Interregional Competition in Cotton Production

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GOVERNMENT programs to control cotton production and raise the price and income from the crop have not been free of criticism. One charge is that the allotment program has prevented the free movement of production to more efficient areas. It is argued that relaxing of Government programs would allow more cotton production to move profitably to irrigated sections of Texas and California. Such movement would be likely to affect the Southeast more than other areas.

The question of where cotton would be produced at various price levels in the absence of allotments is a problem of comparative advantage in interregional competition. The answer does not depend on absolute advantage, i.e., who can produce cotton at the lowest unit cost. The most extensive areas of low-cost cotton production are found in irrigated areas of Southern California and Southwest Arizona, the Texas and Oklahoma Plains, and the Mississippi Delta. Average direct cost per pound of producing cotton in these areas was approximately $0.19 in 1965 (4). In the same year, the average direct cost of producing cotton in the Southern Piedmont, Clay Hills, Black Belt, and Coastal Plains was about $0.25 per pound (4). These data, although useful for many purposes, do not tell us that the Southeast will discontinue cotton production if the price falls below $0.25 per pound.[2] The areas with an average cost of $0.19 per pound have an absolute advantage in cotton production over the areas with an average cost of $0.25 per pound. However, measuring absolute advantage with average cost data may be somewhat misleading because there are many local resource situations in each area which permit production at much lower cost.

Comparative advantage is reflected in the rate of return on scarce resources when farmers produce one commodity in preference to another. An area is said to have a comparative advantage in enterprises which yield the highest profit at specified or equilibrium market prices. The areas producing cotton at low cost may have alternative enterprises such as alfalfa, sorghum, wheat, etc., which are more profitable than cotton. These areas would continue to produce the most profitable crop even though their cost of producing other crops may also be lower than the cost in other areas. Conversely, in some areas with a high cost for producing cotton, cotton may still be the most profitable enterprise. These areas will continue to produce cotton as long as cotton holds this advantage.

Thus, answers to questions about the location of cotton production must consider not only the cost of producing cotton but also the alternative uses of scarce resources within the areas.

What would be the location of cotton production at various prices in the absence of crop allotments? The answer to this question is the subject of this report. Data are from regional research project S-42, "An Economic Appraisal of Farming Adjustment Opportunities in the Southern Region to Meet Changing Conditions" (1). The project was a cooperative

[1] The authors have borrowed heavily from "Cotton: Supply, Demand and Farm Resource Use" (1), published in 1966. Numerous researchers in the Agricultural Experiment Stations and U.S. Department of Agriculture made the 1966 report possible, and must be considered coauthors of the material in the following pages. The contributors to the research project are listed in the report cited above (1). Underscored numbers in parenthesis refer to items in the References, p. 55.

[2] Neither, as the authors make clear, are they intended to do so.

Conditions" (1). The project was a cooperative effort of the U.S. Department of Agriculture and the State agricultural experiment stations.

Past Research

Traditionally, two approaches have been used to study the location of production. One approach has been to estimate the location of production by comparing production costs among areas from detailed crop budgets. A second approach has been to use data from the Census Bureau and other sources to find costs and returns, then to use a single aggregate linear programming model to compute the least-cost or profit-maximizing level of production of commodities by areas (cf. 2). The former approach is inadequate as stated before because it fails to account for the profitableness of cropping alternatives and the fixed rigidity of assets including farmland and family labor. The latter approach provides some interesting results, but has been hampered because the single research model has been unable to include the needed volume and diversity of information. Researchers constructing a single central model are unlikely to have adequate knowledge of current input-output data and resource restraints in each component area.

The research reported herein attempted to circumvent these problems by combining the advantages of the two traditional approaches. The most profitable combination of enterprises was determined by linear programming for individual resource situations by farm management research personnel located in each State and well informed on local conditions. The procedures were carefully specified in advance to permit aggregation of the data and to determine comparative advantage among cotton-producing areas.

Assumptions and Procedure

The assumptions and basic procedure of the S-42 project are specified in (1). The major assumptions are repeated here for clarity. It was assumed that all farms were owner operated and all farmers would adopt the enterprise combination that appeared to be most profitable. It was also assumed that acreage allotments and price support programs were not in effect. The assumption of no acreage allotments for cotton, peanuts, rice, tobacco, and wheat is not a forecast of what is likely to be in the future nor a recommendation of what should be in the future. Rather it is an assumption designed to permit unrestricted adjustments to maximize profits of the individual producer, subject to the relevant market restraints.

