A REGIONAL CROP ACREAGE MODEL: ESTIMATION OF ACREAGE RESPONSE TO GOVERNMENT PROGRAMS FOR THE EAST SOUTH CENTRAL REGION IN THE U.S. WITH A FORECAST FOR 1982-1985

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER 1

INTRODUCTION

Since the early 1930's, Congress has established a number of programs intended to soften the impact of economic forces upon farmers. These programs seek to adjust production to utilization on a year-to-year basis by offering incentives to producers to expand or contract their crop planting. As a result, accurate estimates of producer response to changing market prices and government programs are very important for policy makers as they attempt to adjust programs to balance demand and supply. Good forecasts of future crop acreages can also help economists provide producers and agribusinesses with better guides for strategies and planning, marketing, and production decisions.

Much effort has been made to estimate acreage response at the national level.[1] However, due to differences in the structure of competition for cropland in different regions, the effects of some national programs on crop acreage planted vary at the regional level.[2] Thus, it is argued

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[1]See [8], [12], [14], [15], [16], [28], and [29] for example.

[2]See [22] on p. 4.

that regional estimates of acreage response may provide a clearer, more reliable picture than national estimates of how government programs affect crop acreage planted.

The objective of this study is to forecast acreage planted for a specific region using both national government policy variables and region-specific variables. Two aspects of acreage planted which are of particular interest are: (1) whether or not national variables can be used in the regional model, and (2) what additional information can be added to improve the regional model. To pursue the objective of this study, the East South Central (ESC) region was selected. The East South Central region includes six states: Alabama, Arkansas, Kentucky, Louisiana, Mississippi, and Tennessee. This region was chosen for several reasons. First, since this region is located at the fringe of the Corn Belt (Figure 1), it is expected to respond to regional characteristics more than would a region which has a clearly dominant crop. Except for rice, most crops in this region are not significant, relative to the total crop acreage planted in the nation. As shown in Table 1, acreages planted to corn, sorghum, and wheat in the East South Central region were all less than five percent of the average acreage planted in the nation from 1976 to 1980. If the acreage response for such a region can be explained by national variables, then other regional acreage supply models could be expected to be constructed in a similar way without much difficulty.

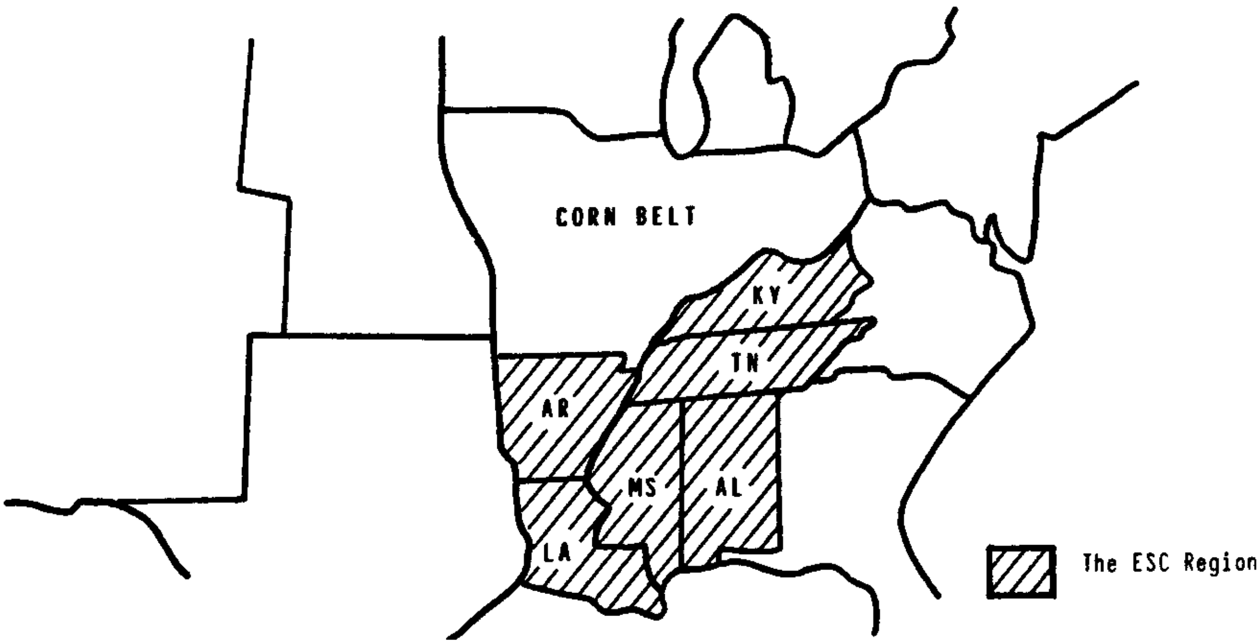

Figure 1. The East South Central Region

Table 1. Percentage of National Crop Acreage of Specified Crops Grown in the East South Central (ESC) Region, 1976-80 Average.

Commodity	Percentage of National Acreage Planted in ESC Region
Corn	4.2
Sorghum	3.2
Wheat	2.5
Soybeans	27.4
Cotton, upland	24.8
Rice	63.5

Source: United States Department of Agriculture

The second reason for studying the East South Central region is related to the region's historically low participation rates in government programs. It is generally assumed that rates of participation would affect the impacts of some commodity programs on acreage response and production.[3] The more farmers participating in the program, the greater the influence the program will exert. Yet with the exception of cotton, rates of participation for government commodity programs are relatively low in the ESC region compared with the national rates (see Table 2).

Table 2. Percentage of Acreage in the East South Central Region (ESC) Enrolled in U.S. Farm Commodity Programs.

Crop Region	Corn	Wheat	Soybeans	Cotton
ESC	24	29	39	76
US	41	71	74	85

Source: USDA[4]

Finally, double cropping of wheat and soybeans is important in this region, and this practice has been growing

[3]Some have argued that output response related to policy variables may also be extended to producers who do not participate in government programs, however. See [32], p. 104 for detail.

[4]See William Lin, James Johnsons, and Linda Calvin, "Farm Commodity Programs: Who Participates and Who Benefits?" USDA Economic Research Service, Agricultural Economic Report No. 474.

in importance in recent years. In the past several years, production costs have risen, while real prices for most agricultural commodities have declined. In turn, this has caused some farmers to begin double cropping in an attempt to utilize their land in a more intensive way and to spread production risks. Nevertheless, as a relatively new type of farming, double cropping has not yet been commonly adopted, though it is becoming more popular in many areas.

A region with a large proportion of crop acreage in double cropping was desired for this study in order to estimate the effects of double cropping on acreage planted. Additionally, in order to capture the influence of increased double cropping on acreage planted, the data needed to show considerable variability. Because the East South Central region satisfied these requirements, it was selected.

In Chapter 2, the theoretical framework of this study will be presented followed by a literature review. Chapter 3 discusses specific considerations in modeling the acreage response for the East South Central region, and estimation results are shown in Chapter 4. Finally, Chapter 5 summarizes the principal conclusions of this research and makes a forecast of acreage planted for 1982-85.

CHAPTER 2

THEORETICAL FRAMEWORK AND LITERATURE REVIEW

This chapter is divided into four parts. First, the basic economic model is presented. Second, farm commodity programs are summarized. Third, the construction of the government policy variables is discussed, and finally, some previous studies are reviewed.

The Basic Economic Model

The primary decision variable which the farmer can control is the acres planted to each crop. Even though production is the product of harvested acres and yield per acre, the farmer's production decision is best reflected by the acres planted variable. Neither crop yields nor harvested acres fully reflect the farmer's decision because both are subject to substantial year-to-year variability due to fluctuations in weather, insect damage, or other factors. Consequently, acreage planted is used as the focus of this study.

Acreage planted can be expressed as an upward-sloping function of the price of the commodity, other things held constant. This reflects the farmer's willingness to increase output as the price of the commodity increases.

Changes in other factors may cause a parallel shift of the supply curve and/or a structural change in the supply. Factors which lead farmers to produce more (or less) at the same price levels are frequently referred to as "supply shifters."[1] The principal shifters of acreage supply include: input prices, the profitability of competing commodities (i.e., those that compete for the same resources, such as land), technology, institutional constraints such as government acreage control programs, weather (temporary shirts), and pests and disease. In the following sections, the above factors which affect crop acreage planted are discussed separately.

Input Prices

The most profitable use of all factors of production is determined by equating the ratio of the price of the product to the prices of inputs, such as labor, fertilizer, and machinery. Thus, an increase in the product price or a decrease in the price of an input will result in an increase in the use of this input and an increase in output. An increase in input prices, other variables held constant, shifts the cost curve of each firm, and hence the supply curve (since the supply curve of the firm is the marginal cost curve in the short run), to the left. A decrease in the price of an input has the opposite effect.

As shown in Figure 2, when input prices rise, supply shifts from SS to S_1S_1. At a given price P_0, farmers will plant Q_1 acres rather than Q_0 in response to the shift of the supply curve. On the other hand, if an input price decreases and the supply curve moves from SS to S_2S_2, the acres planted increase to Q_2.

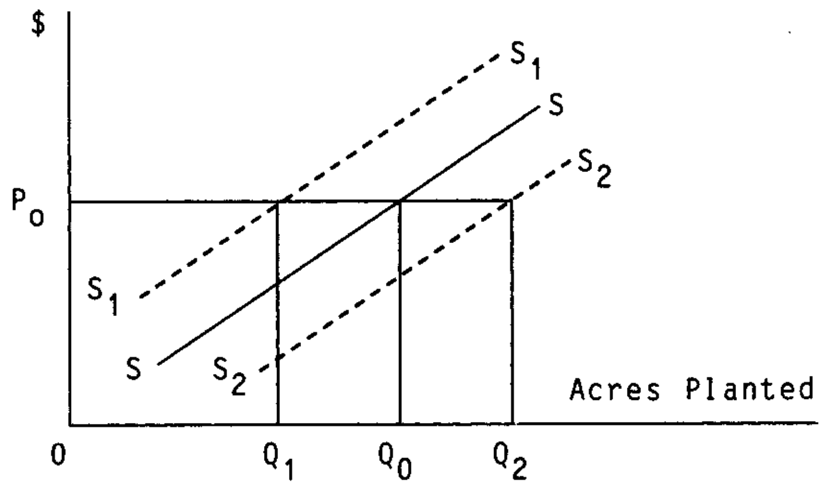

Figure 2. The Effects of Input Price Changes on Acres Planted.

Profitability of Competing Commodities

Competing commodities are commodities that can be produced using the same resources. For example, corn and soybeans are competing crops over much of the central and southern parts of the U.S. Since farmers are assumed to maximize profits, they will attempt to make their planting decisions so as to utilize their scarce resources in the most efficient and profitable way. As a result, a farmer will plant less acres of a crop if its competing crops become more profitable.

A competing commodity Y can become more profitable either because the price of that commodity rises relative to the first commodity X or because the production costs of Y decline relative to the commodity X. In other words, relative changes in product prices, yields, or efficiency can invert the relative profitability of different commodities. Prices of closely competing products are commonly used as indicators of relative profitability among commodities in empirical supply analyses.

Technology

Improvements in technology enable farmers to produce more output with the same quantity of inputs. Important technical changes which have increased agricultural supply are: the development of high-yielding varieties of crops, better methods of controlling insects and diseases, mechanization which makes it possible to plant and harvest more promptly, better tillage techniques, and so on. The effects of these improvements are well known, but it is often difficult to identify and measure precisely how much of a given change in output is due to technical improvements and how much is due to changes in the prices of inputs or products. Because of the definition and measurement problems involved, time or some simple trend variables are often used in regression equations to capture the effects of technological changes.

Institutional Constraints

Because of the involvements of the government, the supply of an agricultural commodity is often influenced by so-called "institutional factors," such as price supports, acreage allotments, and direct payments to retire land or shift it to alternative uses. Government programs apparently have had a marked influence on the production of wheat, corn and other feed grains, cotton, soybeans, and rice in the United States since the depression years of the 1930's. Commodity programs will be summarized, and the construction of policy variables based on these programs will also be discussed in detail later in this chapter.

A very general functional equation based on the above analysis is:

$$A = f\ (M,\ G,\ Z) \tag{2-1}$$

Here, A is the annual acreage planted of the particular crop under consideration, M represents economic forces of markets which influence the decision to plant, G consists of all relevant government policy provisions which affect planting decisions, and Z includes all other supply determinants and random effects.[2]

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[2]See [16].

The major items indicated by M include expected prices for the crop in question and the prices of relevant competing crops. M also includes prices for productive inputs such as machinery, fertilizer, and seed. In addition, interest rates and wage rates available to the farmers for nonfarm employment might also be included in M.

The elements encompassed by Z include the effects of past and current weather patterns, presence of insects and disease, and other random factors. Furthermore, Z might reflect planting decisions made to accommodate long run crop rotations or environmental protection plans, the level of production technology, and some other nonmarket phenomena. Many of these factors are not measurable.

The remaining variables, those reflected in G of equation (2-1), include various commodity program provisions. They include price support loan rates, direct payments to growers, diversion payments, planting restrictions, disaster payments, allotments, marketing quotas, set-aside requirements, long range land retirement payments, and storage payments for grain reserves, etc. It is not possible to include all variables in the model due to statistical considerations. Those variables relating to support prices and acreage control during the sixties, seventies, and early eighties were included in all equations of this acreage supply analysis.

