SUPPLY RESPONSE OF CROPS IN THE SOUTHEAST

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SUPPLY RESPONSE OF CROPS IN THE SOUTHEAST

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SUPPLY RESPONSE OF CROPS IN THE SOUTHEAST

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THESIS ABSTRACT

SUPPLY RESPONSE OF CROPS IN THE SOUTHEAST

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A model was used to estimate the supply response of corn, cotton, and soybeans in the Southeast United States. The analysis includes state-level data from 1991-2005 in Alabama, Florida, Georgia, North Carolina, South Carolina, Tennessee, and Virginia along with wealth, revenue risk, and policy variables. The results indicate that cross-commodity variables, wealth, truncated net returns, and farm policy affect acreage decisions made by producers.

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Style manual or journal used American Journal of Agricultural Economics

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I. INTRODUCTION

The supply response literature has a significant presence in economic analysis. The analysis of the supply response of row crop production began in 1956 with work by Marc Nerlove and has progressed over the years, with many economists making significant advancements in the field over the latter half of the twentieth century. Literature on the topic has expanded since its inception to include other variables that help estimate supply, such as prices, policy, risk, and wealth. Building on a study by Lin and Dismukes, one that estimated supply response of row crops in the North Central United States, this paper estimates the supply response of row crops in the Southeast United States. Because there have not been any recent publications on supply response in the Southeast, this paper will provide updated estimations for the supply response of corn, cotton, and soybeans.

Supply response models take into account farmers' expected planting decisions, expected prices, expected yield, costs of inputs, farm programs, risk, and wealth. Government sponsored farm programs have historically given producers incentives to either increase or decrease production of certain commodities targeted by the legislation. These farm programs serve to reduce the risk that farmers face when making planting decisions. The producers' initial wealth may also impact their planting decisions, by allowing them to bear more risk.

RESEARCH OBJECTIVES

This study has three objectives for the supply response analysis. The first objective of this paper is to identify a consistent theoretical model for supply response of row crops in the Southeast. The second objective is to econometrically use data from 1991 through 2005 to estimate results. The third objective is to take into account how various farm program provisions as well as changes in market prices affect row crop supply in the target region.

II. COTTON, SOYBEANS, AND CORN

Supply response analysis in agriculture focuses on crop production. Some of the major row crops produced in the Southeast U.S. are cotton, soybeans, and corn. Production for each crop varies within each state, but growing seasons tend to be constant throughout the Southeast. Because the three crops' growing seasons overlap, a producer can choose between growing one of the three crops on each acre, but doesn't have the option of growing one of the others at a later point in the year on the same piece of land. The region that this study specifically covers includes Alabama, Florida, Georgia, North Carolina, South Carolina, Tennessee, and Virginia.

Cotton is a textile fiber that is grown in over 80 countries (USDA). The average cotton acreage planted in the Southeast region from 1991-2005 is found in Table 2.1. It is interesting to note that despite the fact that the total cotton acreage planted by the 7 states increased by 66.9% (from 2,198.9 thousand acres to 3,670 thousand acres) over the 15 year period, the various states' individual percentages of the total cotton planted in the region changed a significant amount as well. Initially, Virginia planted the smallest amount of cotton acreage at 0.8% of the total acreage planted, but increased its share to pass Florida by producing 2.53% of the total cotton acreage planted in 2005. North Carolina had the largest percentage of cotton acres planted in 1991 at 20.92%, but slipped to second in cotton acreage planted at 22.21% due to a steady increase in acreage planted by Georgia (from 430 thousand acres in 1991 to 1220 thousand acres in 2005).

Table 2.1 Cotton: Acreage Planted by State (in thousands)

Year	Alabama	Florida	Georgia	North Carolina	South Carolina	Tennessee	Virginia	Total Region
1991	410	50	430	460	211	620	18	2199
1992	415	50	460	380	197	625	22	2149
1993	443	54	615	390	202	625	23	2352
1994	463	69	885	486	225	590	42	2760
1995	590	110	1500	805	348	700	107	4160
1996	520	99	1340	740	284	540	103	3626
1997	535	100	1440	690	290	490	101	3646
1998	495	89	1370	710	290	450	92	3496
1999	565	107	1470	880	330	570	110	4032
2000	590	130	1500	930	300	570	110	4130
2001	610	125	1490	970	300	620	105	4220
2002	590	120	1450	940	290	565	100	4055
2003	525	94	1300	810	220	560	89	3598
2004	550	89	1290	730	215	530	82	3486
2005	550	86	1220	815	266	640	93	3670

Table 2.2 displays the average cotton yield per acre by state:

Table 2.2 Cotton: Yield by State (pounds per acre)

Year	Alabama	Florida	Georgia	North Carolina	South Carolina	Tennessee	Virginia
1991	655	719	812	672	552	786	765
1992	731	701	783	596	651	565	621
1993	524	696	586	535	425	495	634
1994	766	735	843	820	726	846	944
1995	409	472	625	479	527	528	620
1996	734	637	747	659	611	774	748
1997	597	577	646	652	662	688	659
1998	559	489	578	699	589	587	765
1999	535	516	579	475	505	428	635
2000	492	480	591	742	603	627	738
2001	730	612	720	832	763	686	929
2002	507	439	557	421	741	314	465
2003	772	610	785	646	806	718	674
2004	724	601	674	900	900	875	956
2005	747	762	849	852	848	743	955

While the fluctuations in the levels of acreage planted found in Table 2.1 will be potentially explained by the models estimated later in this paper, yield per acre is subject to very different factors. Factors such as advances in technology, natural disasters, farm programs, and changing weather patterns all affect crop yields. All 7 states shown in Table 2.2 indicate fluctuating yields over the period; however, the yields seem to trend upward over the time period. It also must be noted that several of the states have years in which their yield dropped to levels below their 1991 levels. It is possible to attribute these fluctuations in yield per acre to changing weather patterns. Certain years such as 2002 saw 6 of the 7 states produce at well below their 1991 yield levels due to a drought, with some such as Tennessee producing at less than half (from 786 pounds per acre in 1991 to 314 pounds per acre in 2002).

Soybeans are the most widely produced oilseed in the U.S. (USDA). Data of acres planted in the Southeast region of the U.S. by state from 1991-2005 are listed below in Table 2.3. The first point that one will notice in Table 2.3 is the general downward trend in soybean acres planted by state for 4 of the 7 states. Specifically, the state of Florida's acreage planted decreased from 45, 55, and 55 thousand acres of soybeans planted in 1991, 1992, and 1993, respectively, to 13, 19, and 9 thousand acres of soybeans planted in 2003, 2004, and 2005, respectively. However, North Carolina, Tennessee, and Virginia have all maintained or increased their soybean acreage planted from 1991 levels.

Table 2.3 Soybeans: Acres Planted by State (in thousands)

Year	Alabama	Florida	Georgia	North Carolina	South Carolina	Tennessee	Virginia	Total Region
1991	360	45	600	1350	650	1100	530	4635
1992	290	55	650	1400	690	1000	520	4605
1993	310	55	600	1350	600	1050	520	4485
1994	310	45	520	1400	600	1050	540	4465
1995	240	30	320	1150	550	1050	490	3830
1996	320	35	400	1250	560	1150	500	4215
1997	350	47	400	1400	580	1240	510	4527
1998	340	35	300	1475	540	1250	500	4440
1999	240	20	220	1400	480	1250	470	4080
2000	190	20	170	1400	450	1180	490	3900
2001	140	10	165	1380	440	1070	500	3705
2002	170	10	160	1370	435	1160	490	3795
2003	170	13	190	1450	430	1150	500	3903
2004	210	19	280	1530	540	1210	540	4329
2005	150	9	180	1490	430	1130	530	3919

Table 2.4 found below displays the soybean yields per acre by state.

Table 2.4 Soybeans: Yield per acre by State

Year	Alabama	Florida	Georgia	North Carolina	South Carolina	Tennessee	Virginia
1991	23	27	27	30	30	22	29
1992	29	30	29	27	35	22	31
1993	24	25	17	24	31	15	22
1994	31	31	31	31	37	27	32
1995	24	26	27	25	32	24	24
1996	34	32	26	29	35	25	34
1997	25	25	21	29	34	23	23
1998	22	23	21	27	29	21	23
1999	16	32	19	23	19	20	27
2000	18	19	24	33	25	25	39
2001	35	29	26	32	34	21	36
2002	24	33	23	24	31	17	23
2003	36	30	33	30	42	28	34
2004	35	34	31	34	41	27	39
2005	33	32	26	27	38	21	30

In almost every year of the 14 year period listed, Tennessee had the poorest yields in terms of bushels of soybeans per acre. Even in 2003, when every other state managed to produce over 30 bushels per acre, with South Carolina producing 42 bushels per acre, Tennessee only managed to average 28.

Corn is the most widely produced feed grain in the United States. It is used for human consumption, livestock production, and industrial production (USDA). Acres of corn planted in the Southeast region of the U.S. from 1991-2005 are listed below in Table 2.5:

Table 2.5 Corn: Acreage Planted by State (thousands)

Year	Alabama	Florida	Georgia	North Carolina	South Carolina	Tennessee	Virginia	Total Region
1991	260	110	600	1050	280	620	500	3420
1992	330	150	750	1150	375	740	520	4015
1993	300	140	650	1000	330	660	490	3570
1994	290	120	600	1000	370	670	500	3550
1995	250	100	400	800	290	640	430	2910
1996	300	140	580	1000	400	740	450	3610
1997	280	120	500	960	350	700	490	3400
1998	300	160	500	860	350	700	500	3370
1999	220	90	350	750	300	630	500	2840
2000	230	85	360	730	310	650	470	2835
2001	180	65	265	700	260	680	470	2620
2002	200	75	340	780	320	690	500	2905
2003	220	75	340	740	240	710	470	2795
2004	220	70	335	820	315	680	500	2940
2005	220	65	270	750	300	650	490	2745

Though there is somewhat of a gradual decreasing trend in some of the states' acreage planted, it can be observed that North Carolina planted the most acreage every year of the 15 year period and that Florida planted the least acreage every year of the 15 year period. However, despite the fact that North Carolina planted the greatest corn acreage each year, the states' percentages of the seven states total acreage planted decreased over the 15 year period. In 1991, North Carolina planted 30.7% of the 7 state total corn acreage with 1050 thousand acres. In 2005, it only planted 27.3% with 750 acres. This could be due to a variety of different factors, including the fact that the 7 states experienced a 19.7% decrease in total corn acreage planted and that Tennessee increased its percentage of the 7 state total corn acreage planted by 5.5% from 18.1% to 23.6%.

Table 2.6 displays corn yields from 1991-2005 by state.

Table 2.6 Corn: Yield per acre by State (bushels per acre)

Year	Alabama	Florida	Georgia	North Carolina	South Carolina	Tennessee	Virginia
1991	80	68	100	90	86	85	84
1992	94	75	100	95	124	88	116
1993	55	65	70	65	84	40	60
1994	96	85	106	91	116	85	98
1995	75	90	90	107	118	91	111
1996	82	88	95	95	116	79	126
1997	87	80	105	89	102	95	93
1998	63	62	85	70	96	40	84
1999	103	93	103	80	102	70	78
2000	65	75	107	116	114	65	146
2001	107	87	134	125	132	108	123
2002	88	96	110	83	107	47	68
2003	122	82	129	106	131	105	115
2004	123	90	130	117	140	100	145
2005	119	94	129	120	130	116	118

The corn yield per acre shows a general trend upward in all 7 states over the 14 year period, marked by some decreases across the board in certain years such as 1998 and 2002.

FARM PROGRAMS

Farm programs have existed since the 1930's to help farmers stabilize price and support income. Historically programs included acre reduction programs and loan programs. The following policy information was gathered from various United States Department of Agriculture (USDA) publications listed in the Bibliography. The Food, Agriculture, Conservation, and Trade Act of 1990 (FACTA) contained several benefits for agricultural producers. One benefit was the establishment of target prices at fixed rates. Additionally, FACTA allowed for more planting flexibility by permitting farmers to plant any eligible crop, excepting fruits and vegetables, on up to 25% of their base acreage. As long as this percentage is not exceeded, the farmer's base history is preserved, and he or she will receive deficiency payments on 85% of the crop base. Also, FACTA extended the Acreage Reduction Program to be utilized when the USDA predicts excessive supply of certain commodities. In addition, FACTA extended the Secretary of Agriculture's ability to offer and loan deficiency payments (USDA).

The Agricultural Marketing Transition Act of 1996 redefined policy specifications for income support and commodity loan programs. As stated above, the 1996 Act discontinued acreage restriction programs and allowed more flexibility in farms' planting decisions. The loan programs had few changes and loan rates were kept as moving averages of past prices of cotton, corn, and soybeans (Hoffman 1996). The 1996 Act covered the time period of 1996-2001.

Another significant policy that affected cotton, corn, and soybean acreage was the Farm Security and Rural Investment Act of 2002 (FSRIA). First, it altered the requirements for the direct payment program. Under the 1996 AMTA, a producer had to have participated in one of the eligible programs for at least 1 year from 1991 to 1995. He or she was then eligible to enter into a 7 year production flexibility contract which guaranteed payments through 2002. The FSRIA expanded eligibility for direct payment programs by recalculating base acreage. Also, it expanded the direct payment programs to include soybeans. The new base acreage reflected a four year average of planted acre from 1998-2001. The loan program was continued and fixed rates are established. In addition, nonrecourse loans with marketing loan provisions were extended. With a nonrecourse loan, a farmer may choose to forfeit his crop instead of repaying the loan (USDA). The 2002 Act covered the time period from 2002-2005.

