton, and rice. The aggregate gross margin trend of summer and winter crops also characterizes the gross margin of the individual crops. In the initial period of the reforms real gross margins fall, then subsequently increase through the late 1980s or early 1990s, and finally decreased near the end of the period. Among crops, the length, levels, and rates of increase or decrease differ. Other crops exhibiting a similar trend in gross margin include: flax, lentil, millet, onion, Nile maize, rice, sesame, and soybeans. A few crops had a decreasing gross margin trend: barley, peanut, and permanent and temporary clover. The remaining crop, cotton, had a relatively constant gross margin trend until 1990 and then substantially increased. Procurement prices being set above world prices caused the increase in the early 1990s.

3. Cropping pattern responses to gross margins

Figs. 2 and 5 together present the differences in the trend of cultivated area and the real gross margin trend for wheat, bean, summer maize, and sugar

cane. Figs. 3 and 6 present these differences for cotton and rice. For all crops, the real gross margin trend is much more volatile than the cultivated area trend. Furthermore, the cultivated area trend does not appear to closely follow the gross margin trend.

In a few instances, the trends seem to deviate substantially from what would be expected. First, the substantial increase in the real gross margin of cotton coincided with a slight decrease in cultivated area. Another discrepancy occurs in Upper Egypt during the 1980s. The decline and increase in the gross margin of sugar cane occurred with absolutely no change in the cultivated area. Finally, in Upper Egypt during the 1990s, the large decline in the gross margin of beans occurred simultaneously with a constant trend in the cultivated area. These simple comparisons are of interest, but may not tell the full story, since the gross margin trend of most crops followed the same path and it is the relative values that are important. Land reclamation projects have

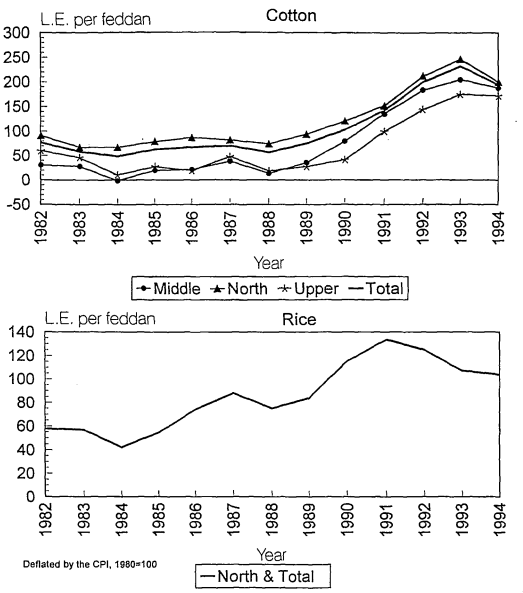

Fig. 6. Crop gross margin - 3 year moving average.