Commodity Programs

Since the early 1930's, Congress has established a number of programs intended to soften the impact of economic forces upon farmers. These programs are commonly referred to as commodity programs or farm programs. This section reviews commodity programs and discusses important changes in program provisions for the period from 1961 to 1981.

Commodity programs were altered to reflect different short-run views of economic conditions after World War II. For example, during the 1950's and 1960's, the substantial increase in the supply of feed grains due to technological advances was not matched with a growth in demand, and government programs attempted to restrict supplies. On the other hand, the Agriculture and Consumer Protection Act of 1973 placed its emphasis on production to respond to "ever-growing world-wide demand for food and fiber."[3] Programs were also altered to reflect changing political views of farm problems and their solutions from administration to administration. The methods applied in different programs which attempt to raise and stabilize crop prices and farm incomes are generally grouped into three categories: price supports, direct payments to farmers, and supply controls.[4]

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[3]See [29], pp. 212-213.

[4]See [40].

Price Supports

Price supports are used to maintain the prices of agricultural commodities at efficient levels and to keep farm incomes from falling precipitously when production gluts or unexpected reductions in demand result in very low prices. There are two principal ways to support prices: nonrecourse loans and commodity purchases.

Nonrecourse loan programs have existed since 1933. The Secretary of Agriculture announces the loan level for each commodity having such a program before the planting season so as to permit the producers to plant and gear his farm operations to appropriate programs. To be eligible for the loan programs, farmers are required to comply with the set-aside requirement and acreage allotment provisions of the commodity programs.

Under these programs, farmers may place any portion of their production in storage and use it as collateral for loans from the Commodity Credit Corporation (CCC), a government-owned corporation directed by the Secretary of Agriculture and other USDA officials. Usually, eligible farmers have eight to ten months after harvest to place commodities under loans, and the loan period runs nine to twelve months.[5] A farmer may either repay the loan with interest on or before its maturity date and take over the

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[5]See [2], pp. 26-27.

storage and marketing of the commodity himself, or the farmer may use the commodity to repay the loan. In this case, the CCC agrees to accept the stored commodity as full satisfaction for repayment of the loan.

Loan rates, in effect, provide a minimum or floor price to farmers. Farmers are guaranteed cash for their crops at the floor price, without losing the opportunity to gain from any future price rise. Nonrecourse loans are made for wheat, feed grains, cotton, soybeans, rice, peanuts, tobacco, sugar, and a few minor commodities.

In addition to nonrecourse loans, direct commodity purchases may be made by the government to support prices. The CCC usually purchases commodities from eligible producers at the county basic loan rate, adjusted by premiums or discounts for quality, to keep market prices from falling below the support prices.

Direct Payments

Direct payments are designed to supplement farm incomes in low price years. They are used to induce farmers to participate in supply control programs. There are several types of direct payments to farmers: deficiency payments, diversion payments, and disaster payments.

Deficiency payments are viewed as income supplements to producers, moderating the effects of short run price fluctuations. Target prices, which serve as the basis for calculating deficiency and disaster payments to producers, are established by the USDA for each commodity under the program (Table 3). When the average market price received by farmers during the first five months of the marketing year (Table 4) or calendar year for cotton is less than the target price, the eligible farmers can receive the deficiency payments. The payment rate is the difference between the target price and the higher of the loan rate or the average market price. The payment received by a farmer is calculated by multiplying the payment rate by the quantity of eligible production.

To illustrate the operation of deficiency payments and loans, three situations are shown in Figure 3:[6]

(1) Market price above target price and loan rate levels. As shown in Figure 3(a), there will be no deficiency payments under this situation, and producers would sell their products in the open market at the market price, P_m.

(2) Market price below the established target price but above the loan rate level. Part (b) of Figure 3 shows that deficiency payments would be made in this case and equal to the difference between the target price, P_t, and the market price, P_m, multiplied by the quantity of eligible production, Q_a. The farmer would sell his production at the market price, P_m.

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[6] See [28].

Table 3. Loan Rates and Target Prices for Major Commodities, 1980 and 1981 (in dollars per unit).

Commodity	Unit	Loan Rate		Target Price	
		1980	1981	1980	1981
Corn	bu	2.10	2.40	2.35	2.55
Grain Sorghum	bu	2.00	2.28	2.50	2.55
Barley	bu	1.71	1.95	2.55	2.60
Wheat	bu	2.50	3.50	3.63	3.80
Cotton, upland	bu	0.48	0.50	0.58	N/A
Soybeans	lb	4.50	5.02	N/A	N/A
Rice	cwt	7.12	8.01	9.49	10.68

Source: United States Department of Agriculture.

Table 4. Marketing Years for Selected Commodities.

Commodity	Marketing Year	
	Begins	Ends
Corn	October 1	September 30
Grain Sorghum	October 1	September 30
Barley	June 1	May 31
Oats	June 1	May 31
Wheat	June 1	May 31
Soybeans	September 1	August 31
Cotton, upland	August 1	July 31
Rice	August 1	July 31

Source: USDA

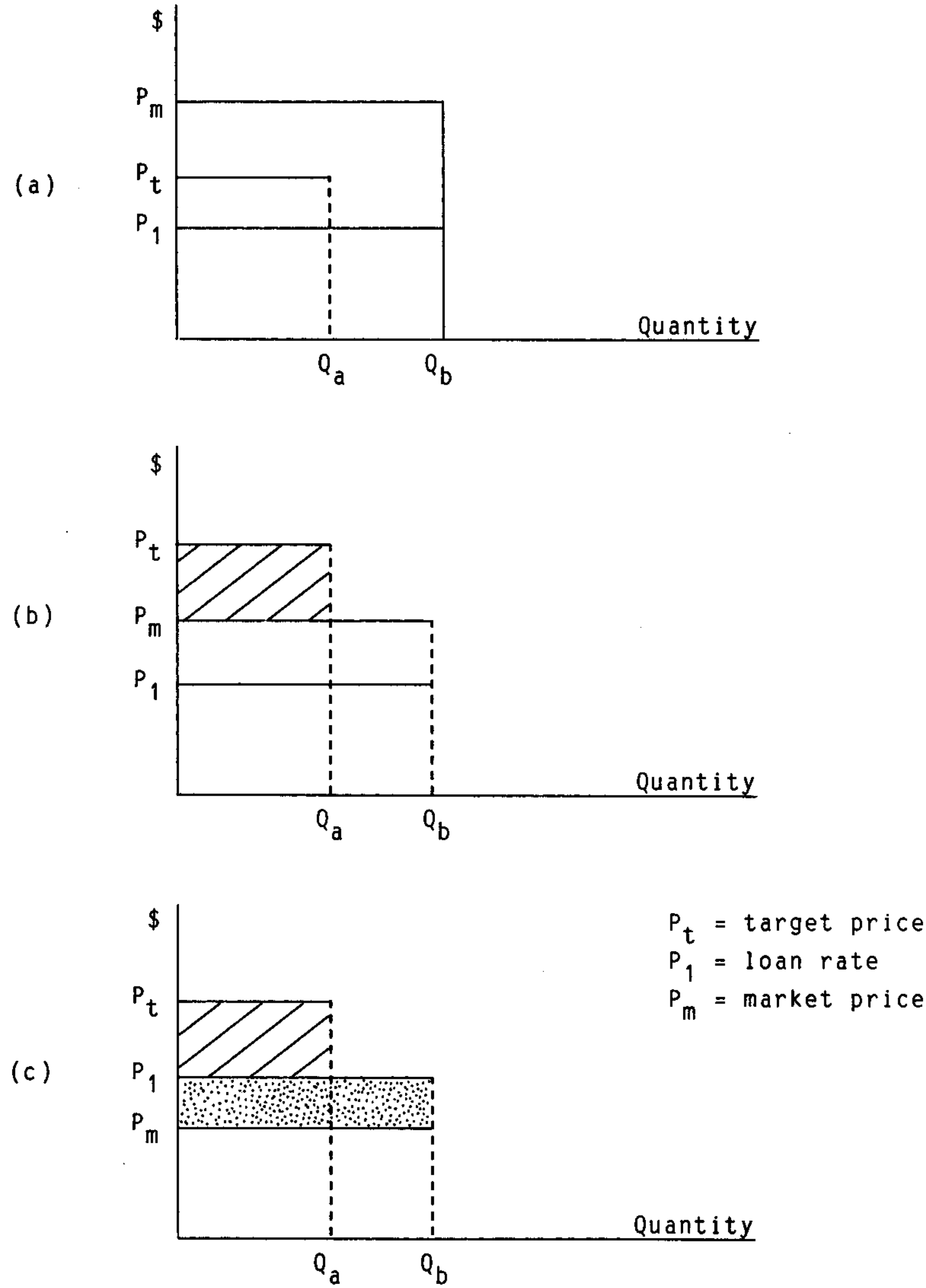

Figure 3. Operation of Target Price and Loan Rate Concepts.

(3) Market price below both the target price and loan rate levels. In part (c), the eligible producer would receive deficiency payments of $(P_t - P_1) * Q_a$. The loan rate also reflects the floor price, and the market price is unlikely to fall much below it. If this situation did happen, farmers would elect to place their production in the nonrecourse loan program and not to redeem it. Farmers receive the loan rate on all production, Q_b, plus the additional deficiency payments on the eligible production, Q_a.

The target price and loan rate concepts were included in the 1973 Act and extended by the 1977 Act through 1981 for wheat, feed grains, cotton, and rice. Before 1973, price supports were related to parity prices—prices based on the 1910-14 period levels.

Another type of direct payment is that of disaster payments. If poor weather prevents planting or causes a poor harvest, a farmer may be eligible for disaster payments. Because disaster payments are made due to uncontrollable variables such as weather, they will in general not affect farmers' planting decisions. As a result, this variable is not considered in the study.

Finally, diversion payments, which are also a kind of direct payment, are devised to encourage participation in supply control programs. Farmers who agree to reduce the acreage under certain crops are eligible for diversion payments. For example, corn farmers who participated in the cropland set-aside program and diverted additional acreage equal to ten percent of corn planted in 1979 received a diversion payment of 10¢ per bushel on their farm yield times their planted acreage in 1980.

Supply Controls

The government has used many tools to restrict the supply of farm products, including acreage allotments, marketing quotas, cropland set-asides, voluntary acreage diversions, and farmer-owned grain reserves. These programs help to limit the supply of farm products and also avoid excessive stocks.

National acreage allotments are determined by the Secretary of Agriculture based on expected domestic and foreign requirements as well as any increase or decrease in stock that is desired. The national acreage allotments are then apportioned among states, counties, and farms, basically consistent with past production. When acreage allotments are in effect, a farmer who chooses to exceed his acreage allotment may lose eligibility for price supports.

Acreage allotments were applied for major crops until the 1977 marketing year. Currently, these programs are only used for rice, peanuts, extra long staple (ELS) cotton, and most types of tobacco. There were no acreage allotments on wheat, feed grains, soybeans, or upland cotton for the 1978-1981 period. Program acreages are used to determine the production eligible for price supports. The national program acreage of a specified crop is the number of harvested acres required to meet estimated domestic and export needs with imports deducted, plus any desired increase or decrease in carryout stocks. The farm program acreage equals the acreage planted for harvest on the individual farm multiplied by the program allocation factor (PAF)—the ratio of the national program acreage to the Secretary's estimate of harvested acreage. Under the 1977 Act, this allocation factor is no less than eighty percent nor greater than 100 percent.

Marketing quotas limit the marketing of certain commodities by imposing penalties on excess production. At present, marketing quotas are in effect for ELS cotton, peanuts, and most types of tobacco.

Cropland set-asides, if in effect, are required as a condition of eligibility for nonrecourse loans, direct payments, and other benefits of programs. Under the set-aside requirements, participating farmers must withdraw cropland equal to a specified proportion of their historically planted or allotted acreage from production and devote it to approved conservation practices.

In addition, voluntary acreage diversion is another tool that the government uses to control crop production. To induce participation, the Secretary of Agriculture can make payments to farmers who divert cropland to conservation uses, regardless of whether a set-aside program is in effect. For the 1978-81 period, producers who voluntarily reduced their acreage planted for harvest from the previous year by the percentage recommended by the Secretary, received any required deficiency payments on their entire harvest acreage. For example, farmers who voluntarily reduced their 1978 planting of corn by five percent (sorghum, 5%; barley, 20%) from the 1977 planted acreage in addition to the ten percent of set-aside received target price coverage on 100% of their 1978 corn harvest acreages. Otherwise, farm acreage eligible for target price protection would be determined by the program allocation factor.

Under the Act of 1977, wheat and feed grain farmers may participate in a government-financed grain reserve (or storage) program. Farmers who participate in this program agree to extend their original nonrecourse loans for three to five years. In return, they receive annual storage payments from the government, and interest may be waived.