Acreage reduction programs (ARP) required producers to retire a specific amount of their base acreage to gain eligibility for loan benefits. These programs affected corn and cotton, but not soybeans. The 1996 Farm Bill ended the acreage reduction program (USDA). The ARP percentages are listed below in Table 2.7.

Table 2.7 Rates for ARP (in percents)

Year	Cotton	Corn	Soybeans
1991	5	7.5	0
1992	10	5	0
1993	7	10	0
1994	11	0	0
1995	7.5	7.5	0

Marketing loan programs contain a specific loan rate under which producers can use their crop as collateral to receive a loan from the government. The loan rate is a guaranteed price the producer receives, when the market price falls below the loan rate. Alternatively, a farmer may choose to sell his crop at the market price and receive a loan deficiency payment, which is the difference between the market price and the loan rate (USDA). The loan rates for each row crop from 1991-2005 are displayed the Table 2.8.

Table 2.8 Loan Rates (Deflated)

Year	Cotton ($/lb)	Corn ($/bu)	Soybeans ($/bu)
1991	0.686	2.189	6.782
1992	0.703	2.310	6.742
1993	0.693	2.277	6.645
1994	0.654	2.471	6.432
1995	0.655	2.386	6.210
1996	0.640	2.330	6.126
1997	0.640	2.331	6.488
1998	0.657	2.391	6.655
1999	0.651	2.370	6.597
2000	0.616	2.242	6.239
2001	0.609	2.217	6.169
2002	0.624	2.377	6.003
2003	0.593	2.257	5.699
2004	0.558	2.092	5.365
2005	0.520	1.950	5.000

III. REVIEW OF LITERATURE

Supply response models originally included prices and little else. Through the years, the theoretical research has progressed to capture other variables. This chapter reviewed published research on supply response.

EARLY THEORETICAL MODELS

Nerlove (1956) developed a model for estimating elasticities for cotton, corn, and wheat from 1909-1932. His work focused on estimating expected prices utilized by farmers in making acreage decisions. He proposed that farmers predicate part of their decision on expected future prices when considering how many acres to plant. Nerlove modeled expected prices as a weighted moving average of past prices. Because the expected prices used by producers to make their planting decision cannot be observed, other more readily available data was used to establish their estimates.

Nerlove surmised that acreage decisions take into account more variables than merely the price of the previous year's crop. He proposed that farmers base their ideas on expected prices for next year. Using a weighted moving average system, Nerlove took into consideration prices from previous years. Equation (3.1) below is the model proposed by Nerlove in which producers modify their expected prices for this year in proportion to the amount of error they estimated from the previous year. The coefficient of expectations is β and t is a time subscript.

(3.1) $PC_t - PC_{t-1} = \beta[AP_{t-1} - PC_{t-1}], \quad 0 < \beta \leq 1$

Where

PC_t = the crop price expected that year
PC_{t-1} = the crop price expected lagged by one year
AP_{t-1} = the actual crop price lagged by one year

Equation (3.2) illustrates how the expectations model above can also be represented as the expected prices being a weighted moving average of the past prices where the weights are a function of the coefficient of expectation.

$$(3.2) \quad PC_t = \beta AP_{t-1} + (1-\beta)\beta AP_{t-2} + (1-\beta)^2 \beta AP_{t-3} + \ldots$$

β has value between zero and one which indicates that weight decreases to zero as time passes. Producers have a greater tendency to use previous expectations when β is closer to zero. Thus, past prices cannot be overlooked. Equation (3.3) shows a linear relationship in which the amount of acreage planted is a function based solely on the expected price for a crop. Nerlove used this model to find both the coefficient of expectation and the elasticity of acreage to expected price.

$$(3.3) \quad A_t = b_0 + b_1 PC_t + u_t$$

Where A_t = the amount of acreage planted that year
u_t = the random residual

The expected price, PC_t, cannot be observed. Equation (3.1) includes the expected price and the actual crop price. Therefore, the actual lagged crop price and the lagged acreage planted received is used in the place of PC_t and PC_{t-1}, respectively. After making the substitutions, Equation (3.4) is derived below:

$$(3.4) \quad A_t = \pi_0 + \pi_1 AP_{t-1} + \pi A_{t-1} + \mu_t$$

Where A_{t-1} = the amount of acreage planted lagged by one year
μ_t = the random residual ($u_t \neq \mu_t$).

Nerlove conjectured that if an expected price is used to make decisions then there should be a relationship between the current year's acreage and the previous year's price and acreage. Two methods were used in an attempt to estimate the equation. The first was called the special method in which Nerlove restricted the coefficient of expectation, β, to equal one. The second method, referred to as the general method, allowed the coefficient of expectation to be unrestricted.

Both estimates of the elasticities of acreage with respect to expected price and coefficient of expectation were significant at the five percent level or higher. The special method estimated the R^2 as 0.59, 0.64, and 0.22 respectively for cotton, wheat, and corn. The general method estimated the R^2 as 0.74, 0.77, and 0.35. The R^2 from the general method were higher in all three crops. The elasticities of acreage to expected price in the special method were 0.20, 0.47, and 0.09 respectively for cotton, wheat, and corn. The general method estimated elasticities of 0.67, 0.93, and 0.18 respectively for cotton, wheat, and corn. Overall, the general method generated higher estimates for the elasticities of acreage to expected price and the coefficient of expectation.

Tomek (1972) modified Nerlove's model by adding a supply shifting variable into the model and changing the price deflator. A dummy variable was used to capture the supply shift and the Index of Prices Paid by Farmers price index. Significant results were estimated for both the variables.

POLICY VARIABLES

Houck and Ryan (1972) analyzed supply relationships for U.S. corn acreage and the U.S. feed grain policy. Their model concentrated on taking government programs into account. They estimated the effects of price support and acreage restricting programs on acreage decisions. The policy variables included were loan rates, price support, and diversion payment rates. The results indicated that from 1948-1970, 95 percent of the variation of U.S. corn acreage was linked with the policy variables.

Lee and Helmberger (1985) estimated supply response of corn and soybeans by including the following farm program variables: participation decisions, cross-commodity effects, and a model for farm programs and the free market. Price responsiveness was estimated under a system including both a "farm program" equation and a "free market" equation, using pooled time-series and cross-sectional data for both. The farm program equation incorporated direct payments which includes allotments and set asides. Corn was more own-price responsive in years of acreage control programs versus years without acreage controls. Soybeans were less own-price responsive during "farm programs" versus the "free market".

Duffy, Wolhgenant, and Richardson (1987) analyzed the supply response of cotton under farm programs in four regions of the U.S. A weighted combination of expected market price and government policy was used to as the own-price variable. Results indicated that prices of competing enterprises were significant in acreage supply in 2 regions, Southern Plains and Southeast. The own-price elasticities of cotton for the short- and long-run were 0.273 and 0.573, respectively.

RISK

Just (1974) developed variables to capture risk when including government programs in estimating acreage response. He used an adaptive expectation geometric lag model. The model was generalized by geometrically including the quadratic lag terms.

Just estimated wheat and grain sorghum acreage in the San Joaquin and Sacramento Valleys in California. In his analysis of the San Joaquin and Sacramento Valleys, three different hypotheses were tested in the paper described below:

> Hypothesis 1: Decisions are not significantly affected by subjective variances or covariances,
>
> Hypothesis 2: Decisions are not significantly affected by the subjective covariances, and
>
> Hypothesis 3: the temporal lag distributions for the subjective mean and variance are equal.

The model is equation (3.5) below:

$$(3.5) \quad Y_t = A_0 + A_1\theta \sum (1-\theta)^k Z_{t-k-i} + \varepsilon$$

Where Y_t = *p* x 1 vector of dependent variables
Z_t = *n* x 1 vector of explanatory variables including prices
A_0 = *p* x 1 parameter vector
A_1 = *p* x *n* parameter matrix
θ = scalar parameter
ε = stochastic disturbance *p* x 1 vector

In equation (3.6), Z^*_t represents the decision maker's expectations for the mean of prices and yields. These decisions are reflected in Y_t. Alternatively, equation (3.7) geometrically weights past observations to predict decision maker's expectation when considering $[Z_{i,t} - Z^*_{i,t}]^2$ as an observation of risk.

$$(3.6) \quad Z^*_t = \theta \sum (1- \theta)^k Z_{t-k-1}$$

$$(3.7) \quad [Z_{i,t} - Z^*_{i,t}]^2 = [Z_{i,t} - \theta \sum (1- \theta)^k Z_{t-k-1}]^2$$

$$(3.8) \quad W^*_{i,t} = \varphi \sum (1- \varphi)^k [Z_{i,\, t-k-1} - Z^*_{i,\, t-k-1}]^2$$

In equation (3.8), $W^*_{i,t}$ is an *n* x 1 vector and φ is a scalar geometric parameter. Thus, the original equation (3.5) is modified to equation (3.9) which includes.

(3.9) $Y_t = A_0 + A_1 Z^*_t + A_2 W^*_t + \varepsilon$

A_2 is a *p* x *n* parameter matrix. Equation (3.10) is an observation of the covariance of the prices or yields. The covariance is considered to be important in the decision maker's expectations. So, equation (3.11) includes the covariance in W^*_t.

(3.10) $\Psi_{i,j,t} = [Z_{i,t} - Z^*_{i,t}]\,[Z_{i,t} - Z^*_{i,t}]$

(3.11) $W^*_t = \varphi \Sigma (1-\varphi)^k \psi_{t-k-1}$

Equation (3.12) is the final model which contains all the modifications from the initial equation (3.5).

(3.12) $Y_t = A_0 + A_1\theta \Sigma (1-\theta)^k Z_{t-k-i} + A_2\varphi_t \Sigma (1-\varphi)^k \psi_{t-k-1} + \varepsilon$

The estimation of model (3.12) produced the rejection of hypothesis 1 because risk was significant in most equations. The exception to risk not being significant was found only in the case where the crops were strongly regulated by government programs.

Pope (1981) explored different levels of price expectations for aggregated supply response. Concave, convex, and linear supply functions are analyzed at different dispersion levels. Results were comparable to those of Just (1974) on supply response under risk.

THEORETICAL RESEARCH

Gardner (1976) used futures prices in his supply analysis of soybeans and cotton. Specifically, he used the prices of futures contracts for next year's crop instead of using the lagged price to represent farmers' expected price. He addressed three problems created by using futures prices. First, the futures price represents nonfarm speculators along with farmers. Second, there is a question of which specific futures contact should be used. Third, there is a question at which point in time should the price be taken. In the end, the use of futures prices proved to be comparable to the lagged prices in the estimations.

Shumway (1983) analyzed Texas field crop production and estimations of product supply and input demand equations. These analyses were based on competitive behavior in output and variable input markets along with a twice continuously differentiable input requirements function. Specifically, the model included a lag structure for the product price and unobserved market price. The estimations indicate inconsistencies in the model and do not support the symmetry restrictions.

Chavas and Holt (1990) used expected utility maximization to develop a supply response model when estimating corn and soybeans on a national basis. Their model took risk (using revenue uncertainty), wealth effects, and government programs into account. The utility maximization function by von Neumann Morgensten is assumed for household preferences.

The model maximizes expected utility subject to equation (3.13), a budget constraint, and equation (3.14), an acreage constraint. Equation (3.13) includes the variables I (the exogenous income/wealth variable), R (the revenue variable), C (the total cost of production), and qG (the household consumption expenditures deflated). Equation 3.13 can also be represented as the second equation that breaks down revenue and total cost of production. The revenue variable includes p (the market price of the crop), and Y (the yield per acre). The total cost of production is estimated with c (the cost of production per acre) and A (the number of acres planted).

(3.13) $I + R - C = qG$ or $I + \Sigma\ pYA - \Sigma\ cA = qG$

(3.14) $f(A) = 0$

The variables subject to risk are p and Y. Neither variable is known when planting decisions are being determined.

After making substitutions with equation (3.13), the final model is present in equation (3.15).

(3.15) $\max \{EU(w + \Sigma_{i=1} \pi A)\}$ s.t. (3.14)

Substitutions were made with w (wealth) and π (profits per acre of crop) that take price, yield, and cost in account. Chavas and Holt denote $A^*(w; \pi; \alpha)$ as the optimal level of acreage per crop which is dependent on wealth, expected profit per acre, and higher moments of the profit distribution (α). The decision of A* made by famers under risk is homogenous of degree zero in initial wealth (w), output price (p), input cost (c), and consumer price (q).

Equation (3.16) represents the symmetry restrictions needed for expected utility. A^C is the wealth compensated acreage decision.

(3.16) $dA^C/d\pi = dA^*/d\pi - dA^*/dw\ A^{*\prime}$

The wealth effects above reflect the different types of risks that can be assumed for optimizing acreage decisions. Specifically, if zero wealth effect is assumed then dA^*/dw becomes zero and symmetric, positive semi definite matrix.

The variance for untruncated normalized prices was calculated as equation (3.17), below.

(3.17) $VAR (P_{it}) = \Sigma \lambda_j [P_{i,t-j} - E_{t-j-1} P_{i,t-j}]^2$

The variance is weighted by the variable λ_j of .5, .33, and .17 for t-1, t-2, and t-3, respectively. Price support, such as loan rates, sets a floor under market prices. Price expectations and riskiness of revenue are affected by the price support rates; the truncated distributions of price take the price support affects into account. The truncated mean for the normal distribution is below in equation (3.18),

(3.18) $E [P \mid P > S] = \mu = \int P f(P|P>S) dx = \mu + \sigma \lambda(\alpha)$

where $\alpha = (S- \mu)/\sigma$ and $\lambda(\alpha) = \varphi(\alpha)/[1 - \Phi(\alpha)]$. P is the expected crop price, S is the loan rate, μ is the untruncated mean, σ is the standard deviation, $\lambda(\alpha)$ is the inverse mills ratio, φ is the standard normal density, and Φ is the standard normal CDF (Greene). The truncated variance for the normal distribution is $\sigma^2 = \int (P - \mu)^2 f(P|P>S) dx$ (Greene).