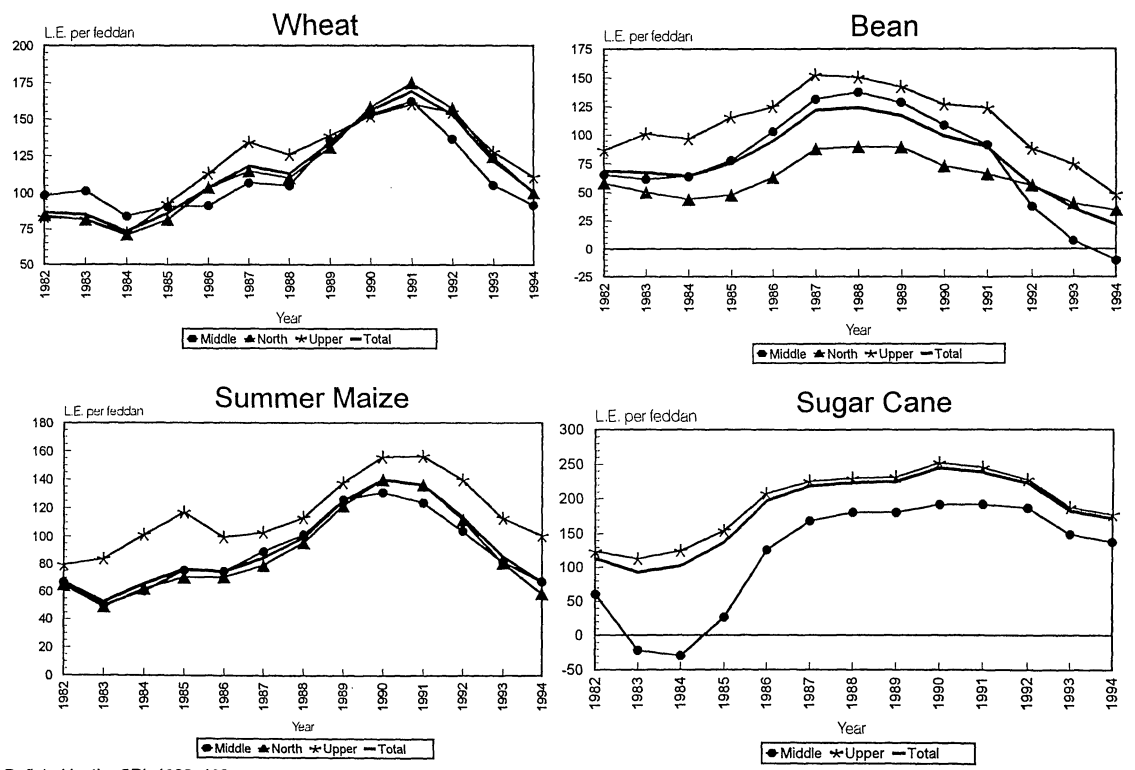

Fig. 5. Crop gross margin—3-yr moving average.

influenced cropping patterns, but the cultivated area of one crop compared to another crop should respond to a change in relative gross margins.

If farmers are responding to market price changes, there should exist a positive relation between relative gross margin and relative area cultivated. For example, if over time the gross margin of barley has become relatively higher than wheat, then the cultivated area of barley relative to wheat should have increased. A three year average of the ratios of relative gross margins and relative areas cultivated for each major crop are calculated at the beginning and end of the period of analysis. Table 2 presents the count of governorate level changes for relative gross margin increases and decreases. The regional results were similar to results at the governorate level.

Table 2 also shows the count and percent of positive cropping pattern responses due to changes in relative gross margins. A 'positive response' occurs when the gross margin of one crop increases (decreases) relative to another crop and the cultivated area responds accordingly. For all governorates and all seasons, there are only 122 positive responses out of 231 responses, or 53% of cultivated area responses to changes in relative gross margin are positive. Hence, in 47% of the cases, if the relative gross margin increased (decreased) then relative cultivated area decreased (increased). Farmers shifted away from crops with more attractive relative gross margins.

Table 2 also shows the asymmetry to the cultivated area responses to changes in relative gross margins. For example, the cultivated area of wheat responded more positively to increases in relative gross margin than to decreases. When the gross margin of wheat increased relative to another crop, the area of wheat cultivated relative to that crop increased in 80% of the cases. However, when the relative gross margin of wheat decreased relative to another crop, the area of wheat cultivated relative to that crop decreased in only 13% of the cases. Other crops showing similar response patterns include rice, beans, and summer maize. A possible explanation

Table 2
Cultivated area response linked to changes in relative gross margins

Season crop	Relative gross margin increases			Relative gross margin decreases		
	Positive responses	Total responses	Percent positive	Positive responses	Total responses	Percent positive
Summer						
Cotton	3	24	13	7	9	78
Maize	13	19	68	4	18	22
Millet	2	11	18	6	10	60
Peanut	1	4	25	4	16	25
Rice	10	10	100	0	3	0
Sesame	3	7	43	4	15	27
Soybean	0	3	0	10	10	100
Sugar cane	3	5	60	0	1	0
Summer	35	83	42	35	83	42
Winter						
Barley	2	6	33	12	19	63
Bean	13	18	72	8	27	30
Flax	2	15	13	12	13	92
Lentil	2	3	67	5	16	31
Onion	16	31	52	0	3	0
Permanent clover	16	27	59	16	21	76
Temporary clover	1	4	25	33	41	80
Wheat	35	44	80	1	8	13
Winter	87	148	59	87	148	59
All season	122	231	53	122	231	53

Source: Principal Bank for Development and Agricultural Credit (PBDAC), unpublished data.

for this type of asymmetric response lies with the local processing industries.