Under this so-called farmer held (owned) grain reserve program, the farmer agrees not to sell his grain until national average farm prices reach the "release level" (e.g., the release price was $2.63 per bushel for corn and $3.75 per bushel for wheat in 1980). Once the release level is achieved, the farmer may repay his nonrecourse loan plus one year's interest and sell the grain without penalty. On the other hand, farmers who decide to sell grain in reserve when the market price is below the release level must repay their loans plus interest and storage payment (provided total payment is no less than 125%

of the current loan rate for corn and 140% for wheat) multiplied by the quantity of grain redeemed. If the national average farm prices achieve the "call levels" ($3.05 per bushel for corn and $4.63 per bushel for wheat in 1980, for example), the farmer must repay his nonrecourse loan plus interest or forfeit the grain to the government. Minimum and maximum release levels and the minimum call level are specified by law for wheat as a proportion of the loan rate, but the Secretary determines the call level for feed grains. This farmer held grain reserve program was in effect through 1981 under the Act of 1977.

Government Policy Variables

The primary purpose of this section is to quantify the price and income support features of the annual commodity programs and their acreage control provisions. In a study by Houck and Ryan (1972), the terms "effective price support" and "effective diversion payment" were first introduced.[7] The fundamental concepts of these two policy variables are illustrated below.

As shown in Figure 4(a), S_1S_1 represents a static acreage supply function of a crop at various price support levels. The position of S_1S_1 will vary due to market conditions and other supply factors; however, the slope of

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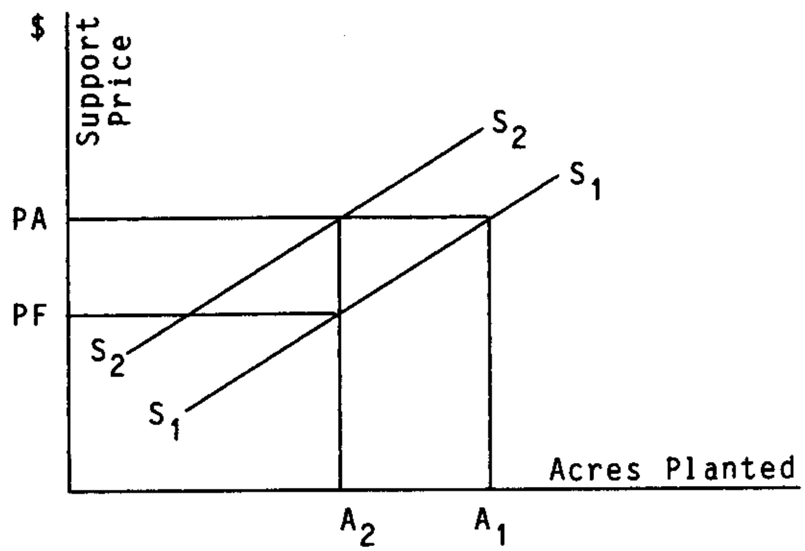
[7] The "effective support" concept was first seen in an even earlier paper. See [15].

(a)



(b)

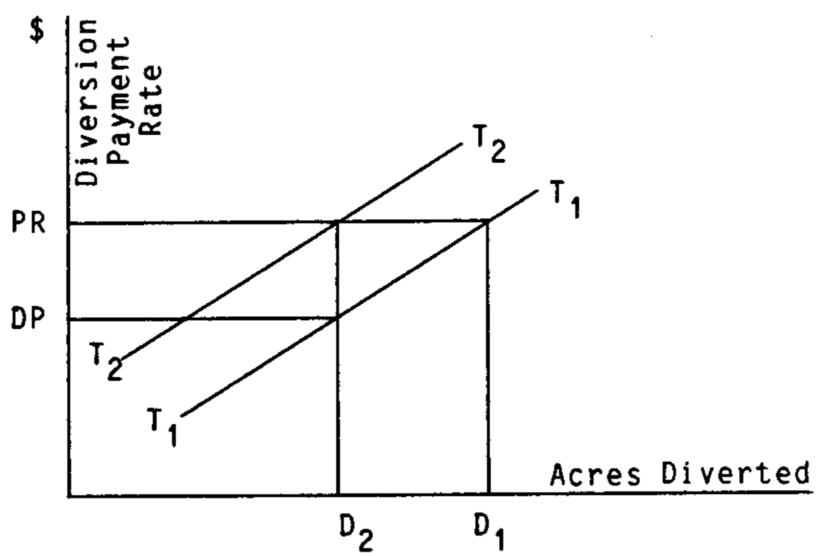


Figure 4. Relationship of Government Commodity Programs to Crop Acreage Planted.

S_1S_1 will always be positive. Producers will view the announced support rate as a price guarantee unless planting restrictions determine the eligibility for receiving the support rate. At the announced price support, PA, producers will plant A_1. At a higher support rate, farmers will increase acres planted. Alternatively, at a lower support rate, farmers will plant less.

If policy makers wish to reduce acreage to, say, A_2, then they can either lower the support rate to PF or attach some condition to restrict acreage planted. The "effective support rate" is given by the combination of the support rate and the planting restriction which determines the eligibility for receiving the support rate. PF is therefore defined as:

$$PF = r * PA \qquad (2\text{-}2)$$

Where r is the proportion of the farmer's production that is eligible for the support rate. The range of r is between 0 and 1; the tighter the restrictions, the closer r will be to zero.

Alternatively, policy makers could reduce planted acreage from A_1 to A_2 in Figure 4(a) by making diversion payments. When diversion payments are made, the crop supply curve will shift to the left. This occurs because some farmers will find it profitable to divert their least productive land from production and accept the government diversion payment. As shown in Figure 4(a), the government could announce an unrestricted support price of PA while offering diversion payments attractive enough to shift the supply curve from S_1S_1 to S_2S_2. This would reduce acreage planted from A_1 to A_2. The "effective diversion rate" is defined as:

$$DP = w * PR \tag{2-3}$$

where PR is the announced payment rate for diversion, w is the portion of the base acreage eligible for diversion, and DP is the effective diversion payment rate. If all land is allowed to be diverted for payments, w equals 1.0. The smaller the required diversion acreage, the closer w will be to zero.

As illustrated in Figure 4(b), if other things remain unchanged and PR is the diversion payment rate without any restriction, then D_1 acres will be diverted from production. If D_2 is the desired diversion, policy makers can simply establish the diversion rate at the lower level, DP. Alternatively, they can impose a constraint on the maximum amount eligible for diversion w, with the announced payment rate for diversion PR. The desired diversion D_2 can also be obtained with the unrestricted PR by increasing the support rate PA or PF sufficiently so that the supply of divertable acreage shifts from T_1T_1 to T_2T_2.

According to the above illustration, the effective support and diversion rates depend upon not only the announced payment levels (PA and PR) but also the amount of acreage eligible for payments (r and w). Other things held constant, changes in any of these factors will affect acreage planted. Increases in r or PA will raise PF and encourage more acres to be planted. On the other hand, increases in w or PR will expand DP and decrease acreage planted.

The estimation of farmers' acreage response requires the inclusion of these government variables. However, in reality, including these variables into estimated acreage equations is difficult because of the number of changes in government programs which have occurred over the last several decades. As government programs have changed, some new policy variables have been introduced while others have been eliminated. This makes it difficult to obtain a consistent data series for individual variables. Other researchers have also addressed this problem, and their work is reviewed in the next section.

Literature Review

Several previous studies in related fields are reviewed in this section, with the primary emphasis on the methods of measuring policy variables and the regression results. An article published by Ryan and Abel (1972) estimated the U.S. corn acreage response to changes in commodity programs. Basically, the two policy variables were calculated according to equation (2-2) and equation (2-3), with r equal to the proportion of the base acreage permitted for corn planting and w equal to the eligible diversion level. For most years in which the range of permitted planting was provided, the simple average of the minimum and maximum shares allowed were used. For example, in 1963, farmers could receive the total support rate of $1.25 if they planted between 0.6 and 0.8 of their base acreage. Hence, $r = \frac{1}{2}(0.6 + 0.8) = 0.7$, and $PF = 0.7 * 1.25 = 0.875$ for 1963. Similarly, if a range of eligible diversion levels was allowed, then the minimum and maximum provisions were averaged as was done in calculating PF. If the diversion payment rate differed for various levels of diversion, then DP would be calculated based on the following equation:

$$DP = w_1 * PR_1 + w_2 * PR_2 \qquad (2\text{-}4)$$

where the subscripts 1 and 2 refer to different payment rates for different portions of the diverted acreage.

Ryan and Abel (1972) argued that policy variables could capture the effect of market prices in inducing changes in the supply of feed grains. Consequently, lagged or expected market prices were omitted in their models. Using ordinary least squares, one of their estimated equations is shown as follows:

$$\underset{}{A = 99{,}316} + \underset{(3.2)}{8{,}954PF} - \underset{(5.3)}{48{,}061DP} - \underset{(4.7)}{10{,}010PSS} - \underset{(3.4)}{0.34AGM} + \underset{(7.5)}{7{,}016DV} - \underset{(2.2)}{243T} \qquad (2\text{-}5)$$

$R^2 = 0.986$

where t-values are shown in parentheses, and:

A = U.S. acreage of corn planted, in thousands

PF = U.S. average corn loan rate, weighted by acreage restriction requirements, in dollars per bushel

DP = corn acreage diversion payment rate, weighted by eligible diversion acreage, in dollars per bushel

PSS = U.S. average soybean price support loan rate, in dollars per bushel

AGM = U.S. acreage of sorghums planted for 1949-60 and the mean of 1949-60 acreage for 1961-70, in thousands

DV = 0 in 1949-65 and 1 in 1966-70

T = linear trend (1949 = 1, 1950 = 2, etc.)

A dummy variable, DV, was included to account for the change beginning in 1966, when direct support payments were shifted from the calculation of PF to DP.

The results of this model show that corn policy variables, PF and DP, contribute importantly to the explanation of changes in acreage planted. A 10¢ increase in PF results in an estimated increase of 895 thousand acres in corn planting. On the other hand, the estimated effect of a 10¢ increase in DP is associated with a decrease of about 4.8 million acres in planting.

Hoffman (1975) also applied the concepts of the effective price support and the effective diversion payment to estimate the impact of government programs on wheat acreage. However, the ways his policy variables calculated were different from Ryan's and Abel's work. Commodity programs for wheat were grouped into three broad historical periods: 1950-63, 1964-73, and the 1974 crop year. The effective diversion payments for wheat were calculated based on equation (2-3) for all three periods; the effective support rate for the 1950-63 period was computed according to equation (2-2). But because the "cross-planting substitution" provision was taken into account, the calculation of the effective support rate was more complicated for the period of 1964-73. This substitution provision allowed producers who complied with the wheat and feed grain programs to substitute acreage of feed grains (corn, grain sorghum, or barley) for wheat or wheat acreage for feed grains, within the total acreage permitted under both programs. In addition, a producer who had an oat-rye acreage base for his farm might also substitute wheat on this acreage. This provision effectively permitted a producer to offset any required diversion by planting on the permitted acreage of the competing crop. The general formula for computing annual effective support rates thus became:

$$PFW = \frac{A_a' - RD + CP - A_d}{A_o} * LR + \frac{A_d}{A_o} * (LR + DP) \qquad (2\text{-}6)$$

where:

PFW = Effective support for wheat, in dollars per bushel

A_a' = Acreage allotment (total) adjusted for diversion and small farm adjustment, in acres

A_d = Acreage allotment (domestic), in acres

A_o = Base acres

RD = Required diversion from adjusted allotment, in acres

CP = Feed grain base available for cross-planting substitution, in acres

LR = Loan rate, in dollars per bushel

DP = Direct payment, in dollars per bushel

The general form used to compute the effective price support rate was modified again for 1974, when target prices were introduced under the Act of 1973; that is:

$$PFW = \frac{A_a}{A_o} * (LR + DP) + \frac{A_o - A_a}{A_o} * LR \qquad (2\text{-}7)$$

where:

PFW = Effective support for wheat, in dollars per bushel

A_a = Acreage allotment (total), in acres

A_o = Base acres

LR - Loan rate, in dollars per bushel

Unlike Ryan's and Abel's work, lagged market prices for wheat were included in the model. In addition, a weather factor was also included as an explanatory variable for wheat acreage planted. Equation (2-8) presents the estimated results:

$$AWP = -15.39 + \underset{(8.9)}{22.45PFW} - \underset{(2.1)}{8.21DPW} + \underset{(5.0)}{13.19PWH_{-1}} + \underset{(2.6)}{0.23RNC} - \underset{(0.3)}{0.04AWP_{-1}} \quad (2\text{-}8)$$

$$R^2 = 0.89$$

where:

AWP = Wheat acreage planted, in million acres

PFW = Effective price support rate, in dollars per bushel

DPW = Effective voluntary diversion payment rate, in dollars per bushel

PWH = Lagged price of wheat received by farmers, in dollars per bushel

RNC = Southern Plain range condition, index value

The results suggest that wheat program policy variables, PFW and DPW, were important factors for explaining annual wheat acreage. Lagged market prices for wheat were also highly significant in the model. The elasticity of response with respect to the lagged market price was 0.28 evaluated at the 1968-70 mean.

It has been argued that whether or not the market prices should be included in the acreage supply model depends on the market conditions. Producers appear to respond primarily to market prices under strong market conditions and to support prices when the market is weak.