The equations below were used to generate the truncated price distributions. H_i represents the level of price support. They define x_i a normally distributed random variable, as H_i if X_i is less than H_i and X_i if X_i is greater than or equal to H_i where i= 1, 2, and so on. Equation (3.19) and Equation (3.20) define the random variables e_i and h_i, respectively.

(3.19) $e_i = (x_i - X_i)/ \sigma_{ii}^{1/2}$

(3.20) $h_i = (H_i - X_i)/ \sigma_{ii}^{1/2}$

Equation (3.20) is the mean of e_i where $\Phi(.)$ is the standard normal distribution function and $\varphi(.)$ is the bivariate standard normal density function.

(3.21) $E (e_i) = h_i \Phi (h_i) + \varphi (h_i)$

Equation (3.22) and equation (3.23) are the second moments of e_i which were derived in Chavas and Holt's appendix.

(3.22) $M_{ii} = E(e_i^2) = h_i^2 \Phi(h_i) + 1- \Phi(h_i) + h_i \varphi(h_i)$

(3.23) $M_{ij} = E(e_i, e_j) = F(h_i, h_j)\rho_{jj} + [(1- \rho_{ij}^2)/2\pi]^{1/2} \varphi(Z_{ij}) + h_i \varphi(h_i) \Phi(k_{ji}) + h_ih_j\Phi(h_i, h_j)$

All of equation (3.23) substitutions are listed below.

(3.24) $F(h_i, h_j) = \Phi(h_i, h_j) + 1 - \Phi(h_i) - \Phi(h_j)$

(3.25) $Z_{ij} = \{(h_i^2 + 2\rho_{ij}h_ih_j + h_i^2)/(1- \rho_{ij}^2)\}^{1/2}$

(3.26) $k_{ij} = (h_i – \rho_{ij}h_i)/(1- \rho_{ij}^2)^{1/2}$

(3.27) $\rho_{ij} = \sigma_{ij}/(\sigma_{ii}\sigma_{jj})^{1/2}$

Equation (3.28), equation (3.29), and equation (3.30) are the mean, variance, and covariance of x_i, respectively.

(3.28) $x_i = E(x_i) = X_i + \sigma_{ii}^{1/2}e_i$

(3.29) $V(x_1) = E(x_i – x_i)^2 = \sigma_{ii} (M_{ii} – e_i^2)$

(3.30) $COV(x_i, x_j) = E(x_i – x_i)(x_j – x_j) = (\sigma_{ii} \sigma_{jj})^{1/2}(M_{ij}– e_ie_j)$

The farm value of proprietor equity was used for the wealth variable. Chavas and Holt defined profit below in equation (3.31).

(3.31) $\pi_{jt} = E_{t-1}[(p_{jt}/q_t)Y_{jt} – (c_{jt}/q_t)|p_t \geq p^s_t\}$

The model estimated by Chavas and Holt is listed below

(3.32) $A_{it} = a_i + \alpha_i (w_{t-1} + \Sigma_j A_j\pi_{jt}) + \Sigma_j Bi_j\pi_{jt} + \Sigma_{k\geq j} \Sigma_j \gamma_{ijk}\sigma_{jkt} + \theta_it + \eta_iD83 + \mu_{it}$

Where A_{it} = Amount of acres planted
w_{t-1} = wealth (farm value of proprietor equity)
π_{jt} = Truncated mean return per acre
$\alpha_i = dA_i/dw$
$\gamma_{ij} = dA_i/d\sigma_{jk}$
σ_{jkt} = covariances
t = Trend variable
D83 = Dummy variable for discount effect of the 1983 payment-in-kind program
μ_{it} = error term

Estimations from the model above indicated that risk and wealth effects were important in the choosing acreage allocation of corn and soybeans. The own-revenue elasticites were 0.068 and .279 for the corn and cotton equations, respectively. The own-revenue elasticites were 0.158 and 0.441 for the corn and soybeans model, respectively. Cross commodity prices effects were also important. When price support for a crop was increased, the expected price also increased and the acreage planted for the substitute crop decreased.

Using the model developed by Chavas and Holt, Duffy, Shalishali, and Kinnucan (1994) analyzed supply response for corn, cotton, and soybeans in the Southeast. The Southeast region included Alabama, Georgia, North Carolina, and South Carolina. Three sets of equations were estimated. They also included variables to capture the diversion payments for cotton and corn. The own-revenue corn elasticity was 0.0954 along with the soybeans own-revenue of 0.560. Thus, the Southeast region was found to be more responsive to changes in profitability than the U.S. as a whole.

Duffy, Shalishali, and Kinnucan also estimated a set of time-varying parameter models. The models allowed for stochastic and systematic changes. The stochastic changes took place around stationary and non-stationary mean values. The systematic changes took place by varying nonrandom parameter values. Results of the model suggested that over time cotton acreage has become more inelastic.

Using a similar framework to that of Chavas and Holt, Lin and Dismukes (2007) analyzed supply response in the North Central region of the United States for corn, soybeans, and wheat. The North Central region included Wisconsin, Illinois, Indiana, Iowa, Michigan, Minnesota, Missouri, and Ohio. They used futures prices for expected crop prices. Instead of price, they used expected variance and covariances of revenues to reflect price and production risk. The household wealth variable was farm operator household net worth which included both farm and non-farm sources. The estimations included a lagged dependent variable as an explanatory variable to take into account the cost of making adjustments in production over time. Their expected yields were generated by regressing actual yields on a trend variable. In addition to the cross-equation symmetry restrictions, Lin and Dismukes restricted the parameter on expected net returns of soybeans to 0.0090 in the soybean equation due to a high collinearity between corn and soybeans net returns.

Equation (3.33) below is the linear acreage model and equation (3.34) is the acreage share model estimated.

(3.33) $A_i = a_{1i} + b_{ij} \Sigma_{j=1} NRT_j + c_{ij} \Sigma_{j=1} VAR_i + d_{ij} \Sigma_{i \neq j, 1} COV_{ij} + e_i W_i + f_i Z_i + \mu_i$

(3.34) $Si = a_{1i} + b_{ij} \Sigma_{j=1} NRT_j + c_{ij} \Sigma_{j=1} VAR_i + d_{ij} \Sigma_{i \neq j,1} COV_{ij} + e_i W_i + f_i Z_i + \mu_i$

Where Σ Si = 1

A_i = acreage planted
Si = share combined acreage of crops
NRT_j = expected net returns
VAR_i = expected variance of revenues
COV_{ij} = expected covariance of cross-commodity revenues
W_i = farm operator household initial net worth
Z_i = APR, state dummies, lagged dependent variable ($A_{i, t-1}$ and $S_{i, t-1}$), and the error term

The own-revenue elasticites were 0.170 and 0.158 for the corn linear and share models, respectively. The own-revenue elasticites were 0.295 and 0.304 for the soybeans linear and share models, respectively. The own-revenue elasticites were 0.336 and 0.248 for the wheat linear and share models, respectively. In the estimations of the model above, risk did not prove to have strong effect across commodities in the North Central region of the U.S. Also, increased initial wealth lead to increased acreage planted of crops.

IV. DATA AND THE MODELS

This analysis used time-series and cross-sectional data from 1991-2005. Data for cotton, soybeans, and corn were collected from the Southeast states of Alabama, Florida, Georgia, North Carolina, South Carolina, Tennessee, and Virginia. Planted acreage and market prices for each row crop from 1987-2005 for each state were collected from the United States Department of Agriculture's Quick Stats website and can be located in Appendix A. All prices were normalized to 2005 levels using Producer Price Indexes for Farm Products. The Producers Price Index for farm products was found at the Bureau of Labor Statistics website and can be located in Appendix A.

An average of three days of futures prices was taken for each crop from a specific time period with relation to the specific time of year the producers made their planting decisions to generate the expected price. This average represents the futures price used in the estimation. The futures data were collected from the period of 1989-2005 from Price Data and can be located in Appendix A. December cotton futures prices were collected in January on the second Tuesday, Wednesday, and Thursday during the same year. September corn futures prices were collected in January on the second Tuesday, Wednesday, and Thursday for the month during the same year. November soybean futures prices were collected in January for the second Tuesday, Wednesday, and Thursday during the same year.

Expected prices were developed by subtracting the futures prices from the state average market price to estimate the basis for that crop in each state. The average basis was then subtracted from the average futures price to get the expected price. The equations (4.1) and (4.2) below illustrate the formulas for the basis and expected price.

(4.1) $\sum_{t=1}$ (Average Market Price $_t$ – Average Futures Price $_t$)/N = Average Basis

(4.2) Average Futures Price $_t$ – Average Basis = Expected Price $_t$

N is the number of observations.

Costs of production, on a regional basis, were collected for each crop for the period 1991 to 2005. Costs of production for 1991-1995 were collected from Southeast region. In 1996, this series ended and was replaced by a new series with different regional names. The costs of production for 1996-2005 were thus collected from the Southern Seaboard region. Since the USDA changed the format of the costs of production from the original 1991-1995 data, the data from 1996-2005 were standardized to 1991-1995 data by adding hired labor and subtracting interest paid on capital to operating costs. The costs of productions for each crop were gathered from the USDA and can be located in Appendix A.

From 1990 to 1995, the loan rates were found in *Cotton: Background for 1995 Farm Legislation* and *Feed Grains: Background for 1995 Farm Legislation* by the USDA. After 1995, they were found in *Provisions for the Federal Agriculture Improvement and Reform Act of 1996* by the USDA for 1996-2001. The 2002-2005 loan rates were found in *The 202 Farm Act: Provisions and Implications of Commodity Markets* published by the USDA. The Acreage Reduction Programs rates were found in *Cotton: Background for 1995 Farm Legislation, USDA's Federal Register: Rules and*

Regulations, and *Feed Grains: Background for 1995 Farm Legislation* by the USDA. The wealth variable used farm equity and was from the Agricultural Resource Management Survey of the USDA and can be located in Appendix A.

EXPECTED YIELDS

The yield data from 1971-2005 was used to generate expected yields by equation (4.3) below:

(4.3) $E(Y_t) = \alpha + \beta_1 Y_{t-1} + \beta_2 T$

where Y_t is the yield, Y_{t-1} is the lagged yield, and T is the trend variable. The yield data were gathered from the USDA Quick Stats website and can be located in Appendix A. The trend variable takes the value of 1 in 1971, 2 in 1972, and so on. In each year of subsequent estimation, a new year of data was added to the model.

TRUNCATED PRICE DISTRIBUTION

Because the loan rate "cuts off" the lower tail of the price distribution, the mean and the variance of price will be affected. Using the same formula as Lin and Dismukes, the mean of the truncated price variable is defined by equation (4.4.) below:

(4.4) $E(TP) = sp + \Phi(\gamma) + \sigma_p^2 * (1/\sqrt{(2*\pi)})^{(-.5*\gamma*\gamma)} + ep*(1-\Phi(\gamma))$

where sp is the support price; ep is the expected market price; σ_p is the untruncated variance of price, calculated as a moving weighted average of the deviations of expected market price from actual market price, using a three-year lag and the weights (0.5., 0.3., and 0.2); γ is defined as $(sp – ep) / \sigma_p$ and Φ is the standard normal distribution.

The truncated variance and covariances were created following the formula found in Greene, as applied by Lin and Dismukes. Also, they can be found in the literature review of Chavas and Holt. The SAS Programs that were used to generate the variables are available in Appendix B.

EXPECTED REVENUE

Equation (4.5) is the formula for expected net revenues, taking into account the truncation of prices by the loan rate.

(4.5) $NRT = E(Y) * E(TP) – CP + (1- \Phi (\gamma)) * (\zeta/\surd\ \sigma_y^{2} * \sigma_p^{2}) * \sigma_y * \surd\sigma_{tp}^{2}$

E(Y) is the expected yield, CP is the lagged costs, ζ is the correlation between untruncated price and yields, σ_p^2 is the variance of untruncated yields, σ_p is the standard deviation for untruncated prices, σ_y is the standard deviation for untruncated yields, and σ_{tp}^2 is the truncated variance of price.

MODELS

This analysis used the framework from Chavas and Holt's model and Lin and Dismukes. Equation (4.6) is the cotton model, equation (4.7) is the soybeans model, and equation (4.8) is the corn model.

(4.6) $A_i = a_i + b_i$ ctexpre + c_i sbexpre + d_i cnexpre + e_i ctrvar + f_i sbrvar + g_i cnrvar + h_i ctidle + i_i covrsbct + j_i covrcnct + k_i wealthadj + l_i lctpa + m_i AL+ n_i GA + o_i FL + p_i NC + q_i SC + r_i TN + s_i VA + t_i Fpdum + μ_i

(4.7) $A_i = a_i + b_i$ ctexpre + c_i sbexpre + d_i cnexpre + e_i ctrvar + f_i sbrvar + g_i cnrvar + h_i covrsbct + i_i covrcnct + j_i wealthadj + k_i lsbpa + l_i AL+ m_i GA + n_i FL + o_i NC + p_i SC + q_i TN + r_i VA + s_i Fpdum + μ_i

(4.8) $A_i = a_i + b_i$ ctexpre + c_i sbexpre + d_i cnexpre + e_i ctrvar + f_i sbrvar + g_i cnrvar + h_i cnidle + i_i covrsbct + j_i covrcnct + k_i wealthadj + l_i lcnpa + m_i AL+ n_i GA + o_i FL + p_i NC + q_i SC + r_i TN + s_i VA + t_i Fpdum + μ_i

The variables from the models above are listed in Table 4.1 below which also contains their definition.

