The Effect of US Energy Policy and Farm Program Payments on the Bio-Fuel Sector: A Regime-Switching Approach

Tyler Mark, Ph.D. Candidate
Louisiana State University – Graduate Student
101 Agricultural Administration Building
Baton Rouge, LA 70803
Phone: (225) 578-2595
Email: *TMark@agcenter.lsu.edu*

Ashok Mishra, Professor
Louisiana State University
101 Agricultural Administration Building
Baton Rouge, LA 70803
Phone: (225) 578-0262
Email: *Amishra@.lsu.edu*

Charles Moss, Professor
University of Florida
1130B MCCB
P.O. Box 110240 IFAS
Gainesville, FL 32611
Phone: (352) 392-1845 ext. 404
Email: cbmoss@ifas.ufl.edu

Selected Paper prepared for presentation at the Agricultural & Applied Economics Association 2010

AAEA,CAES, & WAEA Joint Annual Meeting, Denver, Colorado, July 25-27, 2010

Introduction

The increase in oil prices from 2006 through 2008 and concomitant increase in other commodity prices raises several interesting questions for southern agriculture in the US. In 2007, Southern US producers witnessed a significant run-up in corn prices. On average the US corn prices were $2 and $1.16 higher per bushel than in 2005 and 2006, respectively (USDA, 2009a). This created an interesting situation in the Southern US where cotton's stagnant prices over the past ten years have led to increased corn plantings throughout traditional cotton areas of the southern US. For example, in Arkansas, Louisiana, and Mississippi the planted acres of cotton from 2006 to 2007 dropped by 26, 47, and 46 percent respectively (USDA, 2009a). The decrease in cotton acres for these states were replaced almost 1 for 1 with corn acres. This ability for producers to switch indiscriminately between crops was made possible by the passage of the Federal Agriculture Improvement and Reform Act (FAIR). Thus, allowing producers in the Southern US to capitalize on usually high prices driven partially by the increased demand for biofuels. In addition to being able to switch crops producers are still receiving farm program payments from eligible crops even though they may not be producing them. This dynamic shift in land allocations is changing the face of the Southern Agricultural landscape.

Furthermore, the implementation of the Renewable Fuels Standards (RFS) in 2005 and 2007, in combination with federal and even some state incentives have further contributed to the expansion of the ethanol industry. Traditional agricultural policy, specifically the Federal Agriculture Improvement and Reform Act (FAIR), is also playing a role in ability of producers to respond to the increased biofuel demand. The 1996 FAIR Act created a paradigm shift in agricultural policy as it took a dramatic step toward a market-oriented policy that creates a producer decision environment more conducive to competitive adjustments (Coble et al., 2002).

Additionally, the FAIR Act also allows producers to respond in a more flexible way to changes in market conditions, thereby dampening the influence of weather shocks and technological developments (Lence and Hayes, 2002). Without its passage many producers especially in the south would not have been able to respond to the increased demand for ethanol in the manner they have over the past few years.

Within the agricultural sector the emergence of the biofuel industry has created a couple of unique situations for agricultural policy and producers in the Southern US. The objective of this paper is to first examine how the emergence of the biofuel industries has changed the drivers of producer land allocation decisions (e.g. output prices, input prices, and farm policy).

Methodology

This paper employs a two-step estimation of land allocation decisions for producers. The crop allocation model is adapted from Laitinen and Theil (1978). Specifically, this method is used to investigate land allocation decisions for corn, cotton, rice, soybeans, sugarcane, sorghum, and wheat. Equations 1 and 2 use data collected from a couple of different sources that discussed in the next section but there are a number of data transformations used in this analysis. First, to allow for the model to be estimated both acreages and prices for the crops have been normalized with respect to wheat. Second, differences have been taken for all of the variables included in the model except for the dummy variable in the second stage of the model.