More recent estimates accounted for strong market prices with a spliced supply inducing price.[8]

Finally, a study done by Garst and Miller in 1975 estimated the impacts of the set-aside program on the U.S. wheat acreage in quite a different way. Instead of constructing the "effective support rate" and the "effective diversion payment rate," wheat acreage allotments, additional diversion of allotment acres under the diversion programs, and total acres of wheat set aside under the set-aside program were used as explanatory variables in their wheat acreage supply model.

The regression results from 1961-74 U.S. wheat data are shown as follows:

$$\hat{Y} = 15{,}479.28 + \underset{(***)}{0.62b_1} - \underset{(***)}{0.61b_2} - \underset{(***)}{0.41b_3} + \underset{(***)}{43{,}453.08b_5} + \underset{(***)}{4{,}089.61b_6} \quad (2\text{-}9)$$

$R^2 = 0.987$

where:

$\hat{Y}$ = Acres planted to wheat revised by estimated impacts of wheat prices on acres planted (1,000 acres)

b_1 = U.S. wheat acreage allotment (1,000 acres) ('71-'73 use lagged wheat acreage planted)

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[8] In [16], producers were assumed to respond to the effective support price prior to 1972 and the lagged market price afterwards.

b_2 = Additional diversion of allotment acres under the diversion programs (1,000 acres)

b_3 = Total acres of wheat set aside under the set-aside program (1,000 acres)

b_5 = Dummy variables representing the change in the model structure accompanying removal of acreage allotment

b_6 = Dummy variables representing the removal of marketing quota penalties from the allotment program and allowing substitution of wheat for feed grains

*** Indicates the estimated coefficients are significant at the 0.01 level

Unlike other studies, the model explains acreage response to government programs in a very direct way. In addition to lagged prices for wheat, wheat set-asides, and diverted acres, the results suggest that wheat acreage allotment is also important for explaining wheat acreage adjustment. The model excluded, however, the impacts of price support programs on acreage planted.

More studies have been done in recent years to estimate the impacts of changes in government programs on crop plantings (see, for example, [5] and [6], [7], [8], [16], [21] and [22], [24], etc.). The basic ideas of how to measure policy variables and to construct the models are similar.

CHAPTER 3

SPECIFIC CONSIDERATIONS IN MODELING THE EAST SOUTH CENTRAL REGION

This chapter presents the development of the supply models for the major crops of the East South Central region. First, the trends in production, acreage planted, and yields of these major crops are discussed. Then, the variables used in the models are defined. The practice of wheat-soybean double cropping is discussed, followed by the development of a variable to capture the profitability of double cropping.

Trend in Production, Acreage Planted, and Yield

Changes in crop production for the East South Central area can be viewed by comparing the data of 1961-63 with that of 1979-81. To identify the source of production shifts, the plantings and yields for each of the major crops, including corn, sorghum, oats, soybeans, wheat, cotton, and rice, are presented in Table 5.

Production of corn, sorghum, soybeans, wheat, and rice have increased over the past twenty years, while oats and cotton production have declined forty-eight and forty percent, respectively. The largest increase in sorghum production occurred in 1970, when production was more than

Table 5. Crop Production, Acreage Planted, and Yield for the East South Central Region, 1961-63 and 1979-81.

Crop	Production			Acreage Planted			Yield		
	million bu.		Change	million acres		Change	bu./acre		Change
	1961-63	1979-81	(%)	1961-63	1979-81	(%)	1961-63	1979-81	(%)
Corn	199.0	210.0	5.5	4.9	3.2	-34.0	42.7	75.3	76.3
Sorghum	2.3	19.5	748.0	0.22	0.55	150.0	31.0	46.1	48.7
Oats	2.5	1.3	-48.0	1.3	0.25	-80.0	36.5	51.0	39.7
Soybeans	100.0	423.0	323.0	5.5	18.7	240.0	20.0	23.0	14.4
Wheat	15.0	104.0	593.0	0.74	3.1	319.0	27.0	37.1	37.4
Cotton (upland)	5.2[a]	3.1[b]	-40.0	5.0	3.0	-40.0	521.0	526.0	NS
Rice	33.0[c]	88.0[3]	167.0	0.96	2.2	129.0	3.5[d]	4.14	17.1

[a]millions of 500 pound gross weight bales
[b]millions of 480 pound net weight bales
[c]million cwt
[d]1000 cwt
NS: Not Significant

Source: USDA [40].

three times the previous year's production. Production jumped from 6.78 million bushels in 1969 to 21.40 million bushels in 1970. The increase in wheat production concentrates in the latest two years, while production of soybeans and rice has grown at relatively constant rates.

Almost all crop yields have increased over the 1961-63 to 1979-81 period, except cotton yield, which has changed less than one percent over the last twenty years. Generally speaking, crop yields have improved at steady rates through the period studied, excluding some variations due to weather.

Total acreage planted for these seven major crops in the East South Central region has increased from 18.62 million acres to 31 million acres in twenty years, primarily because of the huge increase in soybean planting. In addition to soybeans, sorghum, wheat, and rice planted acreage has also expanded. Acreage planted for corn, oats, and cotton, however, has decreased.

Figure 5 illustrates the annual changes in planted acreage for each crop. Soybean planting has continuously grown until 1979, when it reached the peak of 19.4 million acres and then began to decline.[1] The most important

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[1]According to Brown (1971, p. 1), the percentage increase in soybean plantings in any year varied with program provisions associated with corn, wheat, and cotton. As a result, the reduction of soybean acreage planted in 1980 and 1981 may correspond with the large increase in wheat allotments.

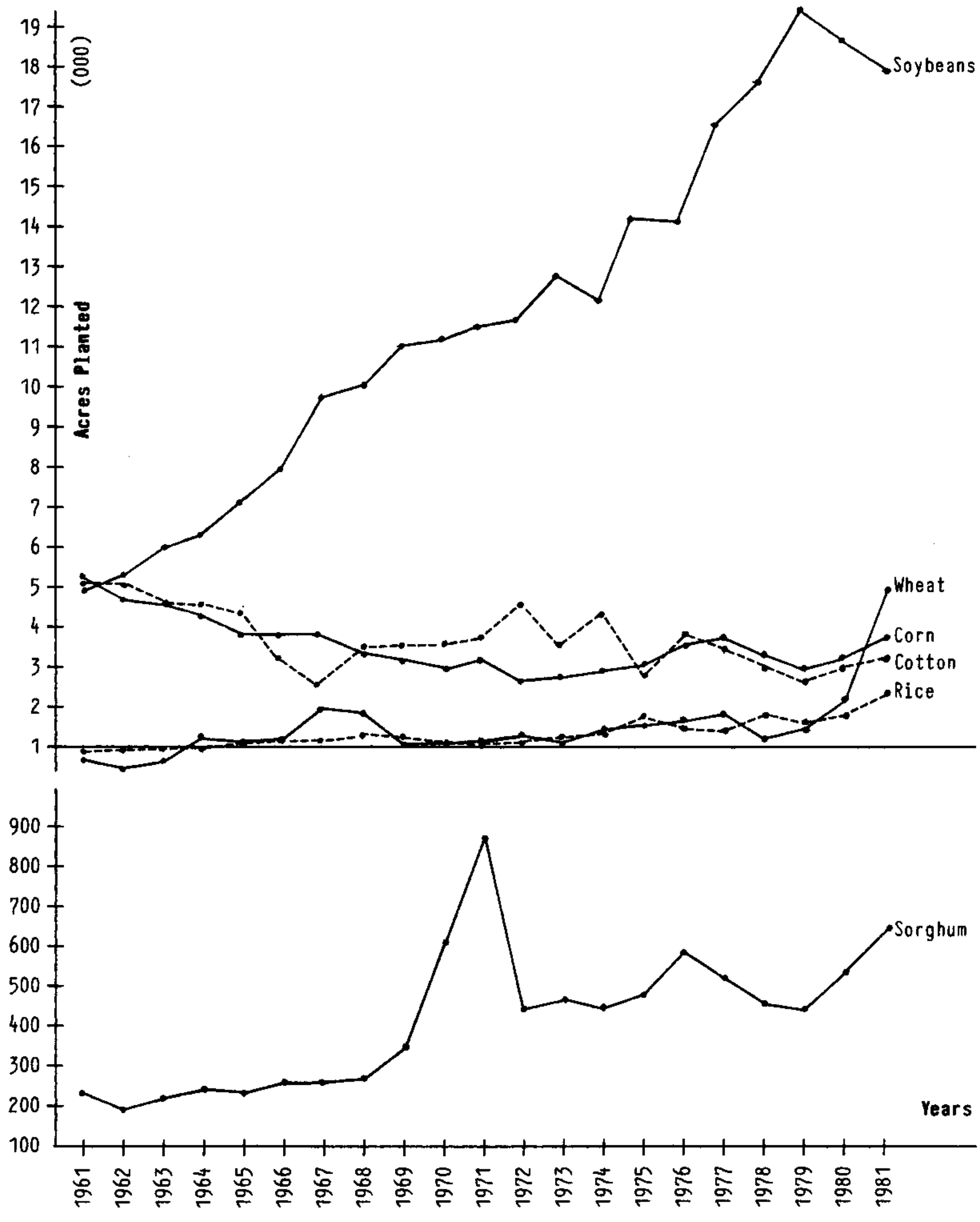

Figure 5. Acreage Planted to Main Crops in the East South Central Region.

factor contributing to the increased soybean acreage was the rapid increase in demand for soybean meal and oil, which has maintained soybean prices at a relatively attractive level.

Mckeon (1974, p. 63) showed that wheat plantings are strongly influenced by government policy, and this is consistent with the results for the East South Central region crops. Wheat planted acreage rose from an average of 740 thousand acres in the 1961-63 period to 1,250 thousand acres in 1964, when marketing quotas were suspended. Marketing quotas have not been in effect since then. In addition, increases in national allotments have also influenced wheat planting. In 1967, for example, the large plantings followed a substantial increase in wheat allotments—from 51.6 million acres to 68 million acres.

Corn planting had shown a downward trend through 1973 but rose between 1974 and 1977. This rise was linked to high prices combined with an absence of set-aside requirements for corn planting. Similarly, the effects of set-aside requirements on corn planting can also be detected in the years of 1978-81.

There has been an upward trend in sorghum acreage planted, with the peak of 880 thousand acres in 1971. Because grain sorghum is a relatively minor crop for some states in the East South Central region, such as Louisiana, it is primarily produced for livestock rather than as a cash crop.[2] This fact may lead to the favorable profits for livestock as a factor for the rise of grain sorghum planted acres in the early seventies.

Acreage planted for rice in the studied region has also expanded in the past twenty years, especially after 1974 when marketing quotas were ceased. From 1973 to 1981, rice acres planted have more than doubled in this region. Cotton planting, in contrast, has decreased about forty percent in these years due to the unfavorable profit situation.

Variables and Data

The variables used in the model were selected or designed primarily based on the theoretical framework discussed in the previous chapter.

Acreage planted is the dependent variable for all equations. Independent or explanatory variables include expected market prices for products, input prices, government policy variables, double cropping variables, trends, weather, etc.

Expected market prices for the crop in question and its competing crops are usually included in crop supply models to capture the effects of the relative profitabilities for the crop. Expected prices cannot be observed and must be approximated by observable prices. The most common

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[2]See [31], p. 39.

expectation model in econometric work is where expected prices are a function of the previous period prices. With the assumption that the latest prices have the most effect on farmers' planting decisions, one-year and two-year lagged market prices were used as expected prices.

Input prices. It is impossible to include all input prices into one equation because of the limited degrees of freedom available for the equation. Hence, only the one or two most important input prices which contribute to production costs were considered. For crops such as corn and wheat, fertilizer costs are the most important items of the production costs. For instance, about forty percent of the total variable cost for corn production in the Southeast region was accounted for by fertilizer in 1980.[3] For a crop like cotton, however, chemicals are even more important and account for almost thirty percent of the total variable costs. Rising energy prices have been the major factor in recent years causing the increases in production costs for most crops. The input price series used were: for fertilizer, the index of prices paid by farmers for fertilizer; for chemicals, the index of prices paid by farmers for chemicals; for energy, the index of prices paid by farmers for fuel and lubrication. As an alternative to these individual input price series, the index of prices

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[3] See [38], p. 11.

paid by farmers for all commodities bought, including interest, taxes, and wage rates, were also used in some equations.

Policy variables. There were two government policy variables, policy variable I (PV1) and policy variable II (PV2), constructed to summarize price support and diversion payment provisions. The general forms used to calculate the values of the two policy variables are shown in equations (3-1) and (3-2):

$$XPV1 = XLR * (1 - XSA) + (XTP - XLR) * XPAF \quad (3\text{-}1)$$

$$XPV2 = (XTP - XLR) * XRVD + XDDP \quad (3\text{-}2)$$

where: X represents the crop names, including corn, sorghum, wheat, soybeans, and cotton; LR means the loan rate; SA is the proportion of crop acreage idled under set-aside requirements; TP indicates the target prices; PAF is the program allocation factor; RVD stands for the announced percentage of the recommended voluntary diversion; and DDP denotes the direct diversion payment rates.