Soybeans and flax also appear to have asymmetric responses to market signals but opposite to that for wheat. In these instances, substituting out of the crop when relative gross margin decreases occur in 100% and 92% of the cases, respectively. Substituting into these crops when relative gross margin increases occur only in zero and 13% of the cases, respectively.

4. Statistical analysis

To empirically estimate the cropping pattern responses to changes in gross margins, we assume farmers can grow only two crops, either the crop under investigation or a composite crop. The composite crop represents all other crops grown during the season. The ith composite crop's cultivated area, denoted as CA_{-i}, is the sum of the cultivated area of all other crops except the ith crop. The ith composite crop's gross margin, denoted as GM_{-i}, is a weighted average of the other crop's gross margins, where the weights are the respective percentages of the cultivated area.

4.1. Crop specific responses

To estimate the crop-specific cultivated area responses to the relative margins, we used the autoregressive form of the geometric distributed lag model. The overall impact of relative gross margin on relative cultivated area will be represented by the value of the parameter on the relative gross margin. If cropping patterns are responding to relative gross margins, the estimate of β will be positive and statistically significant. The estimate of λ indicates the speed at which farmers are responding to changes in relative gross margins. Eq. (1) is the form used for estimation.

$$\begin{aligned} CA_{i,j,t}/CA_{-i,j,t} = {} & \alpha(1-\lambda) + \beta(1-\lambda) \\ & \times (GM_{i,j,t}/GM_{-i,j,t}) \\ & + \lambda(CA_{i,j,t-1}/CA_{-i,j,t-1}) \\ & + \epsilon_{i,j,t} \end{aligned} \quad (1)$$

where, $CA_{i,j,t}$ = cultivated area of crop i in season j during year t, $CA_{-i,j,t}$ = cultivated area of all crops in season j other than crop i (crop i's composite crop) during year t, $GM_{i,j,t}$ = gross margin of crop i in season j during year t, $GM_{-i,j,t}$ = gross margin index of all crops in season j other than crop i (crop i's composite crop) during year t and $\epsilon_{i,j,t}$ = disturbance term.

The strength of the cultivated area response to gross margins likely varied over time due to the gradual introduction of the market reforms. Hence, the analysis is for two time periods; the pre-reform period of 1980–1986 and the reform period of 1987–1994 (Nassar et al., 1996). If market reforms are working, there should be substantially more crops during the reform period with significantly positive coefficients for the gross margin ratios.

Due to the small number of years in each period, pooled cross-sectional time series methods were used in estimation. The pooled model estimation was assuming a random effects model with cross-sectional heteroskedasticity and no autocorrelation. To test for the presence of autocorrelation, the residuals were regressed on $(CA_{i,j,t-1}/CA_{-i,j,t-1})$, $(GM_{i,j,t}/GM_{-i,j,t})$, and a one period lagged residual. The significance of the lagged residual was tested using the standard t-test (Greene, 1993). If autocorrelation was indicated, Hatanaka's two step procedure was used to estimate the model (Hatanaka, 1976).

Table 3 presents the summary for the estimates of, β, the reflective impact of relative gross margins on cultivated area for each summer and winter crop. Estimates for β during the pre-reform period were all not significant. Hence, during the initial stages of the reforms, relative gross margins did not have statistically significantly influence cropping patterns. The number of crops with significantly ($\alpha = 0.05$) positive estimates for β increased to three during the reform period. Only soybean, permanent clover, and wheat had significantly positive estimates for β during the reform period. Summer maize had a significantly negative response during the reform period. With a 10% significance level, barley has a significantly positive estimate for β during the reform period. Table 3 also presents the estimates of λ. A high value of λ (close to 1) implies that farmers are slow to adjust to changing market signals and maybe in need of agricultural extension programs. The mar-

ket reforms appeared to shift the cultivated areas for a few crops. Still, the persistence of cropping patterns that remains suggest continuing rigidity in the system, possibly due to continuing government involvement.