Dummy variables were created for each state to allow for different intercepts, with Alabama as the "base state" without a dummy variable. For example, in the column for Georgia the variable was equal to one and the other states were equal to zero. This was repeated for each state. Also, a policy dummy was used for the years 1991-1995 which pertained to the old farm bill. The year before the 1996 Farm Bill took the value of one and after took the value of zero.

Table 4.1 Independent Variables and Definitions

Variable	Definitions
A	Acreage Planted
Ctexpre	Cotton Truncated Expected Net Returns
Sbexpre	Soybeans Truncated Expected Net Returns
Cnexpre	Corn Truncated Expected Net Returns
Ctrvar	Cotton Truncated Expected Variance of Revenue
Sbrvar	Soybeans Truncated Expected Variance of Revenue
Cnrvar	Corn Truncated Expected Variance of Revenue
Ctidle	Cotton in Acreage Reduction Program in Percentages
Cnidle	Corn in Acreage Reduction Program in Percentages
Covrsbct	Truncated Expected Covariance of Corn and Cotton Revenues
Covrcnct	Truncated Expected Covariance of Soybeans and Cotton Revenues
Wealthadj	Lagged Net Worth for Farm Households
Lctpa	Lagged Cotton Acreage Planted
Lsbpa	Lagged Soybeans Acreage Planted
Lcnpa	Lagged Corn Acreage Planted
FL	Florida Dummy
GA	Georgia Dummy
NC	North Carolina Dummy
SC	South Carolina Dummy
TN	Tennessee Dummy
VA	Virginia Dummy
Fpdum	Policy Dummy

V. RESULTS

In the analysis, the equations were first estimated in OLS and then estimated in SUR. The Seemingly Unrelated Regressions model first estimates the equation in OLS, then takes into account the residual of the variance and covariance matrix to estimate the generalized least squares model (Lin and Dismukes). Two different SUR models were estimated, one with cross equations restrictions on the truncated revenues and one without cross-equation restrictions.

The OLS equations are displayed in Table 5.1. The cotton model estimated in OLS contained the largest number of significant variables. Cotton truncated net returns were significantly positive as expected. Cross price effects of the soybeans and corn truncated net returns were significant and negative indicating a competitive relationship. The cotton variance was significant and negative. The cotton-soybeans covariance was significant and positive. The corn-soybeans covariance was significant and negative.

The OLS soybeans model estimated significant and positive truncated expected returns of soybeans as expected. The OLS corn model estimated significant and positive truncated expected returns of corn as expected. Truncated expected net returns of cotton was positive and significant. The cotton-corn covariance was significant and positive in both the OLS and SUR unrestricted estimations. The farm program dummy was significant in the cotton and corn equations, negative and positive, respectively.

Table 5.1 OLS Estimations of Planted Acreage

Variable	Cotton	Soybeans	Corn
Intercept	157.320	34.451	41.630
	(50.595)***	(34.957)	(55.555)
Ctexpre	0.279	-0.041	0.316
	(0.143)*	(0.124)	(0.162)*
Sbexpre	-0.883	0.822	-0.550
	(0.383)**	(0.339)**	(0.454)
Cnexpre	-0.524	---	0.497
	(0.199)**		(0.231)**
Ctrvar	-4947.281	---	802.060
	(1890.188)**		(2518.725)
Sbrvar	---	8.913	28.558
		(10.424)	(17.321)
Cnrvar	---	---	57.629
			(74.873)
Ctidle	0.033	---	---
	(0.005)***		
Cnidle	---	---	0.003
			(0.007)
Covrsbct	584.432	-30.380	---
	(195.037)***	(163.335)	
Covcnsb	---	---	-46.81
			(63.551)
Covrcnct	-2185.483	---	1640.836
	(480.864)***		(469.914)***
Wealthadj	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)
Lctpa	0.867	---	---
	(0.046)***		
Lsbpa	---	0.746	---
		(0.066)***	
Lcnpa	---	---	0.582
			(0.109)***
FL	15.364	-67.644	-40.03
	(36.250)	(31.447)**	(37.723)
GA	147.836	7.308	27.242
	(43.324)***	(27.573)	(43.536)
NC	81.588	279.483	243.105
	(29.879)***	(77.625)***	(68.550)***
SC	-20.658	69.731	16.994
	(25.560)	(27.830)**	(28.754)
TN	111.908	177.252	188.319
	(40.133)***	(68.730)**	(56.751)***
VA	99.065	12.722	100.781
	(43.908)**	(41.050)	(44.782)**
Fpdum	-137.990	---	51.996
	(26.509)***		(26.085)**
Observations	98	98	98
R^2	0.9832	0.9877	0.9586

Note: The standard deviations are listed below the coefficient estimates in parentheses. The asterisks indicate a 1%, 5%, and 10% significance different from zero by ***, **, and *, respectively.

In the SUR unrestricted regression displayed in Table 5.2, the cotton model estimated significant and positive truncated cotton net returns as expected. The truncated expected net returns of soybeans were negative and significant indicating a competitive relationship. Similar results were estimated in the OLS regression in Table 5.1. In the soybeans equation, the truncated net returns of soybeans were significantly positive as expected. In the corn equation, the truncated expected net returns for corn were significant and positive as expected. The variance for soybeans was significant and positive.

The SUR restricted model used the symmetry restrictions across each of the following equations: soybeans and cotton, corn and cotton, and corn and soybeans. The estimations are displayed in Table 5.3. However, two of the three restrictions are rejected. The soybeans-cotton restriction and the corn-cotton restriction were rejected in the F-test. The corn-soybeans restriction was not rejected in the F-test. The F-test information is also in Table 5.3. In the SUR estimations with restriction, there are not any significant net returns.

Table 5.4 contains the short-run and long-run own-profit elasticities for all three estimations. The long-run elasticites were calculated using the formula from Duffy, Richardson, and Wolhgenant where the coefficient of the own-profit is divided by one minus the coefficient of the lagged acreage. In Chavas and Holt, own-profit elasticites are referred to as own-revenue elastic. Lin reported own-profit elasticity for corn (0.170) and soybeans (.295). Chavas and Holt reported own-profit elasticity for corn (0.158) and

Table 5.2 SUR Unrestricted Estimations of Planted Acreage

Variable	Cotton	Soybeans	Corn
Intercept	29.129	45.458	117.882
	-48.613	(35.370)	(46.994)**
Ctexpre	0.335	0.036	0.179
	(0.157)**	(0.123)	(0.156)
Sbexpre	-0.973	0.597	-0.443
	(0.422)**	(0.337)*	(0.420)
Cnexpre	-0.328	---	0.391
	0.204		(0.209)*
Ctrvar	-483.942	---	-1639.16
	(1983.118)		(2245.068)
Sbrvar	---	9.586	35.102
		(10.392)	(14.602)**
Cnrvar	---	---	56.511
			(66.087)
Ctidle	0.017	---	---
	(0.004)***		
Cnidle	---	---	0.002
			(0.005)
Covrsbct	241.917	48.750	---
	(203.67)	(174.678)	
Covcnsb	---	---	-33.696
			(53.372)
Covrcnct	-482.498	---	678.730
	(454.903)		(405.401)*
Wealthadj	0.000	-0.000	-0.000
	(0.000)*	(-0.000)	(0.000)*
Lctpa	0.827	---	---
	(0.047)***		
Lsbpa	---	0.806	---
		(0.062)***	
Lcnpa	---	---	0.602
			(0.101)***
FL	-41.245	-35.933	-28.606
	(39.451)	(31.443)	(36.648)
GA	133.431	16.026	53.550
	(46.105)***	(27.649)	(41.382)
NC	69.039	228.836	241.067
	(33.598)**	(73.164)***	(64.236)***
SC	-38.14	52.053	15.311
	(28.506)	(27.251)*	(27.658)
TN	97.063	151.469	184.657
	(45.302)**	(65.415)**	(54.424)***
VA	49.394	22.239	97.463
	(48.525)	(40.334)	(43.949)**
Fpdum	---	-26.012	---
		(16.384)	

Note: The standard deviations are listed below the coefficient estimates in parentheses. The asterisks indicate a 1%, 5%, and 10% significance different from zero by ***, **, and *, respectively.

Table 5.3 SUR Restricted Estimations of Planted Acreage

Variable	Cotton	Soybeans	Corn
intercept	23.383	29.680	127.334
	(53.026)	(45.226)	(47.257)***
ctexpre	0.181	-0.108	-0.149
	(0.169)	(0.130)	(0.129)
sbexpre	-0.108	0.551	0.042
	(0.130)	(0.388)	(0.163)
cnexpre	-0.149	0.042	0.317
	(0.129)	(0.163)	(0.196)
ctrvar	-597.616	2144.278	-1053.060
	(2704.510)	(2374.216)	(2434.157)
sbrvar	-9.069	3.201	21.676
	(16.802)	(16.427)	(13.101)
cnrvar	-22.446	23.825	50.604
	(51.030)	(65.723)	(65.157)
ctidle	0.0169	---	---
	(0.004)***		
cnidle	---	---	0.002
			(0.005)
covrsbct	149.009	20.066	---
	(225.651)	(182.204)	
covcnsb	---	8.011	14.920
		(54.507)	(52.049)
covrcnct	-713.960	---	152.408
	(543.902)		(373.820)
wealthadj	0.000	-0.000	-0.000
	(0.000)*	(0.000)	(0.000)*
Lctpa	0.842	---	---
	(0.050)***		
Lsbpa	---	0.832	---
		(0.065)***	
Lcnpa	---	---	0.630
			(0.099)***
FL	-68.929	-45.399	-46.227
	(45.084)	(33.306)	(35.693)
GA	108.034	4.512	63.279
	(45.982)**	(36.582)	(39.923)
NC	28.963	193.307	208.501
	(32.929)	(79.602)**	(63.654)***
SC	-29.737	39.940	14.937
	(31.929)	(32.843)	(27.297)
TN	10.275	116.506	130.315
	(37.684)	(69.466)***	(51.889)**
VA	-31.636	4.891	49.194
	(46.477)	(41.333)	(40.222)
Fpdum	---	-14.978	---
		(20.528)	

Restrictions	Parameter	Standard Error	P-value
Soybeans-Cotton	-8.465	2.325	0.000
Corn-Cotton	-12.556	4.249	0.002
Corn-Soybeans	3.117	2.202	0.158

Note: The standard deviations are listed below the coefficient estimates in parentheses. The asterisks indicate a 1%, 5%, and 10% significance different from zero by ***, **, and *, respectively.

Table 5.4 Short- and Long-Run Own Profit Elasticities

	OLS		SUR Unrestricted		SUR Restricted	
Crop	Short-Run	Long-Run	Short-Run	Long-Run	Short-Run	Long-Run
Cotton	0.068	0.511	0.077	0.093	.041	0.262
Soybeans	0.094	0.224	0.074	0.185	.072	0.427
Corn	0.107	0.421	0.078	0.401	.060	0.162

soybeans (.441). Duffy, Shalishali, and Kinnucan reported a corn own-revenue elasticity of 0.0954 and a soybeans own-revenue of 0.560. The soybeans own-profit elasticites from this study are lower than in Duffy, Shalishali, and Kinnucan and the corn own-profit elasticites are higher than the Duffy, Shalishali, and Kinnucan. The own-profit elasticites from this study are lower than the other elasticites reported by Lin and Dismukes and Chavas and Holt. The APR program affected cotton and corn from 1991-1995. The coefficient of the cotton the ARP variable was significant and positive in the OLS, SUR unrestricted, and restricted estimations. Thus, more idled acres of cotton lead to an increase in acres planted. This could be a result of farmers trying to build their base acreage for cotton. However, the magnitude of the coefficient was small, .033 for the OLS estimations and .017 for the SUR estimation.

Wealth was significant in the SUR unrestricted estimations for cotton and corn. Similar results were found in Lin and Dismukes. The lagged planted acreage for each individual equation in the OLS, SUR unrestricted, and SUR restricted estimations were significant and positive. Similar results can also be found in Lin and Dismukes.

VI. CONCLUSION

This paper identified a theoretical model for supply response of cotton, soybeans, and corn in seven Southeast states based primarily on work by Chavas and Holt. Modifications were made to the model from literature by Duffy, Shalishali, and Kinnucan and Lin and Dismukes, such as the use of futures prices, variances of revenues, and covariance of revenues in the expected truncated net returns and including the dependent variable as lagged explanatory variables. Also, changes to the farm program variable and the wealth variable were made from the original model by Chavas and Holt. A set of three models were estimated in OLS, SUR without restrictions, and SUR with cross-equation restrictions using data from 1991-2005.

The data included futures prices of row crops, market prices of row crops, row crop yields, costs of production, loan rates, ARP rates, and farm equity to generate the variables need for the supply response model. From the econometric estimations, the analysis took into account how loan rates, ARP rates, wealth, and prices affect row crop acreage decisions in the Southeast region. Farm programs were taken into account through the truncation effects for each crop and also through the cotton and corn acreage reduction variables in to account.

The empirical results from the OLS, SUR unrestricted, and SUR restricted varied across model specification. The OLS model for cotton estimated cotton expected truncated net returns, soybeans expected truncated net returns, and corn expected truncated net returns as significant. Soybeans and corn expected truncated net returns were negative indicating as corn and soybeans revenues go up the acreage of planted cotton decreases. Thus, there exists a competitive enterprise between cotton and soybeans and also corn and cotton in the Southeast. In the SUR estimations with out restrictions, the cotton equation estimated significant effect of expected truncated net returns of soybeans again.