In appraising adjustments in enterprise combinations, the time period was assumed to be long enough for intermediate-term capital investments in items such as buildings, farm machinery, equipment, livestock, and pasture improvements to be considered as variable costs. In general, all costs except general overhead, land, operator labor, and management were considered variable. Land, operator labor, and management were considered fixed during the planning period; hence, they became restrictions for programming models for the individual resource situations.

An advanced level of technology was assumed when input-output coefficients and enterprise budgets were developed. This implies that the most profitable level or intensity of production practices (such as rate of seeding, fertilization, and irrigation) is employed based on the physical response expected under farm conditions when carried out by a good manager. In general, the advanced technology assumption implies that profitable practices now being followed by the better farmers will be the modal practices followed at the end of the planning period.[3]

The assumed national average prices received by farmers for selected commodities are summarized in table 1. These prices are below current prices, but were estimated to be consistent with the assumption of no allotment restriction. In the various geographic areas, product prices were adjusted for quality and locational differences. Prices received by farmers for commodities other than cotton were held constant at the level in table 1 while the price of cotton (U.S. average price) was varied over a range of $0.15 to $0.35 per

[3] The "end of the planning period," to which the estimates of representative farm size and demand projections were designed to apply, was 1975. However, recent trends indicate that the estimates are more nearly applicable to 1970.

Table 1.--Assumed U.S. average prices received by farmers[a]

Product	Unit	Price per unit
		Dollars
Corn (shelled)........	Bushel	1.10
Grain sorghum.........	Cwt.	1.77
Wheat................	Bushel	1.25
Oats.................	Bushel	.65
Barley...............	Bushel	.90
Soybeans.............	Bushel	2.00
Hay (average all kinds).............	Ton	18.00
Cottonseed...........	Ton	50.00
Beef cattle (average all kinds).........	Cwt.	17.00
Calves (average all kinds).............	Cwt.	18.00
Hogs.................	Cwt.	14.50
Peanuts..............	Pound	.08
Rice.................	Cwt.	3.85
Flue-cured tobacco....	Pound	.44

[a] Product prices vary between geographic areas. Prices received were developed for each area, based on quality and locational differences, in relation to the U.S. average price.

pound.[4] Cotton prices for specific geographic areas deviated from the U.S. average, depending on quality and location.

It was assumed that unlimited quantities of nonreal-estate capital were available at a 6 percent rate of interest. Interest was considered as an expense and was charged on an annual basis for all capital, regardless of whether the capital was owned or borrowed.

Seasonal labor was assumed to be available as needed and limited only by the wage rate. Operations such as tractor driving were performed only by the operator or skilled labor hired monthly or annually. With these limitations, the fixed supply of skilled labor during a critical period could become a restriction and an important determinant of the most profitable combination of enterprises.

[4] Situations were also programmed with prices of commodities other than cotton set at alternate levels to those in table 1, but the results are not shown in this paper.

Some enterprises were excluded from consideration in developing the most profitable plans for representative farms, and limitations were placed on other enterprises. For example, specialty crops such as fruits and vegetables (except in the Lower Rio Grande Valley), dairy, and poultry enterprises were not included as production alternatives to cotton in most programming models for representative farms. These exclusions were based on the assumption that the typical farms would not view these enterprises as relevant alternatives because of specialized management required and limited market opportunities.

The purchase of feeder pigs and hog feed, except for protein supplement, was not permitted. Beef cattle enterprises were limited to cow-calf herds, grazing of stockers, and feedout operations for which only the protein supplement could be purchased.

Although no acreage allotments were assumed to be in effect, crops were limited in some areas by agronomic restrictions appropriate to the resource situation. For example, soil conservation practices and crop rotations associated with the control of diseases and insects were considered in the limitations imposed on the acreage of selected crops. Specific limitations such as availability of irrigation water restricted the acreage of crops in some areas. In resource situations where flue-cured tobacco was an alternative, tobacco was limited to the acreage planted in 1939, the most recent year in which acreage allotments were not in effect.