Another major provision of the wheat and feed grain programs under the Act of 1977, the farmer-owned reserve, was not included in our equations. Even though the farmer-owned reserve provision increases price expectations of producers both in and out of the program, the nature of this provision leads to neither the release price nor the call price being considered as the primary supply-inducing price.[4] First, since the contract may expire without the release or the call price being reached, these price levels, at most, set an approximate upper bound on the final selling price but not a guarantee. Moreover, the reserve is usually made under a three- to five-year contract; hence, farmers must form their expectations not only of the selling price under the program but also of the time path of price movements. In other words, the expected selling price must be discounted.

Trend variable. Mckeon (1974, pp. 48-57) took crop yields as indicators of comparative advantage with the assumption of neither product nor input prices varying greatly between crop producing regions. The studied region was shown to have comparative advantage in producing soybeans and disadvantage in producing corn. Therefore, corn plantings have declined while soybean plantings have expanded. A simple trend variable was used to capture these supply shifts.

Data. Regional data on acreage planted and production were obtained by summing the figures of each state within the region. Regional yields were calculated as the weighted (by acreage) average yield of all states within the region.

Acreage planted for corn, sorghum, wheat, soybeans, rice, and upland cotton together accounted for about

[4] See [5], p. 3.

eighty-five percent of the planted area in the East South Central region in 1981 (Table 6). This study considered most of these commodities except rice. The estimation procedures were based on ordinary least squares applied to the 1962-81 historical period.

Table 6. Planted Acreage for the East South Central Region, 1981.

Commodity	Percent of Total Plantings
Soybeans	45.9
Wheat	13.4
Corn	8.7
Cotton, upland	8.3
Rice	6.7
Sorghum	1.7

Source: USDA [40].

The Practice of Soybeans Double Cropped Following Wheat and Its Variable

The discussion of this section is divided into three parts. First, the background for adopting this type of farming is examined. Then the profitability of wheat-soybean double cropping and its constraints are analyzed. Finally, a double-cropping variable is devised according to the discussion in the first two parts.

In the past several years, rapid increases in production costs and declining real prices for grains and soybeans (Figure 6) have led to unfavorable profit conditions for farmers. Energy prices, for example, have risen about 270%, and fertilizer costs are up almost 160% over the 1973-81 period. Combined with huge increases in land prices and other productive input prices, the overall production costs for agricultural commodities have more than doubled since 1973 (Table 7). Facing less profits for their products but more undertainty in the markets, farmers have looked for ways to spread risk and improve earnings. Double cropping offered the potential to achieve their objectives.

Table 7. Increases in Production Costs: Index of Prices Paid by Farmers for Fertilizer, Fuel and Lubrication, and All Commodities, 1973 and 1981. (1977 = 100)

Cost Item / Year	1973	1981	Percent Change
Fertilizer	56	144	+157
Fuel and Lubrication	57	213	+274
All Commodities	71	150	+111

Source: USDA [41].

Double cropping has been a common practice since men first cultivated crops, but the practice of soybeans double cropped with wheat or other small grains has only developed recently. Several genetic and technological

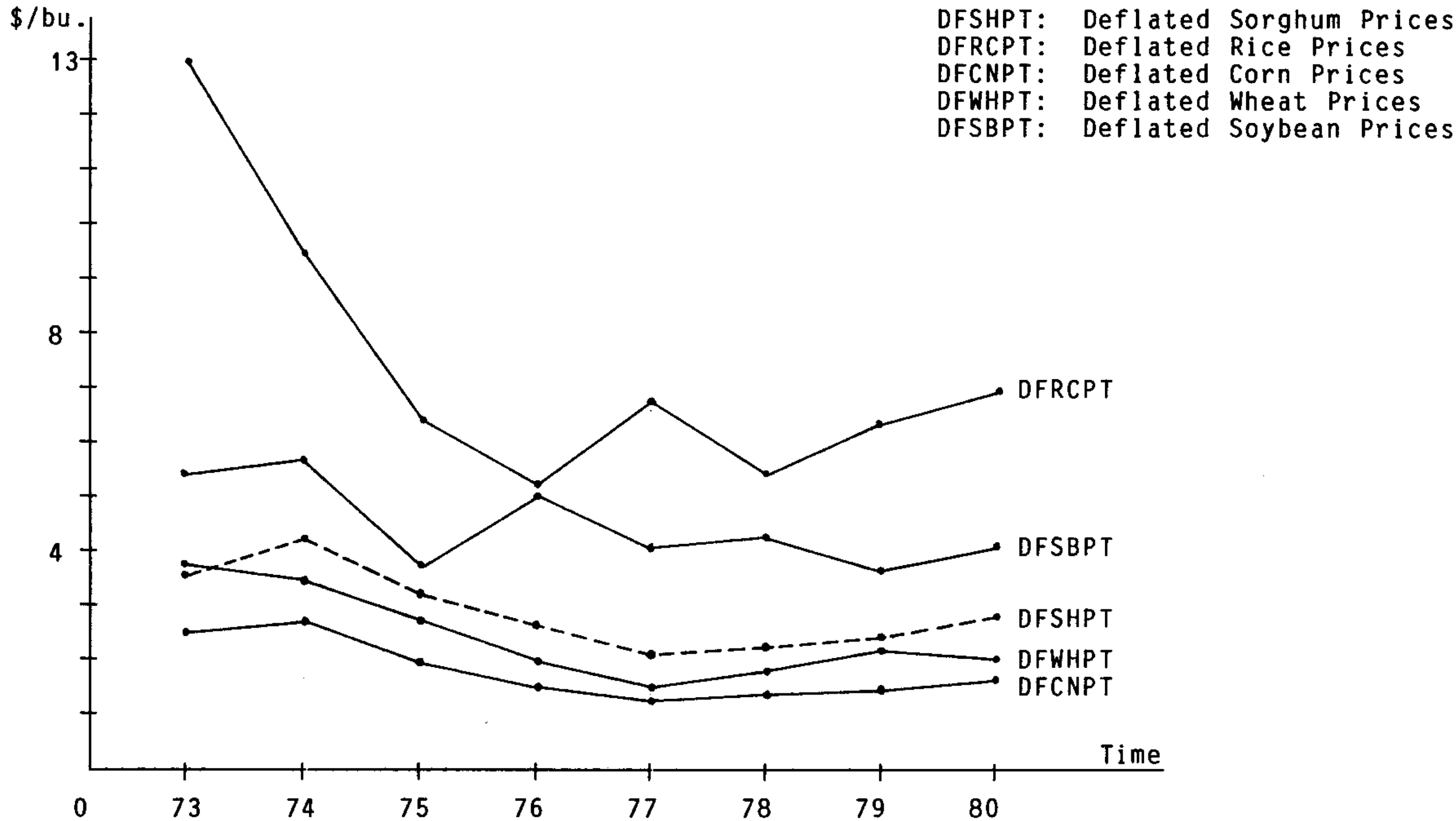

Figure 6. Changes in Real Prices for Grains and Soybeans: 1973-1980

advances plus economic factors have contributed to the success of wheat (or other small grains)/soybeans double cropping and enabled more farmers to engage in the practice. Some of them are:[5]

(1) good world demand for wheat and soybeans;

(2) development of earlier-maturing and high- yield wheat, other small grains, and soybeans;

(3) development and refinement of no-till planting and associated management practices that allow soybeans to be planted into small grain stubble;

(4) development of chemical pest and weed control combinations to use in double cropping; and,

(5) good field tests to determine the needed production equipment and management practices to reduce risk.

Table 8 presents the proportions of soybean acres double cropped following small grains in different states and regions. The figures show that the southern U.S. had a larger percentage of double cropping than the North from 1974 to 1980. In addition, the data also indicate that double-cropped acreages in each state or region varied widely from year to year. The next couple of paragraphs will analyze the factors which affect the wheat-soybean double-cropping acreage.

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[5] See [30].

Table 8. Soybeans Double Cropped Following Small Grains: Percent of Soybean Acres

Region/State	1974	1975	1976	1977	1978	1979	1980
South Atlantic	24.0	23.0	29.5	22.0	20.5	23.5	22.0
VA	39.5	38.0	50.0	22.5	29.0	28.0	NA
NC	21.5	24.0	23.5	22.0	16.0	25.0	NA
SC	16.0	12.5	22.0	14.5	9.5	10.5	NA
GA	25.0	25.0	49.5	29.0	22.0	19.0	NA
East North Central	3.5	4.5	4.5	5.0	2.0	3.5	4.5
OH	2.5	2.0	3.5	1.5	0.5	1.0	NA
IN	3.5	5.5	4.5	4.0	1.5	3.0	NA
IL	4.0	5.0	5.5	7.0	3.0	5.0	NA
MI	0.5	4.5	-	0.5	0.5	1.5	NA
WI	1.5	-	11.5	3.0	-	-	NA
East South Central	13.0	9.5	16.5	12.0	6.5	9.0	13.0
AL	10.0	19.5	18.0	10.0	11.0	12.5	NA
KY	28.5	23.5	29.5	18.0	12.5	18.5	NA
TN	21.5	10.0	22.0	14.0	9.5	14.0	NA
MS	11.0	4.5	7.0	7.0	3.0	5.0	NA
AR	12.0	10.0	19.0	18.5	6.5	8.0	NA
LA	2.0	3.5	5.5	2.5	1.5	1.5	NA
West North Central	3.5	4.0	7.5	7.5	4.5	6.5	7.0
MN	0.5	0.5	0.5	0.5	1.0	0.5	NA
IA	0.5	-	0.5	0.5	-	0.5	NA
MO	10.0	11.0	22.0	19.5	9.5	16.0	NA
ND	-	-	-	-	-	-	NA
SD	-	-	-	2.0	-	-	NA
NE	1.0	2.5	-	1.5	2.0	1.0	NA
KS	10.0	13.0	26.0	30.0	16.5	24.0	NA
West South Central	15.5	8.5	31.5	22.0	2.5	8.5	8.5
OK	14.0	10.0	59.5	47.0	18.0	27.5	NA
TX	17.0	6.5	7.5	9.5	0.5	6.5	NA
United States	8.0	8.5	11.5	9.5	6.0	8.0	9.5

NA: Not Available

Source: USDA

Farmers who decide to double crop soybeans following wheat generally plant their winter wheat between late September and early October. Soybeans are then planted in the mid-June through July period, after the wheat is harvested. Because of the late planting of soybeans when double cropping, soybean yields usually are lower than normal. However, wheat yields are not significantly reduced by the double-cropping practice. In order to interest farmers, the extra earnings from planting wheat must at least compensate for the lower soybean yields. As an illustration, estimated costs and returns per acre for wheat-soybean double cropping and regular soybean planting are compared in Table 9. Due to the limited data available, only an example for Arkansas is shown. Even though this illustration may not represent all cases in the ESC region, it offers a rough idea of the profitability of double cropping. Based on the figures in Table 9, the farmer can make $15.33 more per acre or 61.71% more profit if he chooses to double crop soybeans following wheat rather than plant only soybeans.

The primary determinants of total profits earned from wheat-soybeans double cropping include the soybean and wheat prices, the difference of soybean yields between double cropping and normal planting, and wheat yields. When farmers have to sacrifice too much soybean yield or the expected soybean price is high and the wheat price is not favorable enough to compensate for the profit loss in

Table 9. Estimated Costs and Returns per Acre for Soybeans and Soybeans Double Cropped Following Wheat, Arkansas, 1982.

SOYBEANS			WHEAT-SOYBEANS			
			Wheat			
Gross Income:	$7x25(bu)	$175.00	Gross Income:	$3.5x45(bu)	$157.50	
Variable Cost:		97.12	Variable Cost:		101.46	
Fixed Cost:		53.04	Fixed Cost:		43.87	
Total Net Return		$ 24.84	Net Return			$12.17
			Soybeans			
			Gross Income:	$7x22(bu)	$154.00	
			Variable Cost:		79.33	
			Fixed Cost:		46.28	
			Net Return			$28.00
			Total Net Return			$40.17

Source: [3], [4].

soybeans then farmers may be better off to simply plant soybeans.

The practice of double cropping has its limitations and risks which can prevent farmers from moving into this type of farming. One of the most severe limiting factors is managerial ability. As mentioned above, there is only a very limited time between the harvesting of the first crop and the planting of the second crop for double cropping; in other words, lots of extra work needs to be done in a very short period of time. For double cropping to be successful, a farmer must have the ability to efficiently take advantage of available equipment and labor. As shown in Table 10, for a farmer who plants only soybeans, the maximum labor hours needed in April is 0.619 hours per acre. If he has soybeans double cropped following wheat, then he needs 1.453 labor hours per acre in June, which is more than twice as much labor as needed for planting soybeans. A similar situation happens for the use of machinery. The maximum use of a 150 HP tractor for soybean planting is 0.248 hours per acre, but for double cropping, 0.489 hours per acre is needed in October. In the case of a farmer who has 500 acres of cropland which he plans to transfer into double cropping, he must have an additional 415 labor hours available in June and be able to use the 150 HP tractors for 120 hours more in October. Although this example is selected from Arkansas and the data may change for different regions, it shows that

Table 10. Sequence of Operation and Associated Performance Rates Per Acre, Sandy or Silt Loam Soils, Arkansas, 1982.