In the first-stage, revenue shares for each crop is written as,

$$g_{rt} d \ln\left(z_{rt}\right) = \sum_{i=1}^{n} \Pi_{ri} d \ln\left(q_{it}\right) + \sum_{j=1}^{m} \Phi_{rj} d \ln\left(y_{jt}\right) + \nu_{rt} , \qquad (1)$$

where g is the share crop acreages in the region, $dln(z_{rt})$ is difference of crop revenues, $dln(q_{it})$ is difference in crop input costs, $dln(y_{jt})$ is difference in crop output price, r is crop, t is time, i is input, *and* j is output. Equation 1 is estimated in a system using full information maximum likelihood (FIML). The expected values of revenue shares for this equation are retained and used in the second stage of the estimation.

In the second stage, land allocation for each crop is estimated via,

$$d\ln\left(A_{r,t}\right)=\sum_{s=1}^{m}\Lambda_{rt}\left(g_{rt}d\ln\left(z_{rt}\right)\right)+\left(1+\lambda_r D_t\right)\delta_{rt}d\ln\left(A_{r,t-1}\right)+\varepsilon_{rt} \tag{2}$$

where $dln(A_{r,t})$ is the difference in acres planted, D_t is the dummy variable for the change in agricultural policy, and $dln(A_{r,t-1})$ is the lag difference of acres planted. Equation 2 is also estimated in a system using FIML.

Within each of the six equations estimated it is expected that own revenue share elasticity for each crop will be positive and significant, implying that as revenue for a crop increases the acreage for that crop will increase. Cross revenue share elasticities are expected to be mixed in sign. For example, within the corn equation it is possible that increases in soybean revenue share could have a positive and significant influence on corn acreage. Corn and soybeans are a traditional rotation and it is plausible that as one increases the other will follow.

Furthermore, it is expected that the dummy variable for the 1996 FAIR Act will have mixed signs. For some crops the increased flexibility of the policy will be beneficial for acreages but for others it has allowed significant decreases in acreages. Specifically, it is expect that for the corn acreage equation it will be positive as FAIR Act allowed producers to capitalize on higher than average corn prices while still receiving government payments for cotton or crops for which the operation has base acres. Conversely, for cotton it is expected this coefficient will be negative as it has allowed producers to switch out of cotton into another. For sugarcane it is expected that the 1996 FAIR Act will have no impact because according to the sugar program producers do not receive program payments as they do for all the other crops.

For the variable lag of crop acreages, it is expected to be positive. The intuition for this variable is that even though the 1996 FAIR Act allowed producers to respond quicker to changes in market signals, crop acreages are still sticky. Vasavada and Chambers (1986), find that asset fixity is a possible reason for producers are sluggish in responding to market signals. This is especially true for cotton and sugarcane were specialized equipment is required for different phases of production for these crops. Therefore, it is difficult for producers to switch between crops because they must purchase, rent, or lease equipment which may not even currently be available in their area. Additionally, if acreages are sticky and asset fixity is present then it is expected that the coefficient on lag acres will be close to one.

Data

Table 1 shows the summary statistics and sources for the raw data used in this study. The two data sources used for this study are both United States Department of Agricultural datasets. First, acreages and prices were collected from "Quick Stats" for 1966 to 2007 for Arkansas, Louisiana, Mississippi, and Texas. In this region, soybeans and cotton acreages make up the largest percentages of the cropland. Corn acreages in the region have been increasing and in 2007 reach over four million acres as ethanol production continues to grow. Sugarcane acreages account for the smallest portion because it is only grown in Louisiana and Texas. Additionally, sugarcane acreages exhibit the lowest amount of variability of any crop in the region because it has few competitors for acreages. Prices were also collected from the same source. Sugarcane again had the smallest variability in price because of the current sugar program that includes a quota system and forfeiture price.

The last six variables are indices of prices collected from “Agricultural Prices”. The base year for these indices is 2000. These indices represent United States prices because there is no dataset for this region for the timeframe analyzed in this study. Furthermore, these indices could not be broken out to represent seed costs for individual types of seed or fertilizer so they reflect seed, fertilizer, wages, fuel, chemical, and repair costs for each industry as a whole.