Geographic Areas and Resource Situations

Geographic areas were selected for detailed study on the basis of their homogeneity of resources, problems, and adjustment opportunities. In general, the areas corresponded to the 1959 U.S. Census of Agriculture Economic Subregions. In all of the subregions selected, cotton is an important enterprise and in most it is the most important enterprise. In 1962 these areas accounted for about 81 percent of all cotton produced in the United States. In reporting results pertaining to crop acreage and production and livestock numbers, the 25 geographic areas were combined into 17 areas (fig. 1).

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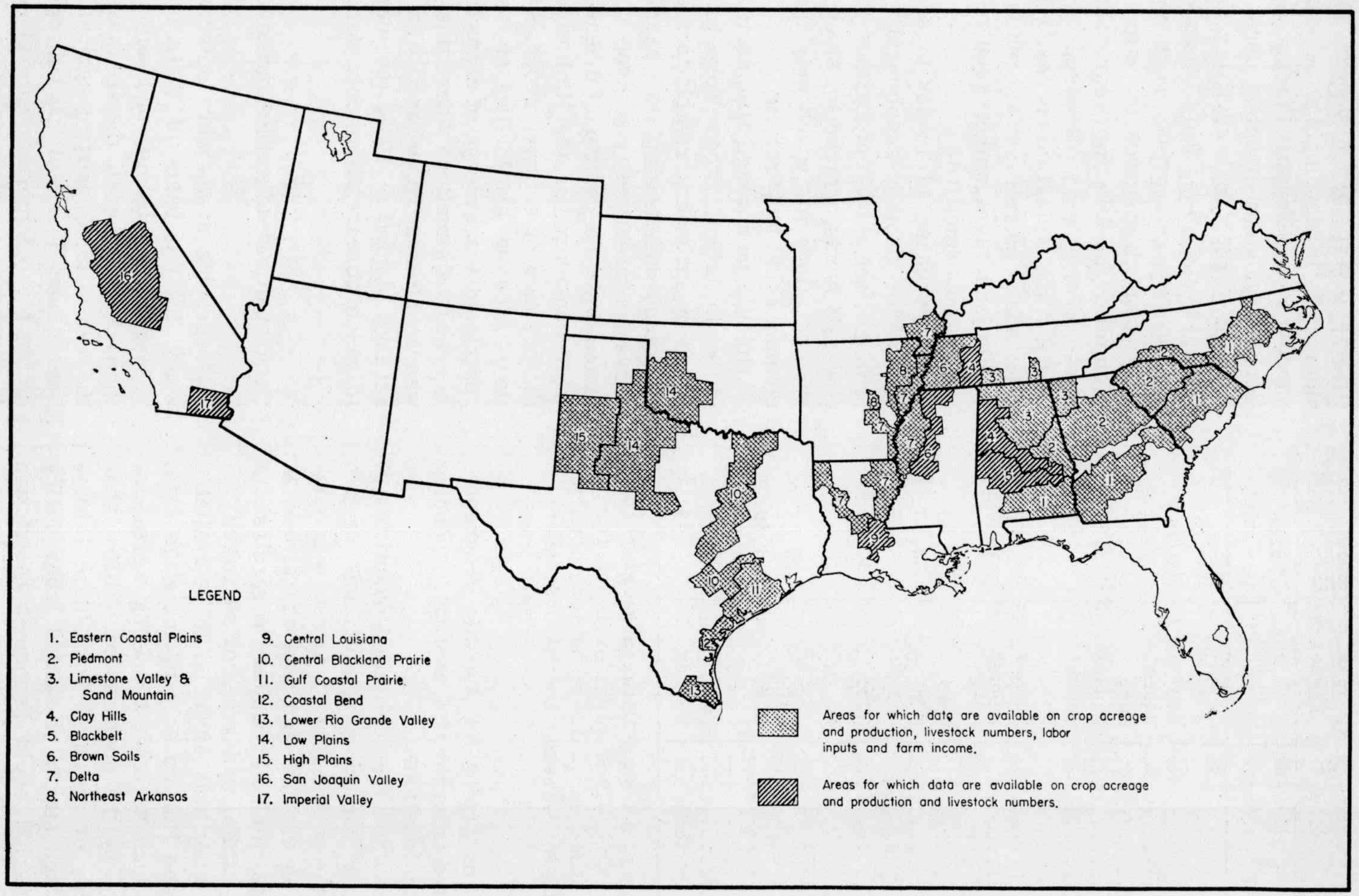

Figure 1.--Geographic areas included in the study.