The SUR estimation with restrictions only estimated five significant variables other than the states dummies and rejected two of the three cross-commodity restrictions. The corn-soybean restriction was the only restriction that was not rejected. The rejection of the restrictions could have been a result of modeling the equations or the model might have needed to include other crops as variables that are competitive in the south with cotton, corn, and soybeans.

Three of the significant variables in the SUR estimations with restrictions were the lagged planted acreage for each crop. The lagged planted acres were significant in the OLS, SUR with out restrictions, and the SUR with restriction. This indicates that the producers are responsive to changes in the markets. These changes can include but are not limited to technological updates, futures and market prices, and biological diseases within the plants. In the cotton equation, the cotton under the ARP was significant and positive. In the corn equation for both SUR estimations, the wealth variable was negative and significant, but the magnitude was 0.000.

Overall, the short-run elasticities for own-profit generated in this paper were lower than the elasticities by Chavas and Holt, Duffy, Shalishali, and Kinnucan, and Lin and Dismukes. This indicates the Southeast crops are less responsive to profitability in the short-run. It is hard for producers to make changes in their decisions with all of the fixed inputs, especially if the crops have already been planted. However, the long-run elasticities for the OLS estimations are considerable higher in magnitude than the short-run elasticities. Thus, in the long-run cotton and corn are more responsive to profitability.

Also, this paper found that there was an importance of initial wealth when producers make planting decisions. Wealth was significant; however, the magnitude of the coefficient was zero to at least the thousandths decimal place. An increase in initial wealth does prove to increase planted acreage. The Acreage Reduction Program had positive effects on producers' decisions for cotton and corn acreage. Thus, the more cotton and corn acres under ARP, the more cotton and corn acres planted.

Further empirical work could include more row crops that are competitive with cotton, soybeans, and corn. For example, peanuts might be considered a competitive crop in the Southeast during the planting season of cotton, soybeans, and corn. Also, further empirical work could include varying the level of farm program support. This would allow analysis of the change in acreage decisions in the Southeast for different levels of support. Also, a similar model could be used in other regions of the United States. Then, supply elasticities could be generated for comparison.

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APPENDICES

APPENDIX A

The Data Used in Thesis

Corn Yields 1971-2005

Year	Alabama	Florida	Georgia	North Carolina	Tennessee	South Carolina	Virginia
1971	45	49	54	57	54	57	68
1972	48	46	52	80	65	70	83
1973	46	43	48	82	58	66	86
1974	43	48	56	75	65	61	80
1975	50	45	55	67	60	68	88
1976	60	60	62	80	82	78	78
1977	29	35	24	51	68	39	55
1978	50	52	50	76	69	57	83
1979	61	53	65	76	85	80	83
1980	36	49	42	60	46	48	55
1981	55	57	50	77	84	58	90
1982	66	66	85	99	90	88	101
1983	59	67	75	60	48	62	48
1984	65	65	82	90	95	78	104
1985	75	65	84	79	98	88	99
1986	57	62	58	69	74	46	54
1987	72	69	84	68	91	78	63
1988	44	58	62	84	73	58	79
1989	81	74	95	93	107	91	110
1990	58	71	68	68	86	48	100
1991	80	68	100	90	86	85	84
1992	94	75	100	95	124	88	116
1993	55	65	70	65	84	40	60
1994	96	85	106	91	116	85	98
1995	75	90	90	107	118	91	111
1996	82	88	95	95	116	79	126
1997	87	80	105	89	102	95	93
1998	63	62	85	70	96	40	84
1999	103	93	103	80	102	70	78
2000	65	75	107	116	114	65	146
2001	107	87	134	125	132	108	123
2002	88	96	110	83	107	47	68
2003	122	82	129	106	131	105	115
2004	123	90	130	117	140	100	145
2005	119	94	129	120	130	116	118

Soybean Yields 1971-2005

Year	Alabama	Florida	Georgia	North Carolina	Tennessee	South Carolina	Virginia
1971	26	28	25.5	24	21.5	26	24
1972	20	21	15	25	18.5	22	23
1973	21	24	21	24	19	23.5	27
1974	23	26	24.5	22	20	21	24
1975	24.5	24	25.5	23.5	25	22	25
1976	24	26	23.5	22	22.5	18	20.5
1977	21	25	20	21.5	23.5	20.5	19
1978	21	25	17.5	24	23.5	22	28
1979	25	29	28	23.5	27	24	28.5
1980	15	22	12	18	18	13	15
1981	23	24	19	25	25	20	28
1982	25	26	27	25	26.5	22	29
1983	20	25	21	20	16	16.5	16
1984	21	24	20	26	26	20	29.5
1985	27	26	24	23	31	20	25
1986	23	23	19	24	25	16.5	24
1987	18	25	21	24.5	23	22	22
1988	25	29	25	27	26	23.5	28
1989	21	22	26	27	24	21	32
1990	17	19	14	24	27	18.5	32
1991	23	27	27	29.5	30	22	29
1992	29	30	29	27	35	22	31
1993	24	25	17	24	31	15	22
1994	31	31	31	31	36.5	27	32
1995	24	26	27	25	32	24	24
1996	34	32	26	29	35	25	34
1997	25	25	21	29	34	22.5	23
1998	22	23	21	27	29	21	23
1999	16	32	19	23	19	20	27
2000	18	19	24	32.5	25	25	38.5
2001	35	29	26	32	34	21	35.5
2002	24	33	23	24	31	17	23
2003	36	30	33	30	42	28	34
2004	35	34	31	34	41	27	39
2005	33	32	26	27	38	20.5	30

Cotton Yields 1971-2005

Year	Alabama	Florida	Georgia	North Carolina	Tennessee	South Carolina	Virginia
1971	640	.	374	135	528	275	.
1972	470	395	572	337	435	543	265
1973	423	499	522	514	473	472	440
1974	429	503	490	440	483	290	384
1975	405	346	443	412	339	454	344
1976	399	514	398	489	295	438	480
1977	337	425	232	305	407	342	194
1978	443	506	463	515	490	562	480
1979	510	565	486	459	357	510	320
1980	411	610	258	381	349	309	320
1981	545	601	436	556	496	667	480
1982	775	627	714	699	638	783	640
1983	409	608	467	350	337	369	360
1984	699	847	784	600	498	785	528
1985	795	693	725	646	600	708	443
1986	506	707	455	646	567	370	554
1987	572	646	662	495	700	428	373
1988	486	566	564	515	529	473	510
1989	571	557	631	615	497	626	498
1990	476	640	555	631	461	452	562
1991	655	719	812	672	552	786	765
1992	731	701	783	596	651	565	621
1993	524	696	586	535	425	495	634
1994	766	735	843	820	726	846	944
1995	409	472	625	479	527	528	620
1996	734	637	747	659	611	774	748
1997	597	577	646	652	662	688	659
1998	559	489	578	699	589	587	765
1999	535	516	579	475	505	428	635
2000	492	480	591	742	603	627	738
2001	730	612	720	832	763	686	929
2002	507	439	557	421	741	314	465
2003	772	610	785	646	806	718	674
2004	724	601	674	900	900	875	956
2005	747	762	849	852	848	743	955

Costs of Production 1989-2005

Year	Corn	Cotton	Soybeans
1989	143.83	299.16	87.94
1990	141.17	303.74	85.54
1991	150.59	271.78	89.77
1992	152.04	275.91	91.92
1993	148.65	283.76	89.78
1994	157.32	291.02	95.1
1995	169.26	307.91	94.53
1996	170.32	308.16	98.88
1997	170.80	295.25	92.43
1998	159.03	285.26	95.09
1999	160.00	270.66	90.87
2000	171.63	320.72	92.89
2001	172.77	355.04	106.71
2002	162.21	327.59	81.98
2003	173.02	332.67	80.23
2004	186.85	339.48	90.21
2005	187.10	376.89	96.96

Producers Price Index 1981-2005

Year	PPI 1982=100	PPI 2005=100
1987	102.8	0.653113088
1988	106.9	0.679161372
1989	112.2	0.712833545
1990	116.3	0.73888183
1991	116.5	0.740152478
1992	117.2	0.744599746
1993	118.9	0.755400254
1994	120.4	0.764930114
1995	124.7	0.792249047
1996	127.7	0.811308767
1997	127.6	0.810673443
1998	124.4	0.790343075
1999	125.5	0.797331639
2000	132.7	0.843074968
2001	134.2	0.852604828
2002	131.1	0.832909784
2003	138.1	0.877382465
2004	146.7	0.93202033
2005	157.4	1

Wealth Data 1987-2003

Year	Alabama	Florida	Georgia	Kentucky	North Carolina	South Carolina	Tennessee	Virginia
1987	8,067,850	19,512,129	10,699,033	12,701,022	11,938,761	4,426,151	12,323,456	10,526,941
1988	8,537,416	19,842,369	11,648,363	12,939,378	12,443,122	5,089,356	12,420,361	11,884,615
1989	8,860,721	21,611,740	12,669,650	14,195,560	12,409,352	5,293,368	13,055,678	14,045,262
1990	8,836,141	21,445,994	12,857,393	14,258,516	12,781,751	5,837,737	13,532,906	12,826,478
1991	9,302,355	20,806,689	12,173,740	14,383,457	13,192,918	6,093,872	13,820,863	13,770,226
1992	10,017,665	21,294,936	12,948,454	15,323,962	14,582,063	6,041,829	15,052,280	13,877,695
1993	11,145,404	21,565,533	13,130,817	16,285,613	14,863,138	6,198,473	15,491,161	13,693,565
1994	11,962,833	21,563,682	13,845,770	17,239,956	15,923,372	6,655,280	16,232,541	14,798,455
1995	12,042,339	21,809,354	14,458,341	17,469,770	16,815,609	6,728,346	17,907,111	15,463,697
1996	12,236,904	21,877,306	14,865,674	17,751,287	17,876,107	6,861,700	18,893,898	16,026,216
1997	12,762,245	21,967,793	15,691,183	19,129,257	18,291,250	7,200,659	20,616,218	16,304,481
1998	13,063,029	21,453,964	16,848,438	19,381,064	18,483,204	7,487,770	21,752,216	16,931,020
1999	13,867,959	22,542,383	18,986,873	20,165,915	20,960,013	7,152,699	23,473,630	18,151,617
2000	14,467,262	24,188,781	20,934,168	22,271,398	23,191,933	7,195,202	24,384,222	19,550,322
2001	15,025,621	25,840,392	22,401,044	23,126,887	23,713,362	7,568,972	25,708,547	20,552,015
2002	15,631,199	27,495,711	24,197,038	24,768,168	24,902,239	7,934,130	26,838,592	21,339,309
2003	16,556,581	29,178,606	25,912,192	25,936,437	26,491,053	8,372,628	27,636,085	22,358,828

Cotton Futures Prices 1987-2005

			Closing Price	
Year	Dates	Tuesday	Wednesday	Thursday
1987	1/13,14,15	56.250	56.070	55.520
1988	1/12,13,14	62.000	63.050	62.550
1989	1/10,11,12	57.850	57.700	57.500
1990	1/9,10,11	63.520	63.400	64.200
1991	1/15,16,17	64.020	64.020	64.560
1992	1/14,15,16	62.600	62.660	62.250
1993	1/12,13,14	60.250	60.200	60.730
1994	1/11,12,13	67.900	68.500	68.300
1995	1/10,11,12	74.750	74.630	74.600
1996	1/9,10,11	77.500	76.700	76.500
1997	1/14,15,16	76.610	77.000	76.960
1998	1/13,14,15	71.650	71.820	71.780
1999	1/12,13,14	63.660	63.340	63.450
2000	1/11,12,13	58.990	59.190	59.500
2001	1/9,10,11	61.600	61.650	62.000
2002	1/15,16,17	43.310	43.710	43.980
2003	1/14,15,16	58.430	58.300	58.380
2004	1/13,14,15	68.770	68.880	69.450
2005	1/11,12,13	51.530	51.500	51.150

Soybeans Future Prices 1987-2005

			Closing Price	
Year	Dates	Tuesday	Wednesday	Thursday
1987	1/13,14,15	481.000	484.750	484.250
1988	1/12,13,14	617.500	626.250	627.750
1989	1/10,11,12	744.750	740.250	741.250
1990	1/9,10,11	618.250	614.250	614.250
1991	1/15,16,17	601.500	606.750	614.250
1992	1/14,15,16	585.750	597.750	599.000
1993	1/12,13,14	596.750	596.250	592.000
1994	1/11,12,13	646.500	646.500	663.250
1995	1/10,11,12	587.750	586.750	585.750
1996	1/9,10,11	706.500	704.250	696.000
1997	1/14,15,16	686.750	688.500	688.750
1998	1/13,14,15	660.500	655.500	657.250
1999	1/12,13,14	554.000	546.500	547.000
2000	1/11,12,13	499.750	505.500	515.000
2001	1/9,10,11	510.250	506.750	496.500
2002	1/15,16,17	457.750	464.000	461.750
2003	1/14,15,16	505.750	510.750	512.000
2004	1/13,14,15	669.750	668.500	671.750
2005	1/11,12,13	562.250	551.500	556.500