	Soybeans, drilled			Soybeans, drilled double cropped following wheat		
	Date	Labor Hours	Machine Hours	Date	Labor Hours	Machine Hours
Wheat (Preharvest)						
Heavy Cut, Disk				Oct.	0.158	0.131
Cutting Disk				Oct.	0.158	0.131[a]
Bed Conditioner				Oct.	0.120	0.099
Grain Drill				Oct.	0.133	0.110[a]
Wheat (Harvest)						
Sp, Combine SB				June	0.236	0.196
Grain Cart, 350bu				June	0.301	0.248
Soybean (Preharvest)						
Cutting Disk	Nov.	0.158	0.131			
Chisel Plow	Mar.	0.170	0.140			
Cutting Disk	Apr.	0.317	0.262[b]	June	0.317	0.262[b]
Water Tank 1000g	Apr.	0.144	0.119	June	0.144	0.129
Field Culti.	Apr.	0.158	0.131[b]	June	0.158	0.131[b]
Tract Mt Spra Bc	Apr.	0.00	0.101	June	0.00	0.101
Field Culti.	May	0.158	0.131	June	0.158	0.131[b]
Grain Drill	May	0.139	0.115	June	0.139	0.115
Soybean (Harvest)						
Sp, Combine SB	Oct.	0.236	0.196	Oct.	0.236	0.196
Grain Cart, 350bu	Oct.	0.301	0.248	Oct.	0.301	0.248[a]
SUMMARY						
Maximum Labor	Apr.	0.619		June	1.453	
Max Machinery	Oct.		0.248[a]	Oct.		0.489[a]
	Apr.		0.393[b]	June		0.524[b]

[a]Tractor, AC, DW, 150 Hp used
[b]Tractor, AC, DW, 175 Hp used

Source: [3]

a farmer's managerial ability, labor, and machinery constraints can greatly affect the expansion of double cropping.

Another important factor limiting double cropping is weather. Prompt germination and emergence of soybeans is a crucial factor for a successful soybean crop. Dr. Marvin Swearingen of Purdue University offered a rule of thumb in determining whether or not to plant the second crop. "If the top two inches of soil are dry and adequate rainfall is not received by the last safe date to plant, forget about double cropping for this year."[6] A capable farmer needs to be able to recognize when he must wait to plant and even when it is best not to plant at all.

There are many factors affecting wheat-soybean double cropping, i.e., soybean and wheat prices, the difference of soybean yields between double cropping and normal planting, wheat yields, a farmer's managerial ability, weather, etc. Technological and genetic advances plus economic conditions have drawn more farmers into double cropping over the past seven or eight years. However, since it always takes time for producers to learn newly developed technology or accept a newly introduced practice, many farmers are still in the process of learning about double cropping.

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[6]See [30], p. 4.

From the above analysis, one can probably see that it is an interesting but rather bold attempt to estimate double-cropping effects on crop acreage planted. Many factors may affect a farmer's decision on double cropping, and some of these factors are not measurable, such as managerial ability. Furthermore, the short history of soybeans double cropped following wheat makes this task even harder to fulfill because not much information and data are available.

To conquer the former problem, one may construct two separate equations. First, double-cropping acres are estimated in one equation. The estimated result is then used as one of the explanatory variables in the crop acreage planted equation. However, this method can not be used at present because the problem of lack of data still exists. In addition, it is believed that, in general, farmers do not pick up a new type of farming abruptly; that is, a continuous learning curve may explain how farmers have slowly moved into the practice of wheat-soybean double cropping rather than a step function. This inference adds even more difficulty to the estimating work since the assumed learning curve is unknown.

Despite all difficulties, an expected revenue ratio was designed to naively estimate how the relative profitability of wheat-soybean double cropping has influenced the crop acreage planted. This double-cropping variable was obtained according to the following equation:

$$\text{DBCROP} = \frac{\bar{Y}_w * P_w^{t-1} + d * \bar{Y}_s * P_s^{t-1}}{\bar{Y}_c * P_c^{t-1}} \tag{3-3}$$

where $\bar{Y}_w$, $\bar{Y}_s$, and $\bar{Y}_c$ represent the expected yield for wheat, soybeans, and corn, respectively (trend yields were used in the models); the lagged one-year market price, P^{t-1}, was used as the expected price; and d stands for the discounted rate of double-cropped soybean yield. The values of d should vary every year; however, a constant value was assigned since no data series are available.[7] This variable was used as an explanatory variable in the planted acreage equations, as shown in the next chapter.

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[7]From [3] and [4], the estimated d is 22/25; according to Dr. Erik J. Wailes of the University of Arkansas, the value of d approximately equals 22/32 for Arkansas. The value of d was estimated to be 25/40 by Stephen Q. Allen, et al., in "Farm Planning Manual for Kentucky Farmers," Agricultural Economics Extension Information, Series No. 11, University of Kentucky, August 1978. Since there is no such data available for the East South Central region as a whole, the average of these three ratios was used. As a result, the value of d was assigned to be 0.73 in the model.

CHAPTER 4

EMPIRICAL RESULTS AND FORECASTING

Using the analytical model discussed in previous chapters, acreage supply equations for corn, sorghum, soybeans, wheat, and cotton in the East South Central region were estimated by ordinary least squares. This chapter presents the results of these equations, followed by the forecast of 1982-1985 acreage planted based on the estimated equations.

Empirical Results

Tables 11 through 15 show the regression results of the equations for corn, sorghum, soybeans, wheat, and cotton, respectively. Several specifications are shown for each commodity. One specification tested the effects of double cropping from the beginning of the studied period. Obviously, this was not consistent with the fact that the practice of double-cropped soybeans following wheat did not become popular until the last seven or eight years. Hence, another model was estimated which included double-cropping variables only for the period of 1974-1981 (Equation 2 in each table). This specification automatically assumed that the learning curve for farmers who practice double cropping is a step function, as discussed in Chapter 3.

Although this is not a reasonable assumption, without further knowledge about the learning curve, this is one way to test the importance of double cropping, and this equation should be more reasonable than Equation 1. The estimated equation, without considering the effects of the double cropping, is also shown in the same table. In addition, a model excluding the policy variables was also run and presented for comparison.

The t value for each estimated coefficient is included in parentheses. Additionally, statistical significance at the ten percent level is indicated by *, significance at the five percent level by **, and significance at the one percent level by ***.

Corn

Table 11 shows that deflated lagged corn price, deflated lagged soybean price, deflated policy variable I for corn, deflated lagged steer price, plus a trend variable explain eighty-five percent of the variation in the dependent variable (acreage planted for corn), as indicated by the R^2. Among them, soybean prices and steer prices were used to measure the degree of competition among corn, soybeans, and livestock. Input prices were first tested in the model by using fertilizer prices, fuel costs, and index of prices paid by farmers for all commodities; however, none of these variables was statistically significant, and most had the wrong signs. Policy variable II for corn was

Table 11. Corn Planted Acres Regression for the East South Central Region (1000 acres).

Equation Number	Estimation Period	DFCNPT1	DFPV1CT	DFSBPT1	DFSTRP1	TREND	DBCROP	ADJDBCR	C	DW	R^2
1	1962-81	975.25 (2.44) **	1756.77 (3.46) ***	-474.17 (2.56) **	-50.06 (2.21) **	-26.3 (0.8)	1118.4 (1.68) *		2204 (3.) ***	1.45	0.88
2	1962-81	341.17 (0.93	1976.80 (4.16) ***	-313.56 (1.95) **	-24.00 (1.19)	-102. (4.2) ***		379.65 (1.30)	3778 (5.) ***	1.73	0.87
3	1962-81	560.91 (1.68) *	2351.07 (6.08) **	-302.44 (1.84) **	-29.60 (1.46) *	-75.2 (5.5) ***			3038 (5.) ***	1.48	0.85
4	1962-81	199.92 (0.33)		62.26 (0.22)	-18.98 (0.51)	-69.1 (2.8)			4373 (4.)	0.49	0.47

DFCNPT1 = Deflated one-year lagged market prices for corn, dollars/bu
DFPV1CT = Deflated policy variable I for corn, dollars/bu
DFSBPT1 = Deflated one-year lagged market prices for soybeans, dollars/bu
DFSTRP1 = Deflated one-year lagged steer prices, dollars/bu
TREND = Trend variable, 2 for 1962, 3 for 1963, and so on
DBCROP = Double-cropping variable
ADJDBCR = Adjusted double-cropping variable, ADJDBCR = 0 for 1962-73 and ADTDBCR = DBCROP for 1974-81

also tested with no success. Consequently, these variables were all excluded from the model.

Generally speaking, the signs of the estimated coefficients in Equation 3 of Table 11 are consistent with prior expectation. The estimated coefficients are statistically significant, and according to the Durbin-Watson (DW) statistic and the pattern of the residuals, there is no evidence of serial correlation. Based on Equation 3, a 10¢ increase in the deflated corn price of last year could lead to a 56.09 thousand acre increase in corn planting for the current year.

Comparing Equation 3 with Equations 1 and 2, neither of these two models is improved by the double-cropping variables. Moreover, the signs of the coefficients of double-cropping variables are not consistent with what were expected.

Even though the policy variable II for corn is not important for explaining the change in corn acreage for the region, policy variable I is highly significant in the model. Equation 4 indicates that omitting policy variable I for corn results in a misspecified model with biased coefficients and a very low R^2.

Sorghum

Table 12 presents the estimated acreage supply models for sorghum. In addition to deflated lagged prices for sorghum, deflated lagged prices for wheat and soybeans were

Table 12. Sorghum Planted Acres Regression for the East South Central Region (1000 acres).

Equation Number	Estimation Period	DFSHPT1	DFPV2SH	DFWHPT1	DFSBPT1	PROCAST	DFSTRP1	DUMSH	DBCROP	ADJDBCR	C	DW	R^2
1	1962-81	91.3414 (0.50)	-962.65 (2.80) ***	-156.95 (0.86)	-99.825 (1.79) *	-2.3287 (1.55) *	5.87216 (0.53)	85.23 (1.1)	-275.2 (1.00)		1477 (2.) **	2.23	0.82
2	1962-81	235.907 (1.86) **	-1064.4 (3.08) ***	-300.97 (1.99) **	-114.86 (1.90) **	-2.3214 (0.90)	10.5314 (0.74)	111.4 (1.2)		-1.3216 (0.008)	948.8 (2.3) **	2.39	0.81
3	1962-81	236.31 (2.10) **	-1064.1 (3.23) ***	-301.81 (2.74) ***	-115.06 (2.14) **	-2.3385 (1.55) *	10.6118 (1.06)	110.9 (1.5) *			948.6 (2.4) **	2.39	0.81
4	1962-81	250.626 (1.70) *		-166.94 (1.25)	-78.496 (1.14)	1.3311 (1.02)	4.07515 (0.32)	180.3 (1.9) **			92.16 (0.2)	1.88	0.64

DFSHPT1 = Deflated one-year lagged market prices for sorghum, dollars/bu
DFPV2SH = Deflated policy variable II for sorghum, dollars/bu
DFWHPT1 = Deflated one-year lagged market prices for wheat, dollars/bu
DFSBPT1 = Deflated one-year lagged market prices for soybeans, dollars/bu
PROCAST = Index of prices paid by farmers for all commodities bought including interest, taxes, and wage rates
DFSTRP1 = Deflated one-year lagged steer prices, dollars/cwt
DUMSH = Dummy variable for sorghum, 0 for 1962-67, 1 for 1968-81
DBCROP = Double-cropping variables
ADJDBCR = Adjusted double-cropping variables, 0 for 1962-73 and DBCROP for 1974-81

included in Equation 3 because of the competition among sorghum, wheat, and soybeans. The index of prices paid by farmers for all commodities was included as an input price variable. As mentioned earlier in the paper, sorghum is produced primarily for livestock, rather than as a cash crop, in some states within the studied region. As a result, deflated lagged steer prices were employed as a proxy for the profitability of livestock enterprises. A positive correlation between the profitability of livestock production and sorghum planting in this regional model was expected. The sign of the estimated coefficient for deflated lagged steer prices is correct; however, the associated t-value indicates that the coefficient is not statistically significant. In addition, a dummy variable (DUMSH) was used to capture the effects of the "cross-planting substitution" provision in the government program beginning in 1968.

Double cropping variables did not seem to improve the overall performance of the model, but both coefficients of double-cropping variables in Equations 1 and 2 are consistent with prior expectation.

Policy variable I for sorghum was left out because it caused the wrong sign and was insignificant. Policy variable II for sorghum, however, is highly significant. Without policy variable II in the model, the explanatory ability of the model becomes relatively low, i.e., $R^2 = 0.64$, and wrong signs are obtained for some coefficients, such as the coefficient of input price variables (PROCOST) as shown in Equation 4.