Table 2.--Cotton production at specified cotton prices, with historical comparisons, 17 study areas[a]

(1,000 bales)

Area	Production		Production at assumed U.S. average price per pound of cotton[b] of--								
	1953	1962	$0.15	$0.20	$0.21	$0.22	$0.23	$0.24	$0.25	$0.30	$0.35
Southeast:											
1. Eastern Coastal Plains------	1,172	913	246	1,140	1,542	2,267	2,630	2,848	3,220	3,949	4,168
2. Piedmont--------------------	542	234	0	360	360	360	530	578	744	878	878
3. Limestone Valley and Sand Mountain------------------	523	364	0	914	926	1,033	1,169	1,506	1,857	2,407	2,407
4. Clay Hills, Ala.-Tenn-------	211	169	2	7	7	7	7	29	360	598	683
5. Black Belt, Ala.------------	128	92	0	0	0	0	0	458	458	776	776
Mississippi Valley:											
6. Brown Soils, Miss.-Tenn.----	938	784	14	284	844	1,018	1,361	1,543	1,817	2,218	2,218
7. Delta-----------------------	2,928	2,640	3	1,979	2,701	3,227	3,402	4,897	5,310	6,125	6,353
8. Northeast Arkansas----------	528	515	81	782	850	1,002	1,148	1,346	1,346	1,444	1,444
9. Central Louisiana-----------	114	97	5	91	119	147	174	202	230	297	300
Texas and Oklahoma:											
10. Central Blackland Prairie---	1,124	462	0	0	0	401	401	401	489	522	522
11. Gulf Coastal Prairie--------	265	232	0	0	0	0	0	0	87	591	600
12. Coastal Bend----------------	75	151	0	0	0	0	0	47	143	286	286
13. Lower Rio Grande Valley-----	258	413	0	1	406	407	559	638	638	707	728
14. Low Plains, Okla.-Texas-----	724	860	30	254	324	533	789	1,607	1,622	1,899	1,914
15. High Plains, Texas----------	1,366	2,270	759	1,760	4,109	4,109	4,132	4,142	4,180	4,528	4,528
California:											
16. San Joaquin Valley----------	1,534	1,665	444	1,862	2,426	2,628	2,708	2,761	2,762	2,768	2,768
17. Imperial Valley-------------	175	181	0	318	459	459	475	578	578	609	609
Total:											
17 areas-----------------------	12,605	12,042	1,584	9,752	15,073	17,598	19,485	23,581	25,841	30,602	31,182
U.S.[a]------------------------	16,465	14,867	1,946	12,040	18,609	21,720	24,056	29,112	31,902	37,780	38,510

[a] Data from (1): See figure 1 for study areas.
[b] Prices of products other than cotton held constant at levels shown in table 1.
[c] Total U.S. production for selected cotton prices is based on the relationship between study areas and U.S. total production is 1962.

In each of the geographic areas, secondary data were used to determine estimates of total land area, total cropland, and number of farms. These data were also used to estimate the resources devoted to producing the specialty crops and other production alternatives not considered for adjustment. Since these alternatives were not considered as adjustment possibilities, the resources devoted to them were subtracted from the total area resources to obtain the resource base for aggregation.

Within each geographic area several resource situations were delineated to represent relatively homogeneous groups of resources. Representative resource situations within each area were delineated on the basis of such factors as size of farm, available allotments, soil capability, topography, availability and cost of irrigation water, adjustment problems, and opportunities for adjustment. Data obtained from the U.S. Census of Agriculture, records of the Agricultural Stabilization and Conservation Service and the Soil Conservation Service, and information from recent farm management studies were used for developing the representative farm resource situations and for estimating their relative weights. The total number of resource situations was 234.