4.2. Composite responses

Table 4 presents the canonical correlation results of the observed relative cultivated area ratios with the ratios of relative cultivated area predicted by the distributed lag model. For each year, the overall correlation between the observed and predicted values exceeds 0.9. The amount of overall variation in the observed ratios of cultivated area explained by the distributed lag model exceeds 0.932 in the pre-reform period and 0.831 in the reform period.

These results also indicate a large amount of stability in the overall cropping pattern during both

Table 3
Regression estimates for β, the effect of the relative gross margins on cultivated area for summer and winter crops

Summer crops	Pre-reform	Reform	Winter crops	Pre-reform	Reform
Cotton			**Barley**		
β	−0.0324	0.1433	β	0.0688	0.0243
t-ratio	(−1.44)	(0.62)	t-ratio	(0.26)	(1.79)
λ	0.8962[a]	0.9728[a]	λ	0.97526[a]	0.8548[a]
t-ratio	(18.81)	(26.53)	t-ratio	(43.66)	(19.32)
Summer maize			**Bean**		
β	−0.7290	−0.0082[a]	β	−0.7251	0.0131
t-ratio	(−1.11)	(−2.15)	t-ratio	(−0.23)	(0.95)
λ	0.99124[a]	0.99103[a]	λ	0.9942[a]	0.4946[a]
t-ratio	(64.33)	(62.59)	t-ratio	(40.72)	(6.55)
Millet			**Flax**		
β	0.0172	−0.0052	β	−0.0008	0.0071
t-ratio	(1.01)	(−0.02)	t-ratio	(−0.17)	(1.28)
λ	0.9726[a]	0.98757[a]	λ	0.6784[a]	0.6093[a]
t-ratio	(45.09)	(89.31)	t-ratio	(8.36)	(4.97)
Peanut			**Lentil**		
β	0.036	0.0853	β	0.0077	0.0024
t-ratio	(0.69)	(0.31)	t-ratio	(0.91)	(0.68)
λ	0.8808[a]	0.9675[a]	λ	0.9259[a]	0.7719[a]
t-ratio	(7.83)	(10.25)	t-ratio	(20.88)	(8.24)
Rice			**Onion**		
β	−0.6313	−1.6250	β	0.0025	−0.0009
t-ratio	(−0.63)	(−0.67)	t-ratio	(1.07)	(−0.67)
λ	0.97170[a]	0.97707[a]	λ	0.8494[a]	0.6039[a]
t-ratio	(41.06)	(49.52)	t-ratio	(10.27)	(5.78)
Sesame			**Permanent clover**		
β	−0.0007	−0.0060	β	0.1457	0.2795[a]
t-ratio	(−0.80)	(−0.08)	t-ratio	(0.46)	(2.36)
λ	0.8814[a]	0.9536[a]	λ	0.9415[a]	0.8936[a]
t-ratio	(13.14)	(17.24)	t-ratio	(16.70)	(23.60)
Soybean			**Temporary clover**		
β	−0.1767	0.0204[a]	β	−1.5004	0.1169
t-ratio	(−0.25)	(2.43)	t-ratio	(−0.70)	(0.42)
λ	0.6939[a]	0.8559[a]	λ	0.9625[a]	0.9465[a]
t-ratio	(8.48)	(19.56)	t-ratio	(20.41)	(30.68)
Sugar cane			**Wheat**		
β	−0.1745	2.2357	β	2.5500	0.1536[a]
t-ratio	(−0.45)	(0.40)	t-ratio	(0.16)	(2.20)
λ	0.97217[a]	0.9829[a]	λ	0.9945[a]	0.6854[a]
t-ratio	(36.67)	(16.95)	t-ratio	(28.84)	(10.68)

[a] Indicates the coefficient is significantly different from zero at the $\alpha = 0.05$ level.

Table 4
Summary of the canonical correlation results for the association between the actual and predicted relative cultivated areas

Year	Canonical correlation	Approximate standard error	Squared canonical correlation
Pre-reform period			
1981	0.965	0.006	0.932
1982	0.987	0.002	0.975
1983	0.989	0.002	0.978
1984	0.993	0.001	0.985
1985	0.990	0.002	0.981
1986	0.996	0.001	0.992
Reform period			
1988	0.949	0.009	0.901
1989	0.965	0.006	0.931
1990	0.957	0.007	0.915
1991	0.958	0.007	0.917
1992	0.912	0.015	0.831
1993	0.962	0.006	0.926
1994	0.948	0.009	0.899

the pre-reform and reform periods. The degree of stability in the cropping pattern has lessened during the latter period, but remains quite high. The overall cropping pattern has not only been unresponsive to changes in gross margins but also to other factors not captured in the distributed lag model. These other factors could include types of external shocks specific to single years or time trends reflecting the gradual implementation of the reforms.