Soybeans

The estimated soybean equations are given in Equations 1-4, Table 13. Following Mckeon (1979), the model is a partial adjustment model.[1] All signs are as expected; the R^2 is 0.98, and the t-values are relatively large. According to Equation 3, the results indicate that in the short run producers make only about 13.5% of their desired adjustment to changing current conditions.[2]

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[1]The general form of the partial adjustment model can be expressed as follows:

$$X_t^* = a_o + a_1P_{t-1} + a_2Z_2 + U_t \qquad (1)$$

$$X_t = (1 - r)X_{t-1} + rX_t^* \qquad (2)$$

From (1) and (2):

$$X_t = (1 - r)X_{t-1} + r(a_o + a_1P_{t-1} + a_2Z_2 + U_t) \qquad (3)$$

where:

- X_t^* is the long-run desired acreage of the crop in period t
- X_t is the actual acreage
- P_{t-1} is the lagged actual prices representing the expected price here
- Z_t is any other relevant variable
- r is the acreage adjustment coefficient, $0<r\leq 1$

See Nerlove (1958) and Narayana & Parikh (1981).

[2]0.8679 = 1-r, so r = 0.1343.

Table 13. Soybeans Planted Acres Regression for the East South Central Region (1000 acres).

Equation Number	Estimation Period	APSBLG1	DFSBPT1	DFCNPT1	DFWHPT1	DFPV1SB	DBCROP	ADJDBCR	C	DW	R^2
1	1962-81	0.9425 (3.95) ***	1016.39 (0.97)	2214.08 (0.31)	-2116.6 (0.65)	186.18 (0.27)	2418.2 (0.33)		-5440 (0.4)	1.71	0.98
2	1962-81	0.7644 (7.01) ***	1094.60 (2.45) **	-177.60 (0.88)	-1344.3 (2.19) **	141.98 (0.27)		936.10 (1.05)	1404. (0.4)	2.28	0.98
3	1962-81	0.8657 (16.97) ***	1338.41 (3.50) ***	-118.67 (0.08)	-1063.7 (1.92) **	338.74 (0.69)			-1346 (0.6)	1.82	0.98
4	1962-81	0.8524 (19.3) ***	1266.17 (4.21) ***		-1137.0 (3.44) ***				-58.5 (.77)	1.69	0.98

APSBLG1 = Lagged acres planted for soybeans, thousand acres
DFSBPT1 = Deflated one-year lagged market prices for soybeans, dollars/bu
DFCNPT1 = Deflated one-year lagged market prices for corn, dollars/bu
DFWHPT1 = Deflated one-year lagged market prices for wheat, dollars/bu
DFPV1SB = Deflated policy variable I for soybeans, dollars/bu
DBCROP = Double-cropping variable
ADJDBCR = Adjusted double-cropping variable, 0 for 1962-73, DBCROP for 1974-81

The response of soybean planting to soybean price and wheat price is significant; however, corn prices and the government policy variable for soybeans have very little influence on soybean acreage planted. A 10¢ increase in the deflated lagged price of soybeans increases current planting by 137,000 acres; a 10¢ increase in the deflated lagged price of wheat, on the contrary, results in a decrease of 106,000 acres in soybean planting (Equation 3).

Even though the double cropping variables in Equations 1 and 2 are not significant, the signs of the estimated coefficients are correct. Comparing Equation 1 with Equation 2, a more reasonable coefficient associated with the adjusted double-cropping variable (ADJDBCR) and larger t-value indicate that the second model is better than the first one, as expected. Moreover, the adjustment factor r equals 0.24 for Equation 2, which is greater than the adjustment factor of Equation 3. This implies that the adoption of double cropping reduces the uncertainty farmers have faced, so they are more confident to make planting adjustments towards their desired level. On the other hand, the r of Equation 1 is too small and is not consistent with prior expectation. These results also indicate that Equation 2 is a better model.

Unlike other cases, the Durbin-Watson test is not applicable for serial correlation between errors in soybean models. The basic assumption under which the DW test is derived is that the regressors are fixed. Because in this soybean acreage supply model one of the regressors is a lagged dependent variable, the DW statistic is no longer useful. Despite this, no obvious evidence of serial correlation between error terms was detected from the pattern of residuals.

Wheat

All signs are as expected, and the R^2 is equal to 0.78 as shown in Equation 3, Table 14. Initially, the policy variable I and the price for wheat were included in the model. Results showed that, as expected, neither of these variables has influenced wheat plantings. Like sorghum, wheat is a minor crop in some states of the studied region, such as Louisiana. Wheat is produced primarily for live-stock rather than as a cash crop. As a result, the price of wheat has little influence on wheat plantings, but the deflated lagged steer price is statistically significant at the five percent level.

There are two unique features of the wheat equations which should be mentioned. First, lagged wheat acreage planted together with a dummy variable (DUMWH) was employed as a proxy for wheat allotment. Wheat allotment was expected to be an important factor affecting wheat plant-ings. However, the national acreage allotment data could not be used since such data were not available for 1971, 1972, and 1973. The DUMWH was included to identify the years in which the national wheat allotment was set at a sharply higher level. Another dummy variable was initially

Table 14. Wheat Planted Acres Regression for the East South Central Region (1000 acres).

Equation Number	Estimation Period	APWHLG1	DFPV2WT	DFCNPT1	DFSTRP1	DUMWH	DUMSH	DBCROP	ADJDBCR	C	DW	R^2
1	1962-1981	1.3346 (3.29) ***	-2158.4 (1.47) *	-434.51 (0.95)	125.312 (2.66) **	363.1 (0.9)	-765. (1.6) *	-729.3 (0.78)		-1825 (0.9)	2.15	0.79
2	1962-1981	1.3523 (3.26) ***	-2215.1 (1.47) *	-423.60 (0.77)	118.267 (2.50) **	391.1 (0.9)	-564. (1.3)		56.775 (0.16)	-2828 (1.8) **	2.07	0.78
3	1962-1981	1.3560 (3.40) ***	-2231.8 (1.55) *	-374.14 (0.84)	117.629 (2.60) **	414.7 (1.1)	-531. (1.4) *			-2892 (2.0) **	2.06	0.78
4	1962-1981	1.3641 (3.27) ***		- 82.82 (0.20)	104.471 (2.24) **	692.0 (1.9) **	-379. (1.0)			-3372 (2.3) **	2.07	0.74

APWHLG1 = Lagged acres planted for wheat, thousand acres
DFPV2WT = DEflated policy variable II for wheat, dollars/bu
DFCNPT1 = Deflated one-year lagged market prices for corn, dollars/bu
DFSTRP1 = Deflated one-year lagged steer prices, dollars/cwt
DUMWH = Dummy variable for wheat, 0 for 1967, 1976-77, and 1980-81 and 1 for others
DUMSH = Dummy variable for sorghum, 0 for 1962-67, 1 for 1968-81
DBCROP = Double-cropping variable
ADJDBCR = Adjusted double-cropping variable, 0 for 1962-73, DBCROP for 1974-81

included to account for the change beginning in 1964 when marketing quotas for wheat were no longer in effect. But it was finally excluded because it had no statistically significant influence on wheat plantings. Secondly, as with the sorghum equations, a dummy variable (DUMSH) was used to capture the effects of the "cross-planting substitution" provision beginning in 1968.

Even though the t-value of the lagged wheat acreage planted is statistically significant at the one percent level, its coefficient is greater than 1, which implies an improper model specification.[3] According to Equation 3 in Table 14, in the short-run, producers make -35.6% of their adjustment to changing current conditions, and that is apparently meaningless. This suggests that the lagged wheat acreage planted variable may capture not only the effect of wheat allotment on wheat plantings but also other effects resulting from other factors. When the results from the wheat equations are interpreted, one has to be cautious because omitting essential variables can lead to biased estimates.

The double-cropping variables again are not significant in the equations; however, a correct sign associated with the coefficient of ADJDBCR in Equation 2 may indicate that

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[3] As seen in footnote 2, the value of r must be greater than zero. If the coefficient of the lagged dependent variable is greater than one, i.e., $1-r>1$, then $r<0$.

it is proper to include the double cropping variable only for the last eight years of the studied period rather than for the whole period.

Like the soybean equations, the Durbin-Watson statistic is not applicable for the wheat equations because one of the regressors is the lagged dependent variable.

Cotton

Generally speaking, all signs are as expected, and t-values are relatively large for the cotton equations shown in Table 15. The R^2, which equals 0.87, indicates the overall fit is good. Soybeans are the principal competitor, so the deflated lagged price of soybeans is included. Input prices or production costs, represented by the index of prices paid by farmers for all commodities bought, have a highly significant influence on cotton planting. The price of cotton also has a great influence on cotton planting. A 10¢ increase in the deflated lagged price of cotton increases current cotton planting by about 610,000 acres (Equation 1).

A dummy variable is included to account for the change beginning in 1971, when marketing quotas were suspended for cotton. The results show the dummy variable (DUMCOT) is significant at the one percent level, and without it, the overall performance of the model becomes very poor (as shown in Equation 4).

Table 15. Cotton Planted Acres Regression for the East South Central Region (1000 acres).

Equation Number	Estimation Period	DFCTPT1	DFSBPT1	PROCAST	DFSTRP1	DUMCOT	DFPV2TT	C	DW	R^2
1	1962-1981	60.89 (4.85) ***	-561.24 (3.85) ***	-27.53 (7.11) ***	52.28 (2.11) **	1352.88 (4.26) ***	-5901.9 (2.55) **	3549.69 (4.15) ***	2.38	0.87
2	1962-1981	70.94 (5.05) ***	-618.75 (3.64) ***	-28.11 (6.16) ***	63.80 (2.22) **	1655.15 (4.76) ***		2757.15 (2.93) ***	2.04	0.80
4	1962-1981	37.90 (1.98) **	-164.59 (0.75)	-13.34 (2.55) **	51.45 (1.15)			2427.96 (1.65) *	1.17	0.47

DFCTPT1 = Deflated one-year lagged market prices for cotton, cents/lb
DFSBPT1 = Deflated one-year lagged market prices for soybeans, dollars/bu
PROCOST = Index of prices paid by farmers for all commodities bought including interest, taxes, and wage rates
DFSTRP1 = deflated one-year lagged steer prices, dollars/cwt
DUMCOT = Dummy variable for cotton, 0 for 1962-70 and 1 for 1971-81
DFPV2TT = Deflated policy variable II for cotton, cents/lb

Policy variable I for cotton was initially included in the model and then excluded because of its statistical insignificance. Policy variable II is statistically significant at the five percent level, however.

Forecast of 1982-85 Acres Planted

Acres planted to corn, sorghum, soybeans, wheat, and cotton in the East South Central region from 1982 to 1985 are forecasted. As shown in Table 16, acres planted to each crop, except cotton, are forecasted in two ways. One is based on the regression equations which include the adjusted double-cropping variable (ADJDBCR); the other uses the estimated equations excluding the ADJDBCR variable. Cotton acres planted are forecasted with only one equation, since the double-cropping variable was not included.

Data used for the forecast and its sources are presented in Appendix II. The projected values of deflated prices for soybeans, cotton, and steers are relatively low compared with the historical data. For example, as estimated, the average of 1981-83 deflated price for soybeans is $3.30, but the average of actual data for 1978-80 was $4.20. In addition, an almost thirty-five percent decrease in the 1981 deflated price for cotton was estimated, and the estimated value of deflated prices for sorghum in 1981 was about thirty percent lower than the actual value in 1980. Because of these low estimates, the forecasts of

Table 16. Forecast of 1982-85 Acreage Planted for the East South Central Region (1000 acres).

Year / Crop	Preliminary[a] 1982	FORECAST[b]							
		1982		1983		1984		1985	
		(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
Corn	3,135	3,333	3,364	2,900	3,019	2,922	3,022	2,593	2,706
Sorghum	868	563	562	461	459	440	438	395	392
Soybeans	17,600	17,207	16,919	16,920	16,437	16,684	16,025	16,559	15,817
Wheat	6,380	7,703	6,706	10,022	8,464	13,447	11,344	18,200	15,415
Cotton	2,700	NA	2,057	NA	1,871	NA	1,535	NA	1,187

[a]Data obtained from Acreage, USDA, June 1982

[b]Forecast (1) is based on the regression equations which include the ADJDBCR
Forecast (2) is based on the regression equations which do not include ADJDBCR

NA = Not available

acres planted to sorghum, soybeans, and cotton tend to be low in general.

Generally speaking, the forecasting results from the two different models are similar for each crop. The low price for soybeans in 1981 caused an increase of corn planting in 1982. After 1982, the downward trend of corn planting continues since deflated prices for both soybeans and steers increase.

Due to a relatively low deflated price for sorghum in 1981, only 563 thousand acres were predicted for sorghum planting. Like corn planting, there is also a downward trend from 1982 because an increase in soybean prices is projected.

The price for soybeans in 1981 was low ($3.12) compared with the actual value for 1980 of $4.26. As a result, a decrease in soybean acreage planted is forecast for 1982. According to the forecast, soybean plantings decrease about two percent each year from 1982 to 1985. This occurs primarily because the current soybean plantings are heavily dependent on the planting of the previous year, as mentioned in the previous sections.

Table 16 projects a rapid increase in wheat acres planted for 1982 to 1985. The more than thirty percent increase in wheat planting each year implies an infinite wheat planting in the future and an improperly specified model. The results were expected since, as pointed out earlier in this paper, the coefficient associated with the lagged wheat acres planted in the model was greater than one. This projection should not be taken seriously and is included only as a reminder of the dangers of projections made from a model of this type.