Input-output budgets which had been developed for use in the overall S-42 project provided the technical coefficients for use with linear programming techniques to determine the optimum combination of enterprises for each representative farm. All cost items which could be reasonably allocated to individual enterprises were covered in the enterprise budgets. General overhead costs which could not be allocated to specific enterprises and land interest charges were subtracted from the programmed return to obtain a return to operator's labor and management.

Deriving Aggregates

The optimum farm plans computed for each representative farm resource situation by linear programming and their appropriate weights were used to develop geographic aggregations. Items for which area and interregional aggregations were developed include crop acreages and production, livestock numbers, labor inputs, and farm incomes.

Results

Programmed estimates of the output of cotton at selected cotton prices ranging from $0.15 to $0.35 per pound, given the underlying assumptions of the study, are depicted in table 2 and figures 2 and 3. The increase in cotton production as the price is increased from $0.15 per pound to $0.35 per pound is substantial in all areas (fig. 2). Estimated production in the 17 study areas increased from 1.6 million bales to 31.2 million bales. Actual production in the areas totaled 12.6 million bales in 1953 and 12.0 million bales in 1962. The width of the graphic area for each region may be viewed as the supply curve. It is characterized as an inverted "lazy S." From low prices to $0.20 per pound, the supply curve rises steeply because cotton is not then competitive for the use of resources at prices shown in table 1 for other commodities. From $0.20 to $0.30 per pound, the most frequent range of actual prices, cotton becomes more profitable than alternatives and acreage is expanded rapidly. Also yields rise because fertilizer and irrigation become more profitable. The result is a somewhat elastic section of the supply curve for cotton in each area within this range of prices. Above $0.30 per pound, the supply curve is steep (inelastic) as land suitable for cotton production is exhausted and the cost rises for additional production.

The average price for cotton in 1963 was $0.32 per pound. Production in that year in the four regions in figure 2 was 12.6 million bales and in the United States was 16.5 million bales. Production in that year was restrained by allotments. Prices would have a fall to nearly $0.20 per pound, according to figure 2, to reduce production to that level without production controls.

The line on the extreme right of figure 2 that borders California is the normative aggregate supply curve for cotton. Anticipated production outside the study areas was added to this supply curve to form the total supply. The aggregate

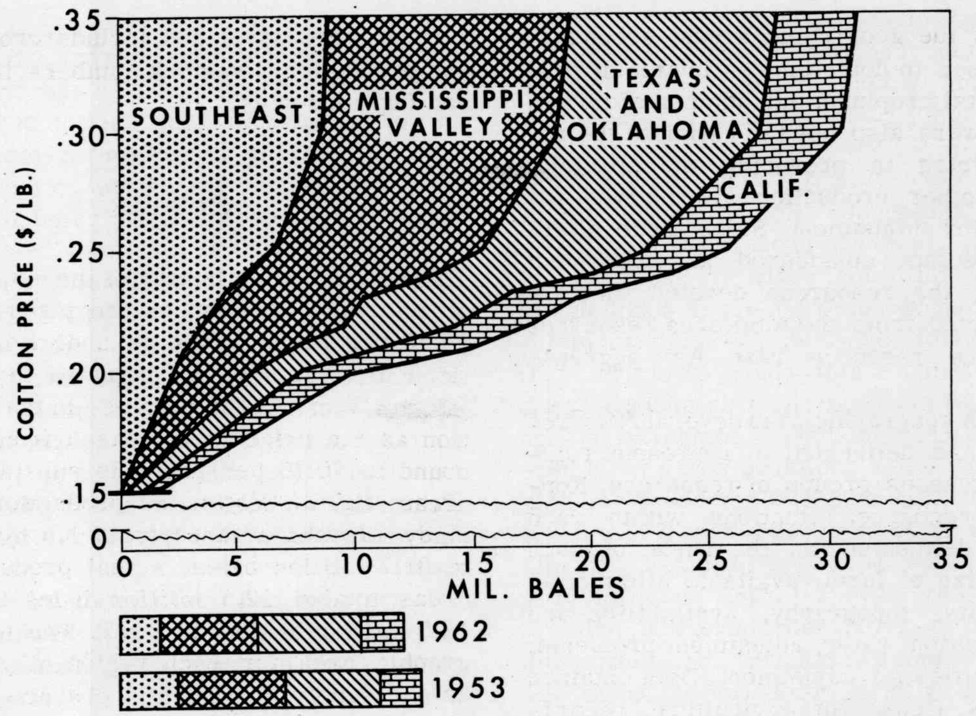

Figure 2.--Actual cotton production in 1953 and 1962, and estimated production at various prices in the absence of acreage controls or price supports, by major regions.