Results

The results for the acreage allocation equations in general follow the expected results. All of the results for crop acreages and prices for these models should be interpreted relative to wheat because they are normalized with respect to wheat. Table 2 contains the fit statistics for each equation in stage two of the model[1]. The land allocation equation that had the highest adjusted R^2 is sugarcane at 84 percent and the cotton had the lowest at 17 percent. All of the other equations have an adjusted R^2 over 49 percent.

Table 3 contains the results for the land allocation model and they are broken down in the table by crop. The allocation of cropland for corn is significantly impacted by revenue share of soybeans and sorghum in the region and the lag of corn acres. Unexpectedly, an increase in the revenue share of soybeans increases the land allocation of cropland to corn. A possible explanation for this is that soybeans and corn work well in a rotation so as soybean acres increase, so do corn acres. As expected increases in the revenue share for sorghum decreases land allocation to corn by -0.5 percent for every one percent increase sorghum. Lastly, as expected the lag of corn acres is positive and highly significant. In this framework the positive

[1] Stage 1 of the model estimates is available upon request.

significance of this variable also eludes to an asset fixity issue in agriculture. The issue has been studied before in American agriculture as Vasavada and Chambers (1986) find that producers are sluggish to react to input and output price changes. For corn this coefficient 1.07 implies that corn acreages have been increasing from one period to the next which is the current situation being observed.

Cotton land allocation is being driven by revenue share of corn and sorghum. As the region has observed with the development of the biofuel industry cotton acres have been losing out to corn. According to this estimation a one percent increase in corn revenue share decreases cotton land allocation by -0.24 percent. An unexpected result for this equation is that increases in sorghum revenue shares increases the cropland allocated to cotton by 0.21 percent. A possible explanation for this is that sorghum is a substitute for corn so when sorghum acres are rising then corn acres are decreasing as shown in the corn equation above. Furthermore, as expected the previous periods cotton planting play a significant role in the current periods cropland allocation for cotton. This coefficient is one implying that cotton acres remain almost constant from one period to the next. This is indicative of the highly specialized equipment used to harvest cotton and the difficulty producers have in switching in out of cotton quickly. However, in recent years it appears this switching has accelerated with commodity prices above average, especially for corn.

Crop allocation for rice land is driven by the lag of rice acres. The coefficient for lag rice acres is 0.99 implying that rice acres from one year to the next are almost constant. It was unexpected that this would be the only significant variable but there are several possible explanations. First, rice land preparation requires time and specialized equipment and once producers have invested this time it is difficult to get them to switch crops. Secondly, especially in Louisiana rice producers will use the rice fields for the production of crawfish to generate a second source of income using the same land. This could be adding to the fixity of rice acres.

Unexpectedly the only significant driver of cropland allocation for soybeans is the previous year's soybean plantings. For soybeans the coefficient is 0.99 so acres are almost constant from one period to the next. Furthermore, soybean acres and corn acres have a strong positive correlation and both have been rising in this region as corn acres continue to expand to meet biofuel demands.

For sugar as expected the only driver of land allocation is the lag of sugarcane acreages. This crop requires highly specialized equipment for ground preparation, planting, and harvesting. Furthermore, this crop is perennial unlike any of the others included in this study making it difficult for producers to switch between crops. Another factor increasing the fixity of sugarcane acres is the lack of competition for land from other crops because yields for these crops in this region are at or below breakeven levels.

Cropland allocation for sorghum is driven by the rice, soybean and sorghum revenue shares. It is positively influenced by rice and soybean revenue shares by 0.002 and 0.11 percent, respectively. However, rice and soybean acres are quasi-fixed because of rice's land preparation equipment needed and soybean acres are positively correlated with corn acres. But, in recent years corn acres have been increasing and so have sorghum acres. Sorghum acres are negatively influenced by own revenue shares relative to wheat. Therefore, as sorghum revenue shares increase the land allocated to sorghum decreases by -0.26. This is unexpected and counter intuitive to what was expected. A possible reason for this is that corn and sorghum are highly substitutable so lower sorghum prices increase the demand for sorghum by the livestock industry. Lastly, sorghum land allocation is driven by the previous period's sorghum plantings. Asset fixity also is present in sorghum where relative to wheat the current periods planting are 0.97 of the previous year's plantings.