Finally, the forecast of cotton acres planted for 1982 is 643 thousand acres less than the preliminary data. It mainly results from the extremely low deflated price for cotton in 1981. Additionally, cotton planting decreases in the 1982-85 period because of the increasing production costs. The overall production cost for cotton was estimated based on the rate of increase in the Consumer Price Index. Specifically, the production cost index was assumed to increase at a rate of six percent per year—the rate at which the Consumer Price Index is expected to increase each year.[4]

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[4] See Appendix II

CHAPTER 5

SUMMARY AND CONCLUSIONS

Summary

Accurate estimates of acreage response to changing market prices and government programs are very important for policy makers for adjusting programs to balance supply and demand. Good forecasts of crop acreage can also help farmers and agribusinesses make production and marketing decisions. The objective of this study was to develop a regional acreage supply model and to forecast acreage planted for the East South Central region in the United States. The particular interests of the study were to examine: (1) whether or not national variables can be used in the regional model, and (2) what additional information can be added to improve the regional model. Because of the characteristics of the East South Central region, it was felt that if national variables worked in this model, then other regional models could be built in a similar way.

For the purpose of the study, acreage planted was selected to be the dependent variable in all equations, and national commodity prices, policy variables, indices of production costs, and the double-cropping variable were included as explanatory variables. The double-cropping variable was of particular interest because the practice of double cropping is important in this region, plus few studies have been done on this practice.

A rather simple revenue ratio was used in the double-cropping variable because there was not enough data and information available to develop a more complete variable. The practice of wheat-soybean double cropping has become noticeable only during the past seven or eight years. In addition, farmers are assumed to learn this relatively new method of farming gradually. A learning curve should be used to explain the process for farmers to move into the practice. Since the history of double cropping is short and no further knowledge about the learning curve was available, a step function was assumed to represent the learning curve in the model.

Government policy variables were calculated based on the concepts of effective price supports and effective diversion payments. Other program provisions were also considered in the models by properly employing dummy variables.

The results showed that the models explain 80% to 98% of the changes in acreage planted. The general performance of the models is good, with the exception of the wheat acreage model. National prices and government policy variables were highly significant in most equations. The double-cropping variables, however, were not significant at the 10% level in any equation.

The results of the wheat acreage model indicated the possibility of an improper model specification. The coefficient associated with the lagged dependent variable was greater than one, which implies that some relevant variables may have been omitted. The omitted variables could bias the estimates of the other variables. Therefore, the projection of wheat acreage planted in the study should not be taken seriously and is included only as a reminder of the dangers of projections made from a model of this type.

Due to low prices for most crops in 1981, acreage planted for 1982 was generally low for most studied crops. In addition, acres planted for corn, sorghum, soybeans, and cotton are predicted to decrease in the period 1982-85, given the assumptions of Appendix II.

Conclusions

The major conclusions of this study include:

(1) National variables such as commodity prices, indices of production costs and government policy variables can be used to estimate a regional crop acreage model.

(2) Acreage planted is significantly affected by government programs, even though participation rates are low.

(3) Double cropping of wheat and soybeans was not found to be an important explanatory variable in the estimated models.

(4) The forecasts for corn and cotton are consistent with prior expectations; however, more acreage planted for soybeans and sorghum may be expected.

The results showed that 80% to 98% of the changes in acreage planted were explained in the model by using national variables. In general, these variables had correct signs and were statistically significant. The evidence supports the hypothesis that national variables can be used in a regional model. Because of the special characteristics of the East South Central region, if national variables can be used in this region, then they should also work for other regional models.

Government programs have substantially affected acreage planted for all crops except soybeans based on the estimated results. This occurs in spite of the low participation rates for most crops in this region. This conclusion supports Ryan's and Abel's (1972) argument that output response related to policy variables may also be extended to producers who do not participate in government programs.

The wheat-soybean double-cropping variable was not statistically significant at the 10% level in the models. However, this does not necessarily mean that the practice of wheat and soybean double cropping has not affected acreage planted in the studied region. Instead, it only indicates that the null hypothesis about the double-cropping variable in the models cannot be rejected. In fact, with such limited data and information, it was not surprising that the double-cropping variable failed to explain acreage planted.

Even though the task of estimating the double-cropping effects on acreage planted was not successfully fulfilled, this attempt was at least a starting point. With some slight modification, it is believed that the double-cropping variable can be very useful to explain changes in acreage planted in the near future. As more farmers move into the practice of wheat-soybean double cropping, more data and information are expected to become available, and this variable will become more important for estimating acreage response.

The model forecasts corn acreage planted to decrease in the 1982-85 period, primarily because of a decrease in deflated support prices for corn. Although a slight increase in corn market prices is projected, the relative profitability for planting corn relative to soybeans is still low. Therefore, the downward trend for corn planting is expected to continue.

Acreage planted for cotton is also predicted to decline in the next several years. Increasing production costs and rather stable prices for cotton explain this result. The large use of energy-related inputs such as fertilizer, chemicals, irrigation pumping, and other fuel and lubrication costs have caused cotton production costs to rise more rapidly than costs for other crops. The rapid increase in energy prices for the past several years has led to rather low (sometimes even negative) net profits for cotton planting. As a result, cotton acres planted have decreased. This tendency is likely to continue as production costs for cotton increase.

According to the forecast, soybean acres planted also decreases in the 1982-85 period. This occurs mainly because of the low soybean prices of 1981. The declining prices for soybeans in 1981 results in a notable decrease in the 1982 acres planted and, hence, decreasing acreage planted for 1982-85 because of the partial adjustment specification used. Additional information, however, indicates that an adjustment to the forecast of soybean acres planted may be necessary. First, even though the soybean price dropped substantially in 1981, the expected price for farmers is more likely to remain high, since the previous prices for soybeans were relatively high, in general. Secondly, soybeans are still more profitable than other crops in spite of a decrease in its price. Consequently, soybean acres planted are expected to be higher than the forecast.

The forecast of sorghum acreage planted may also need to be modified based on additional information not included in the model. Sorghum acreage predicted for 1982 is about 35% lower than the preliminary 1982 data because the price for sorghum in 1981 was very low. Similar to the case of soybeans, it is argued that farmer 's expected prices for sorghum are above the prices of 1981 because of the increasing prices for sorghum since 1977. Moreover, sorghum planting increases as livestock numbers expand because sorghum is planted mostly for grazing uses in this region.

The acreage decline projected for most crops over the 1982-85 period will probably lead to additional livestock production which should increase sorghum planting. This was not projected by the sorghum model because the linkage between crop acreages and livestock numbers was not included in the model.

Finally, a lesson which is valuable for research is learned from this study: Just because the historical data fits well in a model does not necessarily imply a good forecast. The model is built based only on changes in the past, and due to possible structure changes, it may not represent the future. The example, because of the sharp decreases in crop prices in 1981, farmers may rely more on government support prices. Hence, greater effects of policy variables on acreage planted after 1982 are expected. A good forecast model needs to be able to explain the possible changes in the future as well as in the past. Therefore, for the purpose of forecasting, one needs not only study what happened in the past but also observe what is likely to occur in the future so that he can properly judge the forecast.

APPENDICES

APPENDIX I

SOURCES OF DATA

Data on acreage planted, production, and yields for all crops were obtained for each state in the ESC region from the USDA, "Crop Production," 1962-81 [40]. Data on national prices received by farmers were obtained from the USDA, "Agricultural Statistics," 1961-80 [41]. GNP implicit deflators, which were used as the deflators for all price variables, were obtained from Business Statistics, US Department of Commerce, Bureau of Economic Analysis. The indices for all commodities bought were obtained from the USDA, "Agricultural Statistics."

Data on policy variables I and II were those used in the MSU Agriculture Model, Department of Agricultural Economics, Michigan State University. Trend yields were used as expected yields, and double-cropping variables were calculated based on Equation (3-3). Tables I.A and I.B show the data of policy variables I and II, trend yields and the calculated double-cropping variables, respectively.

Table I.A. Policy Variables I and II Data for Corn, Soybeans, Wheat, Sorghum, and Cotton, 1961-81.

	Corn[a]		Soy-beans[a]	Wheat[a]		Sorghum[a]		Cotton[b]	
Year	PVI	PVII	PVI	PVI	PVII	PVI	PVII	PVI	PVII
1961	.84	.19	2.30	1.25	.00	1.35	.30	.24	.00
1962	.84	.19	2.25	1.18	.25	1.35	.30	.23	.00
1963	.88	.11	2.25	1.28	.19	1.40	.18	.21	.00
1964	.81	.18	2.25	1.09	.04	1.30	.29	.16	.02
1965	.81	.18	2.25	1.53	.09	1.30	.29	.16	.03
1966	.65	.24	2.50	1.63	.16	.99	.41	.11	.08
1967	.84	.15	2.50	1.66	.00	1.29	.26	.11	.10
1968	.68	.24	2.50	1.67	.00	1.05	.41	.11	.09
1969	.68	.24	2.25	1.67	.20	1.05	.40	.23	.00
1970	.68	.23	2.25	1.48	.18	1.05	.39	.24	.00
1971	1.05	.16	2.25	1.66	.00	1.73	.26	.23	.03
1972	.94	.24	2.25	1.59	.18	1.52	.44	.22	.03
1973	1.05	.16	2.25	1.42	.32	1.79	.27	.22	.00
1974	1.36	.00	2.25	1.94	.00	2.34	.00	.36	.00
1975	1.35	.00	2.25	1.91	.00	2.34	.00	.38	.00
1976	1.56	.00	2.50	2.29	.00	2.66	.00	.43	.00
1977	2.00	.00	3.50	2.86	.22	4.07	.00	.44	.00
1978	1.90	.21	4.50	2.93	.21	3.73	.25	.51	.03
1979	1.99	.12	4.50	3.40	.14	3.82	.25	.56	.01
1980	2.35	.00	4.50	3.63	.00	4.46	.00	.62	.01
1981	2.40	.00	5.02	3.81	.00	4.50	.00	.68	.01

[a]$/bu [b]$/lb

Table I.B. Double Cropping Variables and Trend Yields Data, 1962-81.

Year	DBCROP	Trend Yield (bu.)		
		Corn	Soybeans	Wheat
1962	1.82	40.36	21.12	27.08
1963	1.90	42.16	21.26	27.47
1964	1.81	43.96	21.40	27.86
1965	1.45	45.76	21.54	28.25
1966	1.39	47.57	21.67	28.64
1967	1.45	49.37	21.81	29.03
1968	1.50	51.17	21.95	29.42
1969	1.30	52.97	22.09	29.81
1970	1.17	54.78	22.23	30.21
1971	1.13	56.58	22.36	30.60
1972	1.42	58.38	22.50	30.99
1973	1.32	60.19	22.64	31.38
1974	1.37	61.99	22.78	31.77
1975	1.24	63.79	22.92	32.16
1976	1.17	65.59	23.05	32.55
1977	1.39	67.40	23.19	32.94
1978	1.25	69.20	23.33	33.34
1979	1.31	71.00	23.47	33.73
1980	1.27	72.80	23.60	34.12
1981	1.14	74.61	23.74	34.51

APPENDIX II

DATA USED FOR THE FORECAST

The projected price and policy variables for 1981-85 were obtained from "The MSU Agriculture Model Long Term Forecast—A Forecast of U.S. and World Agriculture to the Year of 1990," Department of Agricultural Economics, Michigan State University, Spring 1980. The projected GNP implicit deflators for 1982-85 were obtained from The Wharton Magazine, Vol. 7, No. 1, University of Pennsylvania, Fall 1982.

Overall production costs for crops were assumed to increase at the same rate with the Consumer Price Index for 1982-85. The Consumer Price Index was predicted to increase at the rate of 6% each year in 1982-85. As a result, the 6% increasing rate for production costs was assumed in the forecast of 1982-85.

Data on prices and policy variables and GNP implicit deflators used in the forecast of 1982-85 are shown in Tables II.A and II.b, respectively.

Table II.A. Projected Price Data for Corn, Soybeans, Wheat, Sorghum, Cotton and Steer, 1981-84.

Year	DFCNPT[a]	DFSBPT[a]	DFWHPT[a]	DFSHPT[a]	DFCTPT[b]	DFSTRP[c]
1981	1.29	3.12	1.91	2.12	28.24	30.52
1982	1.36	3.38	1.94	2.01	30.47	31.93
1983	1.40	3.46	2.03	2.17	29.84	32.43
1984	1.45	3.60	2.06	2.22	29.12	33.72

[a]$/bu
[b]¢/lb
[c]$/cwt

Table II.B. Predicted Policy Variables Used in the Forecast and Predicted GNP Implicit Deflator, 1982-85.

Year	DFPV1CT[a]	SFPV1SB[a]	DFPV2SH[a]	DFPV2WT[a]	DFPV2TT[b]	GNP Implicit Deflator
1982	1.32	2.44	.00	0.01	0.0048	206.5
1983	1.24	2.29	.014	0.14	0.0046	219.1
1984	1.28	2.28	.00	0.00	0.0043	233.3
1985	1.20	2.27	.00	0.00	0.0040	248.2[c]

[a]$/bu
[b]$/lb
[c]estimated

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