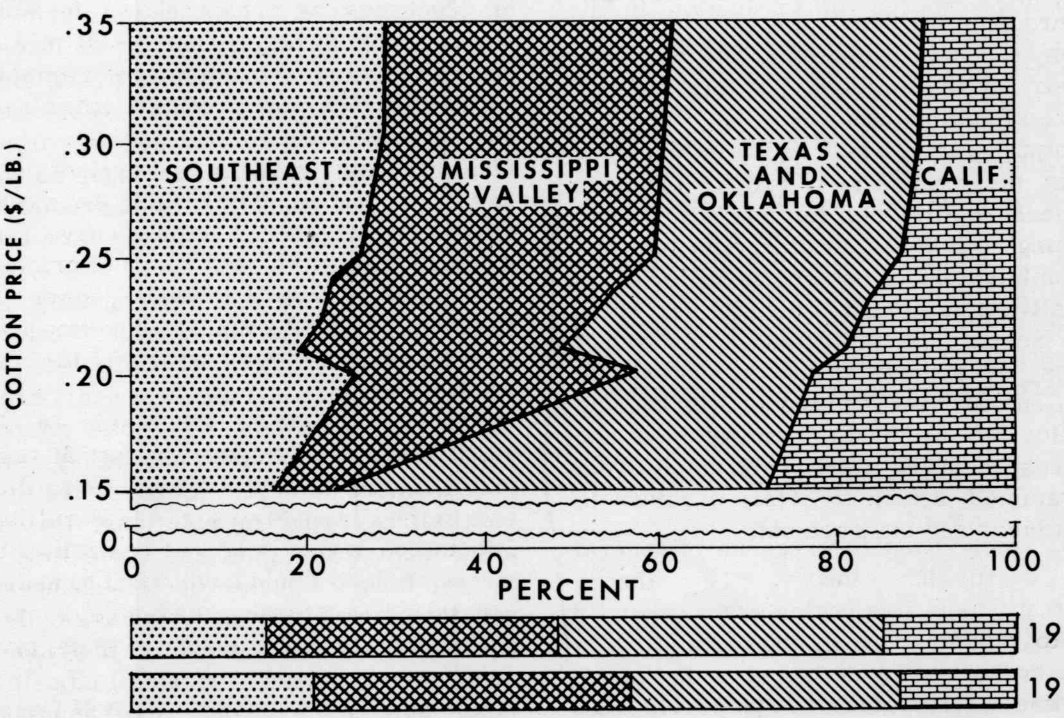

Figure 3.--Percentage shares of cotton production in 1953 and 1962, and estimated percentage shares of production at various prices in the absence of acreage controls or price supports, by major regions.

domestic and foreign demand for cotton was also estimated. The two curves intersected at an equilibrium production of 17 million bales and equilibrium price of $0.21 per pound (cf. 1, p. 52).

Figure 3 more clearly illustrates the comparative advantage of cotton production in the four regions. The share produced in the Mississippi Valley falls markedly as the price of cotton is reduced below $0.20 per pound due to profitableness of soybeans. The Southeast maintains a somewhat stable share of output at all prices. At low prices, California and the Texas and Oklahoma regions have a comparative edge in production. Their combined share is 78 percent of production at $0.15 per pound and only 38 percent at $0.35 per pound. If the free market price were below $0.24 per pound, California would profitably have a larger share of production than in 1962; and above that price it would have a smaller share. The equilibrium market price without production controls was estimated to be $0.21 per pound. California and the Southeast would raise their market shares under a free market. At the equilibrium price the percentage shares of production in the Southeast, Mississippi Valley, Texas and Oklahoma, and California regions respectively would be an estimated 19, 30, 32 and 19, compared with 16, 33, 36, and 15 in 1962. Thus a free market would not materially alter the distribution of cotton production according to the S-42 study.

It does not follow, however, that income would increase in areas where market shares expand. Actually, total farm income falls in all regions, including those that increase their market share, as the cotton price is lowered.