Conclusions

In recent years, the crop mixes in Arkansas, Louisiana, Mississippi, and Texas have changed significantly as producers attempt to maximize profits and capitalize on above average commodity prices. Of particular interest in this study are the factors driving cropland allocation decisions for corn and cotton. Corn acreage in the region has been growing, primarily at the expense of cotton acreage. A couple of the key drivers thought to be behind this growth in corn acres are the passage of the 1996 FAIR Act, allowing producers flexibility in crop selection, and government mandates on biofuel production. In general the results from this study show that 1996 FAIR Act has not played a significant role in cropland allocations for any of the crops as was expected and intended for the bill to accomplish. Instead this study shows that irrespective of the 1996 FAIR Act there is asset fixity within cropland acreages as Vasavada and Chambers (1986) pointed out. However, in 2008 and 2009 significantly more cropland in this region has been shifting into corn acres and acreage fixity could be decrease. Therefore, the next step in this study is to continue our examination of this issue of acreage fixity since the 1996 FAIR Act and the influence of biofuels on acreages.

References

Coble, K. H., T. O. Knight, G. F. Patrick, and A, E. Baquet. “Understanding the Economic Factors Influencing Farm Policy Preferences.” *Review of Agricultural Economics.* 24, no. 2(2002): 309-321.

Laitinen, K. and H. Theil. “Supply and Demand of the Multiproduct Firm.” *European Economic Review.* 11(1978): 107-154.

Lence, S.H. and D.J. Hayes. “U.S. Farm Policy and the Volatility of Commodity Prices and Farm Revenues.” *American Journal of Agricultural Economics.* 84, no. 2(2002): 335-351.

United States Department of Agriculture (a). .“Quick Stats.” *National Agricultural Statistics Service.* 2009.

United States Department of Agriculture (b). “Agricultural Prices.” *National Agricultural Statistics Service*. 2009.

United States Department of Agriculture (c). .“Fertilizer Use.” *National Agricultural Statistics Service.* 2009.

Vasavada, U. and R. Chambers, “Investment in U.S. Agriculture.” *American Journal of Agricultural Economics.* 68(4)1986:950-960.