Corn Future Prices 1987-2005

			Closing Price	
Year	Dates	Tuesday	Wednesday	Thursday
1987	1/13,14,15	171.750	174.000	172.250
1988	1/12,13,14	204.000	206.000	206.500
1989	1/10,11,12	284.000	283.000	282.750
1990	1/9,10,11	249.000	247.500	247.000
1991	1/15,16,17	250.250	254.000	256.000
1992	1/14,15,16	266.250	269.750	267.000
1993	1/12,13,14	239.250	237.250	237.250
1994	1/11,12,13	289.000	286.500	291.000
1995	1/10,11,12	248.750	248.750	250.000
1996	1/9,10,11	314.000	310.250	305.250
1997	1/14,15,16	267.250	270.250	269.750
1998	1/13,14,15	278.500	280.250	283.250
1999	1/12,13,14	235.500	233.500	233.000
2000	1/11,12,13	228.750	236.500	241.500
2001	1/9,10,11	250.000	252.250	246.250
2002	1/15,16,17	231.750	233.500	232.000
2003	1/14,15,16	237.750	238.000	237.250
2004	1/13,14,15	268.500	270.000	270.500
2005	1/11,12,13	228.250	222.750	222.000

Corn Market Prices ($/bu)

Year	Alabama	Georgia	Florida	North Carolina	South Carolina	Tennessee	Virginia
1990	2.69	2.77	2.70	2.53	2.72	2.43	2.51
1991	2.60	2.72	2.60	2.63	2.65	2.50	2.60
1992	2.35	2.31	2.30	2.26	2.30	2.10	2.25
1993	2.64	2.72	2.55	2.65	2.75	2.55	2.65
1994	2.50	2.47	2.40	2.48	2.40	2.25	2.40
1995	3.50	3.55	3.20	3.54	3.40	3.50	3.35
1996	3.45	3.58	3.80	3.43	3.55	2.90	3.20
1997	2.82	2.90	2.90	2.83	2.79	2.65	2.69
1998	2.31	2.46	2.30	2.33	2.40	2.13	2.24
1999	2.26	2.27	2.32	2.27	2.29	1.92	2.15
2000	2.16	2.06	2.24	2.01	2.10	1.96	2.02
2001	2.35	2.32	2.25	2.36	2.20	2.06	2.14
2002	2.72	2.70	2.60	2.89	2.70	2.58	2.73
2003	2.36	2.45	2.55	2.68	2.70	2.37	2.57
2004	2.48	2.20	2.30	2.44	2.30	2.17	2.17
2005	2.50	2.20	2.00	2.33	2.19	2.07	2.14

Cotton Market Prices ($/lb)

Year	Alabama	Florida	Georgia	North Carolina	South Carolina	Tennessee	Virginia
1990	0.690	0.680	0.694	0.690	0.682	0.658	0.690
1991	0.566	0.554	0.600	0.593	0.604	0.539	0.593
1992	0.562	0.561	0.557	0.574	0.563	0.531	0.553
1993	0.571	0.555	0.599	0.577	0.607	0.587	0.570
1994	0.691	0.722	0.733	0.727	0.723	0.696	0.722
1995	0.729	0.800	0.766	0.783	0.797	0.750	0.730
1996	0.709	0.686	0.705	0.719	0.738	0.671	0.710
1997	0.673	0.654	0.677	0.659	0.701	0.653	0.675
1998	0.606	0.542	0.614	0.649	0.659	0.619	0.692
1999	0.478	0.425	0.453	0.455	0.455	0.436	0.473
2000	0.528	0.565	0.556	0.530	0.550	0.455	0.607
2001	0.277	0.295	0.306	0.317	0.320	0.305	0.301
2002	0.435	0.440	0.443	0.422	0.410	0.453	0.415
2003	0.596	0.655	0.612	0.647	0.623	0.570	0.640
2004	0.406	0.464	0.428	0.437	0.430	0.405	0.380
2005	0.495	0.510	0.491	0.454	0.490	0.471	0.455

Soybeans Market Prices ($/bu)

Year	Alabama	Florida	Georgia	North Carolina	South Carolina	Tennessee	Virginia
1990	5.89	5.65	5.74	6.68	5.78	5.95	5.55
1991	5.60	5.40	5.53	5.56	5.68	5.73	5.50
1992	5.63	5.20	5.49	5.48	5.44	5.61	5.50
1993	6.40	6.35	6.52	6.41	6.52	6.60	6.45
1994	5.65	5.40	5.37	5.36	5.47	5.62	5.35
1995	7.10	6.50	6.71	6.95	6.93	6.88	6.85
1996	7.40	7.00	6.87	7.07	7.40	7.25	6.80
1997	6.65	7.00	6.68	6.68	6.55	6.89	6.20
1998	5.30	5.20	5.24	5.03	5.00	5.37	5.30
1999	4.80	4.65	4.79	4.61	4.70	4.69	4.50
2000	4.75	4.45	4.43	4.51	4.50	4.69	4.35
2001	4.60	4.20	4.35	4.29	4.45	4.46	4.30
2002	5.55	5.35	5.45	5.63	5.60	5.70	5.54
2003	7.25	6.90	7.47	7.29	7.60	7.05	7.67
2004	6.25	5.60	5.60	5.56	5.60	5.58	5.32
2005	5.95	5.40	5.50	5.64	5.55	5.73	5.53

APPENDIX B

SAS Programs

***This SAS Program was used to Estimate Expected Yields for Alabama**

```
/*Alabama*/
data fake; set Yields.Cotton_Yields;
*CHANGE ADD TREND1 VARIABLE TO MAKE ESTIMATES;
*CHANGE START TREND WITH NUMBER 1 instead of 0 for neatness;

trend = year - 1970; trend1 = year - 1969;

*CHANGE MAKE A SECOND YEAR VARIABLE FOR OUTPUT;

YR1 = year + 1;

vctyld = Alabama;
ctyld = int(vctyld);
lctyld = lag(ctyld);
one = 1;
run;
proc print; run;
data fakesim; set fake;
*start simulation with data from 1990 for 1991 estimate;
*if need more lags in estimates, create as variables (expand XVAR matrix, not years);
if year gt 1985;
*stop simulation with data from 2004 for 2005 estimate;
if year lt 2005;
data fake86; set fake;
if year lt 1987;
data fake87; set fake;
if year lt 1988;
data fake88; set fake;
if year lt 1989;
data fake89; set fake;
if year lt 1990;
data fake90; set fake;
if year lt 1991;
data fake91; set fake;
if year lt 1992;
data fake92; set fake;
if year lt 1993;
data fake93; set fake;
if year lt 1994;
data fake94; set fake;
if year lt 1995;
data fake95; set fake;
if year lt 1996;
```

```
data fake96; set fake;
if year lt 1997;
data fake97; set fake;
if year lt 1998;
data fake98; set fake;
if year lt 1999;
data fake99; set fake;
if year lt 2000;
data fake00; set fake;
if year lt 2001;
data fake01; set fake;
if year lt 2002;
data fake02; set fake;
if year lt 2003;
data fake03; set fake;
if year lt 2004;
data fake04; set fake;
if year lt 2005;
proc reg data = fake86 outest=est86;
    model ctyld = lctyld trend;
  run;
proc reg data = fake87 outest=est87;
    model ctyld = lctyld trend;
  run;
proc reg data = fake88 outest=est88;
    model ctyld = lctyld trend;
  run;
proc reg data = fake89 outest=est89;
    model ctyld = lctyld trend;
  run;

proc reg data = fake90 outest=est90;
    model ctyld = lctyld trend;
  run;
 proc reg data = fake91 outest=est91;
    model ctyld = lctyld trend;
  run;

proc reg data = fake92 outest=est92;
    model ctyld = lctyld trend;
  run;
  proc reg data = fake93 outest=est93;
    model ctyld = lctyld trend;
  run;
  proc reg data = fake94 outest=est94;
```

```
    model ctyld = lctyld trend;
  run;
  proc reg data = fake95 outest=est95;
    model ctyld = lctyld trend;
  run;
  proc reg data = fake96 outest=est96;
    model ctyld = lctyld trend;
  run;
  proc reg data = fake97 outest=est97;
    model ctyld = lctyld trend;
  run;
  proc reg data = fake98 outest=est98;
    model ctyld = lctyld trend;
  run;
  proc reg data = fake99 outest=est99;
    model ctyld = lctyld trend;
  run;
  proc reg data = fake00 outest=est00;
    model ctyld = lctyld trend;
  run;
  proc reg data = fake01 outest=est01;
    model ctyld = lctyld trend;
  run;
  proc reg data = fake02 outest=est02;
    model ctyld = lctyld trend;
  run;
  proc reg data = fake03 outest=est03;
    model ctyld = lctyld trend;
  run;
  proc reg data = fake04 outest=est04;
    model ctyld = lctyld trend;
  run;

  proc iml;
*read the parameter estimates into separate row vectors,
  keeping only the paramater estimates from the outputed
  estimated data set;
use est86;
READ all var{intercept lctyld trend} into b_86;
use est87;
READ all var{intercept lctyld trend} into b_87;
use est88;
READ all var{intercept lctyld trend} into b_88;
use est89;
READ all var{intercept lctyld trend} into b_89;
```

```
use est90;
READ all var{intercept lctyld trend} into b_90 ;
*print b_90;
use est91;
READ all var{intercept lctyld trend} into b_91;
use est92;
READ all var{intercept lctyld trend} into b_92;
use est93;
READ all var{intercept lctyld trend} into b_93;
use est94;
READ all var{intercept lctyld trend} into b_94;
use est95;
READ all var{intercept lctyld trend} into b_95;
use est96;
READ all var{intercept lctyld trend} into b_96;
use est97;
READ all var{intercept lctyld trend} into b_97;
use est98;
READ all var{intercept lctyld trend} into b_98;
use est99;
READ all var{intercept lctyld trend} into b_99;
use est00;
READ all var{intercept lctyld trend} into b_00;
use est01;
READ all var{intercept lctyld trend} into b_01;
use est02;
READ all var{intercept lctyld trend} into b_02;
use est03;
READ all var{intercept lctyld trend} into b_03;
use est04;
READ all var{intercept lctyld trend} into b_04;


*concatenate the parameter estimates;
Bmat =
b_86//b_87//b_88//b_89//b_90//b_91//b_92//b_93//b_94//b_95//b_96//b_97//b_98//
b_99//b_00//b_01//b_02//b_03//b_04;
print Bmat;

* get the data needed to do the rolling estimates of predicted
yield and to output the variables;

*CHANGE BRING IN YR TO READ OUTPUT BETTER;
*CHANGE BRING IN TREND1 TO GET ESTIMATE;
```

```
use fakesim;
read all var{one ctyld trend year} into X;
read all var{YR1} into YR;
read all var{one ctyld trend1} into XVAR;
print X XVAR;

* use matrix multiplication to get the output;
*note the transpose operator is the backwards quote at
upper left of keyboard;
XTRAN = Xvar` ;
print XTRAN;
estfull = Bmat*Xtran;
*estimators are in the diagonal of this matrix;
*use element multiplication and add;
esparts = Bmat#Xvar;
est1 = esparts[,1]; est2 = esparts[,2];
est3 = esparts[,3];
*CHANGE MAKE CtYDAL INCLUDE YEAR;
ctydsAL = est1 + est2 + est3; ctydAL = ctydsAL||YR;
print ctydAL;
* check against diagonal elements of estfull ;
print estfull;
*output the predicted values to a SAS data set;
*CHANGE NAME TO INCLUDE YEAR AND MAKE CLEAR THIS IS EXPECTED
YD;
cname = {"exctydAL" "year"};
*note, this is a temporary data set, a permanent data set
could also be created with only a little modifiction;
  create cottonydAL from ctydAL [ colname=cname ];
  append from ctydAL;
quit;
```