5. Conclusions and implications

The total economic reform package has had some influence on Egyptian agriculture as measured by cropping pattern changes and their relationships to gross margins. Total cultivated for Nile maize has steadily declined as more land has been used for the production of fruits and vegetables. Total cultivated area during the summer and winter seasons was approximately constant throughout the 1980s but has increased since 1990 due to land reclamation. The cultivated areas for selected crops (wheat and rice) has increased greatly since the introduction of the reforms, while the cultivated area of cotton has decreased. However, for most other crops, the area cultivated has been relatively constant.

The question for this analysis was whether the changes in gross margins have influenced cropping patterns. In particular, are the responses similar to those predicted by profit maximizers in an economy characterized by markets and low levels of government intervention. First, the overall changes in gross margins were similar for most crops and followed the pattern of government participation. The cultivated area trends did not follow the gross margins. Furthermore, the gross margin trend is more volatile than the cultivated area trends. The analysis focused on relative gross margins compared to cultivated area. There was a slight increase in the number of crops responding 'positively' to relative gross margin changes during the reform period compared to the pre-reform period. However, for 12 of the 16 crops included in the analysis, there was not a significantly positive response relative to gross margin changes, even during the reform period. The canonical correlation analysis showed as well that the overall cropping pattern was stable during both the pre-reform and reform periods.

There are many possible explanations for the lack of responsiveness of cropping patterns to the relative gross margins. First, the 1961 Agricultural Reclamation Law states that personal ownership of land cannot exceed 100 feddan. Small-scale farming has been prevalent in Egypt. In 1990, 95.8% of the Egyptian farmers owned less than five feddans of land. These small farmers accounted for 56.3% of the available farm land (Central Agency for Public Mobilization and Statistics, various years). The law may prevent the realization of managerial efficiencies by making it difficult for efficient farms to take over land operated by inefficient farms. Second, many of the small farms are subsistence level. Changing cropping patterns and using new farming practices can be difficult for such farmers, and these subsistence farmers may not fully participate in the market economy. Third, the agricultural extension services have limited scope. Farmers have little assistance in using new crops or existing resources more efficiently. The high estimates of λ indicating farmers are slow to adjust to market changes are consistent with these possible explanations.

Fourth, the explanation for the stability of crop-

ping patterns may lie with the linkages to the processing industry. Before reforms, the public sector controlled all wheat storage and flour production, as well as, one-half the productive capacity of the rice mills (Nassar et al., 1996). Pressures on farmers by local authorities may still exist to produce supplies necessary to keep local processing plants at historical operating levels. The asymmetry of the cultivated area responsiveness to relative gross margins for wheat, summer maize, rice, and beans support this possibility. Wheat, summer maize, beans, and rice are major inputs to local processing plants. Farmers substituted into these crops when their relative gross margin increased relative to other crops. However, they appeared to be reluctant to substitute out of these crops when their relative gross margin decreased relative to other crops. Programs to reduce adjustment costs for these processing industries may accelerate the response to the reforms.

The mechanism local leaders can still use to maintain cropping patterns is the rationing of agricultural credit. Most farmers borrow from the agricultural credit bank. Thus, there must be a form of nonporous rationing in place. Credits for inputs, seeds, fertilizers, and chemicals, may be given if farmers explicitly or implicitly agree to cropping patterns or only for certain crops. In this manner, local officials control production, keep processing plants operating, and limit the impacts of the reforms on the vested interests in the local economy. Various subtleties in the results on cropping patterns and gross margins are consistent with these conjectures. The main implication of the results is, however, that the Government of Egypt, if it wishes to have a market-based agriculture, must look to the reasons for the failure of farmers to respond to margins that are a result of changing relative market prices.

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