Figure 1: Historical Land Allocations

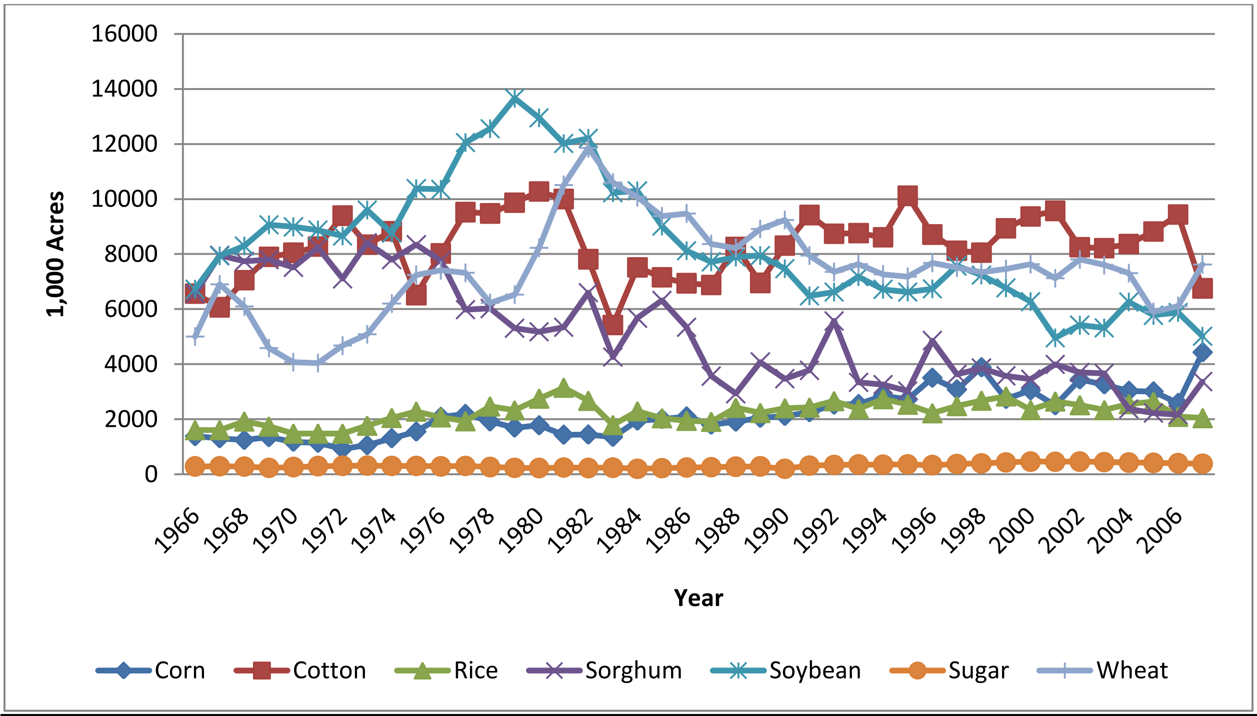

Table 1: Summary Statistics

	Units	Mean	Stdev	Max	Min	Source
Corn Acres	1,000 Ac	2205	836	4430	927	USDA, 2009a
Cotton Acres	1,000 Ac	8319	1142	10270	5427	USDA, 2009a
Rice Acres	1,000 Ac	2255	400	3150	1486	USDA, 2009a
Sorghum Acres	1,000 Ac	5088	1930	8409	2168	USDA, 2009a
Soybean Acres	1,000 Ac	8339	2301	13660	4960	USDA, 2009a
Sugar Acres	1,000 Ac	321	77	465	201	USDA, 2009a
Corn Price	$/bu	$ 2.44	$ 0.64	$ 3.91	$ 1.21	USDA, 2009a
Cotton Price	$/lb	$ 0.51	$ 0.14	$ 0.75	$ 0.22	USDA, 2009a
Rice Price	$/cwt	$ 7.92	$ 2.44	$ 15.19	$ 3.96	USDA, 2009a
Sorghum Price	$/cwt	$ 3.81	$ 1.05	$ 6.42	$ 1.73	USDA, 2009a
Soybean Price	$/bu	$ 5.58	$ 1.49	$ 9.05	$ 2.34	USDA, 2009a
Sugar Price	ct/lb	$ 22.83	$ 7.93	$ 52.00	$ 8.86	USDA, 2009a
Seed	Index	74.7	36.4	164.8	19.5	USDA, 2009b
Fertilizer	Index	88.7	35.5	195.5	33.2	USDA, 2009b
Chemical	Index	73.0	24.1	108.1	36.2	USDA, 2009b
Fuel	Index	83.1	41.9	197.3	24.3	USDA, 2009b
Wages	Index	63.7	33.0	126.4	15.6	USDA, 2009b
Repair	Index	73.1	26.7	120.3	30.8	USDA, 2009b

Table 2: Land Allocation Model Fit Statistics

Equation	DF Model	DF Error	SSE	MSE	Root MSE	R-Square	Adj R-Sq
Corn Acres	8	33	0.007	0.00022	0.015	0.785	0.740
Cotton Acres	8	33	0.039	0.00119	0.035	0.317	0.173
Rice Acres	8	33	0.003	0.00008	0.009	0.580	0.491
Soybean Acres	8	33	0.013	0.00039	0.020	0.843	0.810
Sugar Acres	8	33	0.000	0.00000	0.001	0.865	0.836
Sorghum Acres	8	33	0.016	0.00049	0.022	0.861	0.832