***This SAS Programs was used to estimate the Net Worth Calculations**

```
data equity; set Rachel.networth;
if year ne .;

proc sort; by  year;
data usequity; set Rachel.Usequity;
if year ne . ;

proc sort; by year;
data alleq;
merge equity usequity ; by year;
run;
```

```
* normalize wealth with PPI and put it in terms of avreage farm wealth for
usda data;
data new; set alleq;
usfarmr= (1000*usequity)/(farms*ppi);
****************** ;
alusdaf = 1000*(uswal/alnumb); alusdaf2 = 1000*(uswal/alnumarm);
alusdafr = alusdaf/PPI; alusdaf2r = alusdaf2/PPI;
alarmsr = alarms/PPI;
**** ;
gausdaf = 1000*(uswga/ganumb); gausdaf2 = 1000*(uswga/ganumarms);
gausdafr = gausdaf/PPI; gausdaf2r = gausdaf2/PPI;
gaarmsr = gaarms/PPI;
*****************;
flusdaf = 1000*(uswfl/flnumb); flusdaf2 = 1000*(uswfl/flnumarms);
flusdafr = flusdaf/PPI; flusdaf2r = flusdaf2/PPI;
flarmsr = flarms/PPI;
************************* ;
kyusdaf = 1000*(uswky/kynumb); kyusdaf2 = 1000*(uswky/kynumarms);
kyusdafr = kyusdaf/PPI; kyusdaf2r = kyusdaf2/PPI;
kyarmsr = kyarms/PPI;
************************* ;
tnusdaf = 1000*(uswtn/tnnumb); tnusdaf2 = 1000*(uswtn/tnnumarms);
tnusdafr = tnusdaf/PPI; tnusdaf2r = tnusdaf2/PPI;
tnarmsr = tnarms/PPI;

************************* ;
ncusdaf = 1000*(uswnc/ncnumb); ncusdaf2 = 1000*(uswnc/ncnumarms);
ncusdafr = ncusdaf/PPI; ncusdaf2r = ncusdaf2/PPI;
ncarmsr = ncarms/PPI;

************************* ;

scusdaf = 1000*(uswsc/ncnumb); scusdaf2 = 1000*(uswsc/scnumarms);
scusdafr = scusdaf/PPI; scusdaf2r = scusdaf2/PPI;
scarmsr = scarms/PPI;

************************* ;

vausdaf = 1000*(uswva/vanumb); vausdaf2 = 1000*(uswva/vanumarms);
vausdafr = vausdaf/PPI; vausdaf2r = vausdaf2/PPI;
vaarmsr = vaarms/PPI;

* generate state level estimates of wealth using us level from usda data ;
title ;
proc reg ;
```

```
model alusdafr =  usfarmr;
output out= alpred
        p= alwhat;
title "alabama to alabama";
run;
proc reg;
model gausdafr =  usfarmr;
output out= gapred
        p= gawhat;
title "georgia to national";
proc reg;
model flusdafr = usfarmr;
output out= flpred
        p= flwhat;
title "florida to national";
proc reg;
model kyusdafr = usfarmr;
output out= kypred
        p= kywhat;
title "kentucky to national";
run;
proc reg;
model tnusdafr = usfarmr;
output out= tnpred
        p= tnwhat;
title "tennessee to national";
run;
proc reg;
model scusdafr = usfarmr;
output out= scpred
        p= scwhat;
title "s.c. to national";
run;
proc reg;
model ncusdafr = usfarmr;
output out= ncpred
        p= ncwhat;
title "nc to national";
run;
proc reg;
model vausdafr = usfarmr;
output out= vapred
        p= vawhat;
title "va to national";
run;
```

```
* arms regressions -- regress on predictions from above models;
proc reg ;
model alarmsr =  alwhat;
output out= alpreda
        p= alwhata;
title "arms to usda alabama";
run;
proc reg ;
model gaarmsr =  gawhat;
output out= gapreda
        p= gawhata;
title "arms to usda georgia";
run;
proc reg ;
model kyarmsr =  kywhat;
output out= kypreda
        p=  kywhata;
title "arms to usda kentucky";
run;
proc reg ;
model flarmsr =  flwhat;
output out= flpreda
        p= flwhata;
title "arms to usda florida";
run;
proc reg ;
model tnarmsr =  tnwhat;
output out= tnpreda
        p= tnwhata;
title "arms to usda tennessee";
run;
proc reg ;
model scarmsr =  scwhat;
output out= scpreda
        p= scwhata;
title "arms to usda south carolina";
run;
proc reg ;
model ncarmsr =  ncwhat;
output out= ncpreda
        p= ncwhata;
title "arms to usda north carolina";
run;
proc reg ;
```

```
model vaarmsr =  vawhat;
output out= vapreda
        p= vawhata;
title "arms to usda virginia";
run;
* wealth1 uses predicted values from regressions on arms models ;

data wealth1; set vapreda;
keep year alwhata flwhata gawhata kywhata ncwhata scwhata tnwhata vawhata;

* wealth2 uses predicted values from regressions on usda data;

data wealth2; set vapreda;
keep year alwhat flwhat gawhat kywhat ncwhat scwhat tnwhat vawhat;

data makenw; set vapreda;
alarms2 = alarmsr ; if alarmsr = "." alarms2 = alwhata;
gaarms2 = gaarmsr ; if gaarmsr = "." gaarms2 = gawhata;
flarms2 = flarmsr ; if flarmsr = "." flarms2 = flwhata;
kyarms2 = kyarmsr ; if kyarmsr = "." kyarms2 = kywhata;
ncarms2 = ncarmsr ; if ncarmsr = "." ncarms2 = ncwhata;
scarms2 = alarmsr ; if scarmsr = "." scarms2 = scwhata;
tnarms2 = tnarmsr ; if tnarmsr = "." tnarms2 = tnwhata;
vaarms2 = vaarmsr ; if vaarmsr = "." vaarms2 = vawhata;

* note wealth3 uses arms wealth when available, fills in with estimate when not ;
data wealth3; set makenw;
keep year alarms2 garms2 flarms2 kyarms2 ncarms2 scarms2 tnarms2 vaarms2;
run;
quit;
```

***This SAS Program was used to Estimate the Expected Profits**

```
/* Program to run data*/

data actprice; set actprices;
data actyield; set actyields;
data exprice; set exprices;
data expyield; set expyields;
data supprice; set supprices;
data vcost; set vcosts;
data profits;
merge actprice actyield exprice expyield supprice vcost;
by year;
```

```
run;
quit;
data variances; set profits;
*NOTE:  Make sure all prices and costs have been set to 2005 value
 by use of a price index!!! ;

*MP1 = actual market price crop1, EP1 = expected market price crop1, SP1 = support
price crop 1;
*AY1 = actual yield of crop 1, EY1 = expected yield of crop 2;
*Repeat codes for second crop (2) and so on up to all 4 crops;
*sort data so that most recent year is at the bottom to create lags;
* CROP ORDER:  CORN  COTTON SOYBEANS WHEAT ;

sp1 = cnsup; sp2 = ctsup; sp3 = sbsup; sp4 = wtsup;
cost1 = cnvcost; cost2 = ctvcost; cost3=sbvcost; cost4=wtvcost;
ecost1 = lag(cost1); ecost2 = lag(cost2); ecost3 = lag(cost3) ; ecost4=lag(cost4);

proc sort data=variances;
by year;
run;
* ALABAMA DATA *******************************************
*created the untruncated variances of the market prices;
data Alabama; set variances;

**** SET THE DATA TO THE STATE************************;

mp1 = scpcn; mp2 = scpct; mp3 = scpsb; mp4 = scpwt;

ep1 = scepcn; ep2 = scepct; ep3 = scepsb; ep4 = scepwt;

ay1 = sccnyd; ay2 = scctyd; ay3 = scsbyd; ay4 = scwtyd;

ey1 = scecnyd; ey2 = scectyd; ey3 = scesbyd; ey4 = scewtyd;


************************ created price variances ************************;

l1p1 = lag(mp1); l2p1 = lag(l1p1); l3p1= lag(l2p1);
l1ep1 = lag(ep1); l2ep1 = lag(l1ep1); l3ep1= lag(l2ep1);
varp1 = (l1p1-l1ep1)*(l1p1-l1ep1)*.5 + (l2p1-l2ep1)*(l2p1-l2ep1)*.3 + (l3p1-
l3ep1)*(l3p1-l3ep1)*.2;

l1p2 = lag(mp2); l2p2 = lag(l1p2); l3p2= lag(l2p2);
l1ep2 = lag(ep2); l2ep2 = lag(l1ep2); l3ep2= lag(l2ep2);
```

```
varp2 = (l1p2-l1ep2)*(l1p2-l1ep2)*.5 + (l2p2-l2ep2)*(l2p2-l2ep2)*.3 + (l3p2-
l3ep2)*(l3p2-l3ep2)*.2;

l1p3 = lag(mp3); l2p3 = lag(l1p3); l3p3= lag(l2p3);
l1ep3 = lag(ep3); l2ep3 = lag(l1ep3); l3ep3= lag(l2ep3);
varp3 = (l1p3-l1ep3)*(l1p3-l1ep3)*.5 + (l2p3-l2ep3)*(l2p3-l2ep3)*.3 + (l3p3-
l3ep3)*(l3p3-l3ep3)*.2;

l1p4 = lag(mp4); l2p4 = lag(l1p4); l3p4 = lag(l2p4);
l1ep4 = lag(ep4); l2ep4 = lag(l1ep4); l3ep4= lag(l2ep4);
varp4 = (l1p4-l1ep4)*(l1p4-l1ep4)*.5 + (l2p4-l2ep4)*(l2p4-l2ep4)*.3 + (l3p4-
l3ep4)*(l3p4-l3ep4)*.2;


sdp1 = sqrt(varp1); sdp2 = sqrt(varp2); sdp3 = sqrt(varp3); sdp4 = sqrt(varp4);

* create the yield variances;

l1y1 = lag(ay1); l2y1 = lag(l1y1); l3y1= lag(l2y1);
l1ey1 = lag(ey1); l2ey1 = lag(l1ey1); l3ey1= lag(l2ey1);
vary1 = (l1y1-l1ey1)*(l1y1-l1ey1)*.5 + (l2y1-l2ey1)*(l2y1-l2ey1)*.3 + (l3y1-
l3ey1)*(l3y1-l3ey1)*.2;

l1y2 = lag(ay2); l2y2 = lag(l1y2); l3y2= lag(l2y2);
l1ey2 = lag(ey2); l2ey2 = lag(l1ey2); l3ey2= lag(l2ey2);
vary2 = (l1y2-l1ey2)*(l1y2-l1ey2)*.5 + (l2y2-l2ey2)*(l2y2-l2ey2)*.3 + (l3y2-
l3ey2)*(l3y2-l3ey2)*.2;

l1y3 = lag(ay3); l2y3 = lag(l1y3); l3y3= lag(l2y3);
l1ey3 = lag(ey3); l2ey3 = lag(l1ey3); l3ey3= lag(l2ey3);
vary3 = (l1y3-l1ey3)*(l1y3-l1ey3)*.5 + (l2y3-l2ey3)*(l2y3-l2ey3)*.3 + (l3y3-
l3ey3)*(l3y3-l3ey3)*.2;

l1y4 = lag(ay4); l2y4 = lag(l1y4); l3y4= lag(l2y4);
l1ey4 = lag(ey4); l2ey4 = lag(l1ey4); l3ey4 = lag(l2ey4);
vary4 = (l1y4-l1ey4)*(l1y4-l1ey4)*.5 + (l2y4-l2ey4)*(l2y4-l2ey4)*.3 + (l3y4-
l3ey4)*(l3y4-l3ey4)*.2;

stdevy1 = sqrt(vary1); stdevy2 = sqrt(vary2); stdevy3 = sqrt(vary3); stdevy4 =
sqrt(vary4);

*calculate the correlation between untruncated price and yields;

varp1y1 = (l1y1-l1ey1)*(l1p1-l1ep1)*.5 + (l2y1-l2ey1)*(l2p1-l2ep1)*.3 + (l3y1-
l3ey1)*(l3p1-l3ep1)*.2;
```

```
varp2y2 = (l1y2-l1ey2)*(l1p2-l1ep2)*.5 + (l2y2-l2ey2)*(l2p2-l2ep2)*.3 + (l3y2-
l3ey2)*(l3p2-l3ep2)*.2;
varp3y3 = (l1y3-l1ey3)*(l1p3-l1ep3)*.5 + (l2y3-l2ey3)*(l2p3-l2ep3)*.3 + (l3y3-
l3ey3)*(l3p3-l3ep3)*.2;
varp4y4 = (l1y4-l1ey4)*(l1p4-l1ep4)*.5 + (l2y4-l2ey4)*(l2p4-l2ep4)*.3 + (l3y4-
l3ey4)*(l3p4-l3ep4)*.2;

rhoy1p1 = varp1y1/sqrt(varp1*vary1) ;
rhoy2p2 = varp2y2/sqrt(varp2*vary2) ;
rhoy3p3 = varp3y3/sqrt(varp3*vary3) ;
rhoy4p4 = varp4y4/sqrt(varp4*vary4) ;


*created the truncated means and variances of prices;
*normalize;

h1 = (sp1-ep1)/sdp1 ; h2 = (sp2-ep2)/sdp2;
h3 = (sp3-ep3)/sdp3 ; h4 = (sp4-ep4)/sdp4;


*caldulate pdf value using formula;
fi1= (1/sqrt(2*3.141592654))*exp(-.5*h1*h1);
FIC1=probnorm(h1);

fi2= (1/sqrt(2*3.141592654))*exp(-.5*h2*h2);
FIC2=probnorm(h2);

fi3= (1/sqrt(2*3.141592654))*exp(-.5*h3*h3);
FIC3=probnorm(h3);

fi4= (1/sqrt(2*3.141592654))*exp(-.5*h4*h4);
FIC4=probnorm(h4);

*truncated expected prices -- note will be higher than expected prices;
tp1=sp1*FIC1 + sdp1*fi1 + ep1*(1-FIC1);
tp2=sp2*FIC2 + sdp2*fi2 + ep2*(1-FIC2);
tp3=sp3*FIC3 + sdp3*fi3 + ep3*(1-FIC3);
tp4=sp4*FIC4 + sdp4*fi4 + ep4*(1-FIC4);

*truncated variances -- note they will be lower than untruncated variances;
tvarp1 = (sp1*sp1*FIC1) + (varp1*h1*fi1) + (2*ep1*sdp1*fi1) +
(ep1*ep1 + varp1)*(1-FIC1) - (tp1*tp1);

tvarp2 = (sp2*sp2*FIC2) + (varp2*h2*fi2) + (2*ep2*sdp2*fi2) +
(ep2*ep2 + varp2)*(1-FIC2) - (tp2*tp2);
```

```
tvarp3 = (sp3*sp3*FIC3) + (varp3*h3*fi3) + (2*ep3*sdp3*fi3) +
(ep3*ep3 + varp3)*(1-FIC3) - (tp3*tp3);

tvarp4 = (sp4*sp4*FIC4) + (varp4*h4*fi4) + (2*ep4*sdp4*fi4) +
(ep4*ep4 + varp4)*(1-FIC4) - (tp4*tp4);

*calculate the covariance between prices untruncated;
*there will be 6 of these for four crops;

varp12 = (l1p2-l1ep2)*(l1p1-l1ep1)*.5 + (l2p2-l2ep2)*(l2p1-l2ep1)*.3 + (l3p2-
l3ep2)*(l3p1-l3ep1)*.2;

varp13 = (l1p3-l1ep3)*(l1p1-l1ep1)*.5 + (l2p3-l2ep3)*(l2p1-l2ep1)*.3 + (l3p3-
l3ep3)*(l3p1-l3ep1)*.2;

varp14 = (l1p4-l1ep4)*(l1p1-l1ep1)*.5 + (l2p4-l2ep4)*(l2p1-l2ep1)*.3 + (l3p4-
l3ep4)*(l3p1-l3ep1)*.2;

varp23=  (l1p2-l1ep2)*(l1p3-l1ep3)*.5 + (l2p2-l2ep2)*(l2p3-l2ep3)*.3 + (l3p2-
l3ep2)*(l3p3-l3ep3)*.2;

varp24 = (l1p2-l1ep2)*(l1p4-l1ep4)*.5 + (l2p2-l2ep2)*(l2p4-l2ep4)*.3 + (l3p2-
l3ep2)*(l3p4-l3ep4)*.2;

varp34 = (l1p3-l1ep3)*(l1p4-l1ep4)*.5 + (l2p3-l2ep3)*(l2p4-l2ep4)*.3 + (l3p3-
l3ep3)*(l3p4-l3ep4)*.2;

*calculate rho;

rho12 = varp12/(sqrt(varp1*varp2));
rho12s = rho12*rho12;

rho13 = varp13/(sqrt(varp1*varp3));
rho13s = rho13*rho13;

rho14 = varp14/(sqrt(varp1*varp4));
rho14s = rho14*rho14;

rho23 = varp23/(sqrt(varp2*varp3));
rho23s = rho23*rho23;

rho24 = varp24/(sqrt(varp2*varp4));
rho24s = rho24*rho24;
```

```
rho34 = varp34/(sqrt(varp3*varp4));
rho34s = rho34*rho34;

*calculate terms needed in truncated covariance formula;
e1 = fi1 + h1*FIC1;
e2 = fi2 + h2*FIC2;
e3 = fi3 + h3*FIC3;
e4 = fi4 + h4*FIC4;
pi = 3.141592654;

* delete years with missing variables or functions will return error codes;

data new; set Alabama;
if year ge 1990;

data Alabama; set new;
BIVAR12=probbnrm(h1,h2,rho12);
BIVAR13=probbnrm(h1,h3,rho13);
BIVAR14=probbnrm(h1,h4,rho14);
BIVAR23=probbnrm(h2,h3,rho23);
BIVAR24=probbnrm(h2,h4,rho24);
BIVAR34=probbnrm(h3,h4,rho34);

BIGF12 = 1 - BIVAR12;
BIGF13 = 1 - BIVAR13;
BIGF14 = 1 - BIVAR14;
BIGF23 = 1 - BIVAR23;
BIGF24 = 1 - BIVAR24;
BIGF34 = 1 - BIVAR34;

Z12s = (h1*h1 + h2*h2 - 2*rho12*h1*h2)/(1-(rho12*rho12));

Z13s =(h1*h1 + h3*h3 - 2*rho13*h1*h3)/(1-(rho13*rho13));
Z14s = (h1*h1 + h4*h4 - 2*rho14*h1*h4)/(1-(rho14*rho14));
Z23s = (h3*h3 + h2*h2 - 2*rho23*h3*h2)/(1-(rho23*rho23));
Z24s = (h4*h4 + h2*h2 - 2*rho24*h4*h2)/(1-(rho24*rho24));
Z34s = (h3*h3 + h4*h4 - 2*rho34*h3*h4)/(1-(rho34*rho34));
z12 = sqrt(z12s); z13 = sqrt(z13s); z14 = sqrt(z14s);
z23 = sqrt(z23s); z24 = sqrt(z24s); z34 = sqrt(z34s);

fiz12 = (1/sqrt(2*3.141592654))*exp(-.5*z12*z12);
fiz13 = (1/sqrt(2*3.141592654))*exp(-.5*z13*z13);
fiz14 = (1/sqrt(2*3.141592654))*exp(-.5*z14*z14);
fiz23 = (1/sqrt(2*3.141592654))*exp(-.5*z23*z23);
fiz24 = (1/sqrt(2*3.141592654))*exp(-.5*z24*z24);
```

```
fiz34 = (1/sqrt(2*3.141592654))*exp(-.5*z34*z34);

k12 = (h1 - rho12*h2)/(sqrt(1 - rho12*rho12));
k13 = (h1 - rho13*h3)/(sqrt(1 - rho13*rho13));
k14 = (h1 - rho14*h4)/(sqrt(1 - rho14*rho14));
k23 = (h2 - rho23*h3)/(sqrt(1 - rho23*rho23));
k24 = (h2 - rho24*h4)/(sqrt(1 - rho24*rho24));
k34 = (h3 - rho34*h4)/(sqrt(1 - rho34*rho34));

FICK12= probnorm(k12); FICK13= probnorm(k13); FICK14= probnorm(k14);FICK23=
probnorm(k23);
FICK24= probnorm(k24); FICK34= probnorm(k34);



k21 = (h2 - rho12*h1)/(sqrt(1 - rho12*rho12));
k31 = (h3 - rho13*h1)/(sqrt(1 - rho13*rho13));
k41 = (h4 - rho14*h1)/(sqrt(1 - rho14*rho14));

k32 = (h3 - rho23*h2)/(sqrt(1 - rho23*rho23));
k42 = (h4 - rho24*h2)/(sqrt(1 - rho24*rho24));

k43 = (h4 - rho34*h3)/(sqrt(1 - rho34*rho34));


FICK21=probnorm(k21);
FICK31=probnorm(k31);
FICK41=probnorm(k41);
FICK32=probnorm(k32);
FICK42=probnorm(k42);
FICK43=probnorm(k43);

*calculate MIJ;

M12 = BIGF12*rho12 + sqrt((1-rho12s)/(2*pi))*fiz12

+ h1*fi2*FICK12 +  h2*fi1*FICK21 + h1*h2*BIVAR12;

M13 = BIGF13*rho13 + sqrt((1-rho13s)/(2*pi))*fiz13 + h1*fi3*FICK13 +
h3*fi1*FICK31 + h1*h3*BIVAR13;

M14 = BIGF14*rho14 + sqrt((1-rho14s)/(2*pi))*fiz14 + h1*fi4*FICK14 +
h4*fi1*FICK41 + h1*h4*BIVAR14;

M23 = BIGF23*rho23 + sqrt((1-rho23s)/(2*pi))*fiz23 + h2*fi3*FICK23 +
```

```
h3*fi2*FICK32 + h2*h3*BIVAR23;

M24 = BIGF24*rho24 +  sqrt((1-rho24s)/(2*pi))*fiz24 + h2*fi4*FICK24 +
h4*fi2*FICK42 + h2*h4*BIVAR24;

M34 = BIGF34*rho34 + sqrt((1-rho34s)/(2*pi))*fiz34 + h3*fi4*FICK34 +
h4*fi3*FICK43 + h3*h4*BIVAR34;

*calculate the truncated covariance;
cov12 = sqrt(varp1*varp2)*(M12 - e1*e2);
cov13 = sqrt(varp1*varp3)*(M13 - e1*e3);
cov14 = sqrt(varp1*varp4)*(M14 - e1*e4);
cov23 = sqrt(varp2*varp3)*(M23 - e2*e3);
cov24 = sqrt(varp2*varp4)*(M24 - e2*e4);
cov34 = sqrt(varp3*varp4)*(M34 - e3*e4);

*calculate the expected profit of crop 1 to 4;
*expected cost is lagged cost;

term1 = (1-probnorm(h1))*rhoy1p1*stdevy1*sqrt(tvarp1);
part1 = 1-probnorm(h1); part2 = rhoy1p1*stdevy1*sqrt(tvarp1);
part3 = part1*part2;
term2 = (1-probnorm(h2))*rhoy2p2*stdevy2*sqrt(tvarp2);
term3 = (1-probnorm(h3))*rhoy3p3*stdevy3*sqrt(tvarp3);
term4 = (1-probnorm(h4))*rhoy4p4*stdevy4*sqrt(tvarp4);

prof1 =tp1*ey1 - ecost1 + term1;
prof2 =tp2*ey2 - ecost2 + term2;
prof3 =tp3*ey3 - ecost3 + term3;
prof4 =tp4*ey4 - ecost4 + term4;


data ALprofit1; set Alabama;
alcnprof = prof1; alctprof = prof2; alsbprof = prof3; alwtprof= prof4;
alvarcn = varp1; altvarcn = tvarp1;
alvarct = varp2; altvarct = tvarp2;
alvarsb = varp3; altvarsb = tvarp3;
alvarwt = varp4; altvarwt = tvarp4;
alcvcnct = cov12; alcvcnsb = cov13; alcvcnwt = cov14;
alcvctsb = cov23; alcvctwt = cov24;
alcvsbwt = cov34;
data  alprofit; set alprofit1;
keep year alcnprof alctprof alsbprof alwtprof
altvarcn altvarct altvarsb altvarwt
alcvcnct alcvcnsb alcvcnwt
```

```
alcvctsb alcvctwt
alcvsbwt
sp1 sp2 sp3 sp4 mp1 mp2 mp3 mp4 ep1 ep2 ep3 ep4
ay1 ay2 ay3 ay4 ey1 ey2 ey3 ey4;
run;
/*data check2; set alprofit1;
if year = 2002;
data check; set check2;
keep year part1 part2 part3 term1;
run;
proc sort;
by descending year;
run;*/
quit;
```