Some Limitations

Regional competition is a branch of general economic equilibrium theory. This theory stresses that prices in a region are continually adjusting to supply, demand, and institutions in the entire economy. To reduce the size of the model, it was necessary in this study to abstract from many interrelationships between supply and demand in the total economy.

Prices (except for cotton), transportation costs, wage rates, and interest rates were considered to be unaffected by the changes in the use of resources and production of commodities predicted by the programming models. Prices for commodities other than cotton were based on past history and anticipated future conditions, but their fixed level may be an inaccurate forecast of actual conditions. The price of feed grain, for example, may be influenced by the change in feed grain production as the price of cotton in varied. However, these macro effects are expected to be small and an unimportant source of error. In response to changes in cotton prices, the changes in production of alternatives would be a small part of national output. It follows that the price effects would be small.

Farm size and family labor were considered to be fixed in the portion of the study reported above. Over a longer time, these fixed assets would become variable. The farm size was allowed to change in another portion of the study (cf. 5). As the cotton price is lowered, farm size tends to expand to compensate for reduced income. That is, the farm operator expands his operation to obtain an income comparable to what he would earn with alternative use of his labor and capital. Results indicated that cotton production tended to vary proportionately with the farm acreage, so that farm size does not appear to be a crucial variable in predicting changes in total cotton production for a region.

The linear programming format used in the above analysis assumed that farmers make adjustments that are most profitable. The model itself is timeless--the adjustments are instantaneous. Comparison of linear programming results with actual behavior of farmers shows that farmers do in fact move toward the profit-maximizing program solutions. However, the adjustment takes time and costs money. Few, if any, farmers make the full changes in crop and livestock production that are called for by the model. Following a change in price, several years are required to make all adjustments. In other studies, recursive programming, which explicitly includes time lags in the model, has been used to introduce the time dimension.

Also positivistic techniques such as multiple regression have been used to predict from past behavior the response of farmers to changing prices. These positivistic techniques are limited by somewhat narrowly circumscribed past behavior, and are not yet flexible enough to include a wide, complex range of possible price and cropping alternatives, and the farming technology that is available but is not yet used by farmers. Thus the static programming model used in our analysis, despite its limitations, appeared to have fewer shortcomings than other approaches to answer the questions posed for this study.

Research Complementarities

The analysis of interregional competition in cotton production was feasible only because it was complementary with other research goals. The linear programming analysis of profitable plans for representative farms was an excellent base for improving farm management decisions. The extension service and land grant universities utilized the results in classroom teaching of farm management and in extension programs to help farmers find the organization of crops and livestock that raise income on individual farms. This was perhaps the major contribution of the study.

In another phase of the study, researchers estimated the minimum size farm that will pay all real and opportunity costs of farming, including a $5,000 income to the operator for his labor, management, and risk.[5] The results were used for farm management planning. They also were used to compute the maximum number of farms possible in a given area if all farmers were to have a "parity" $5,000 income. For example, the results indicated that the number of crop farms in Southwestern Oklahoma would need to decline by approximately 70 percent to assure at least a $5,000 operator labor income (6). These results of the adjusted farm structures were used to determine the farm population, and purchases of farm household supplies and production inputs associated with the adjusted structure through the use of income and population multipliers. The implications of this adjusted structure were determined for schools, machinery dealers, fertilizer dealers, stores, etc. (6). A final phase of the study, nearing completion, is an analysis of the implications for farm income of alternative cotton price supports and acreage allotments.

[5] Another approach to determine the impact of changing prices on farm sizes and numbers is found in Sobering and Tweeten (3).

Summary and Conclusions

The methodology of the S-42 study reported here was a microeconomic linear programming analysis of representative farms located throughout cotton growing areas of the Nation. The format for the study was carefully planned to insure comparable procedures and results that would be aggregated to answer macroeconomic questions.

The results suggest that at very low cotton prices the share of production would rise in California and in Texas and Oklahoma. At high cotton prices and with no allotments, these areas would have a smaller percentage of production than their historic share. At the estimated free market equilibrium price of $0.21 per pound of cotton, the shares of cotton production in the four major areas considered in this study would not differ substantially from the 1962 pattern.

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