Table 3: Results for Acreage Allocation

Variable	Description	Estimate	Std Error
Corn Acres			
cornrevsh	ln diff. corn share of revenue	0.020	0.043
cottonrevsh	ln diff. cotton share of revenue	-0.006	0.006
ricerevsh	ln diff. rice share of revenue	0.000	0.000
soybeanrevsh	ln diff. soybean share of revenue	0.033*	0.018
sugarrevsh	ln diff. sugarcane share of revenue	-0.028	0.086
sorghumrevsh	ln diff. sorghum share of revenue	-0.051	0.022
farmbill96	dummy 1996 Farm Bill	-0.033	0.054
lagcornac	ln diff. lag of corn acres	1.075***	0.044
cornrevsh	ln diff. corn share of revenue	-0.249*	0.141
Cotton Acres			
cottonrevsh	ln diff. cotton share of revenue	0.008	0.033
ricerevsh	ln diff. rice share of revenue	0.000	0.002
soybeanrevsh	ln diff. soybean share of revenue	-0.060	0.080
sugarrevsh	ln diff. sugarcane share of revenue	0.492	0.666
sorghumrevsh	ln diff. sorghum share of revenue	0.214*	0.124
farmbill96	dummy 1996 Farm Bill	-0.011	0.040
lagcottonac	ln diff. lag of cotton acres	1.005***	0.024
Rice Acres			
cornrevsh	ln diff. corn share of revenue	-0.012	0.039
cottonrevsh	ln diff. cotton share of revenue	-0.009	0.009
ricerevsh	ln diff. rice share of revenue	0.000	0.001
soybeanrevsh	ln diff. soybean share of revenue	0.016	0.022
sugarrevsh	ln diff. sugarcane share of revenue	0.036	0.186
sorghumrevsh	ln diff. sorghum share of revenue	0.012	0.035
farmbill96	dummy 1996 Farm Bill	0.001	0.039
lagriceac	ln diff. lag of rice acres	0.995***	0.024
Soybean Acres			
cornrevsh	ln diff. corn share of revenue	-0.075	0.086
cottonrevsh	ln diff. cotton share of revenue	0.014	0.021
ricerevsh	ln diff. rice share of revenue	0.000	0.001
soybeanrevsh	ln diff. soybean share of revenue	-0.032	0.050
sugarrevsh	ln diff. sugarcane share of revenue	-0.483	0.419
sorghumrevsh	ln diff. sorghum share of revenue	0.050	0.078
farmbill96	dummy 1996 Farm Bill	-0.006	0.030
lagsoybean	ln diff. lag of soybean acres	0.988***	0.013
Sugarcane Acres			
cornrevsh	ln diff. corn share of revenue	-0.003	0.005
cottonrevsh	ln diff. cotton share of revenue	0.001	0.001
ricerevsh	ln diff. rice share of revenue	0.000	0.000
soybeanrevsh	ln diff. soybean share of revenue	-0.003	0.003
sugarrevsh	ln diff. sugarcane share of revenue	0.008	0.026

sorghumrevsh	ln diff. sorghum share of revenue	0.002	0.005
farmbill96	dummy 1996 Farm Bill	0.030	0.035
lagsugarac	ln diff. lag of sugar acres	0.992***	0.025
Sorghum Acres			
cornrevsh	ln diff. corn share of revenue	0.136	0.095
cottonrevsh	ln diff. cotton share of revenue	0.012	0.023
ricerevsh	ln diff. rice share of revenue	0.002*	0.001
soybeanrevsh	ln diff. soybean share of revenue	0.114**	0.055
sugarrevsh	ln diff. sugarcane share of revenue	0.220	0.466
sorghumrevsh	ln diff. sorghum share of revenue	-0.265***	0.087
farmbill96	dummy 1996 Farm Bill	-0.017	0.058
lagsorghumac	ln diff. lag of sorghum acres	0.975***	0.021
* significant at 10% level; **significant at 5% level, significant at 1%level			