***This SAS Program was used for Estimating the Models**

```
data rachel1; set rachel.stackdata ;
 lwealth = lag(wealth);
 lcnpa = lag(cnpa); lwtpa = lag(wtpa); lctpa = lag(ctpa); lsbpa = lag(sbpa);
  wealthadj = lwealth + cnpa*cnexpre + sbpa*sbexpre + ctpa*ctexpre;
lcnexpre = lag(cnexpre);
cnidle = cnidled*cnpa; wtidle = wtidled*wtpa; ctidle = ctidled*ctpa;
data rachel2; set rachel1;
if state='Alabama' then d1=1;
     else d1=0;
  if state='Florida' then d2=1;
     else d2=0;
  if state='Georgia' then d3=1;
     else d3=0;
  if state='NorthCar' then d4=1;
     else d4=0;
  if state='SouthCar' then d5=1;
     else d5=0;
  if state='Tennessee' then d6=1;
     else d6=0;
  if state='Virginia' then d7=1;
     else d7=0;
     label d1='Alabama dummy'
           d2='Florida dummy'
           d3='Georgia dummy'
           d4='Northcar dummy'
           d5='Southcar dummy'
           d6='Tennessee dummy'
           d7='Virgina dummy'
```

```
                        ;
fpdum = 0; if year lt 1996 then fpdum = 1;
sumpa = cnpa + sbpa + ctpa;
lsumpa + lag(sumpa);
blexpre = cnexpre*lcnpa + ctexpre*lctpa + sbexpre*lsbpa;
blrvar = cnrvar*lcnpa + ctrvar*lctpa + sbrvar*lsbpa;
  run;
  title ;
  title 'OLS regressions';
  title 'wheat'; run;
  proc reg;
  model wtpa = wtexpre wtrvar wealthadj wtidle lwtpa d2 d3 d4 d5 d6 d7 fpdum ;
  run;
  title ; run;
title 'cotton'; run;
proc reg;
  model ctpa = ctexpre sbexpre cnexpre ctrvar ctidle
  covrsbct covrcnct
wealthadj lctpa d2 d3 d4 d5 d6 d7 fpdum ;
run;
title ; run;
title 'soybeans' ; run;
  proc reg;
  model sbpa = sbexpre ctexpre sbrvar
  covrsbct
wealthadj  lsbpa  d2 d3 d4 d5 d6 d7 ;
run;
title ; run;
title 'corn'; run;
proc reg;
model cnpa = cnexpre ctexpre sbexpre cnrvar ctrvar sbrvar covrcnsb covrcnct cnidle
wealthadj lcnpa  d2 d3 d4 d5 d6 d7 fpdum;
run;
title 'all summer crops';
proc reg;
model sumpa = blexpre blrvar lsumpa wealthadj d2 d3 d4 d5 d6 d7 fpdum;
 proc reg;
 model sumpa = cnexpre ctexpre sbexpre cnrvar sbrvar ctrvar lsumpa wealthadj
d2 d3 d4 d5 d6 d7 fpdum;
run; quit;
title run;
title 'system sur no restrictions - order ct sb cn'  ; run;
proc syslin sur;
eq1: model ctpa = ctexpre sbexpre cnexpre ctrvar
  covrsbct covrcnct
```

```
wealthadj lctpa d2 d3 d4 d5 d6 d7 ctidle ;
eq2: model sbpa = sbexpre ctexpre sbrvar
  covrsbct
wealthadj  lsbpa  d2 d3 d4 d5 d6 d7 fpdum;
eq3: model cnpa = cnexpre ctexpre sbexpre cnrvar ctrvar sbrvar covrcnsb covrcnct
wealthadj lcnpa  d2 d3 d4 d5 d6 d7 cnidle;

run; quit;
title run;
title 'system sur with restrictions - order ct sb cn'  ; run;
proc syslin sur;
eq1: model ctpa = ctexpre sbexpre cnexpre ctrvar sbrvar cnrvar
  covrsbct covrcnct
wealthadj lctpa d2 d3 d4 d5 d6 d7 ctidle ;
eq2: model sbpa = sbexpre ctexpre cnexpre sbrvar cnrvar ctrvar
  covrsbct covrcnsb
wealthadj  lsbpa  d2 d3 d4 d5 d6 d7 fpdum;
eq3: model cnpa = cnexpre ctexpre sbexpre cnrvar ctrvar sbrvar
covrcnsb covrcnct
wealthadj lcnpa  d2 d3 d4 d5 d6 d7 cnidle;
srestrict eq1.sbexpre=eq2.ctexpre;
  srestrict eq1.cnexpre=eq3.ctexpre;
  srestrict eq2.cnexpre=eq3.sbexpre;

run; quit;
```