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Evaluating the Switch from Cotton to Corn: Impacts on the Louisiana Economy (Bulletin #888)

J. Mathew Fannin

Kenneth W. Paxton

John D. Barreca

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J. Matthew Fannin, Kenneth W. Paxton and John D. Barreca

Table of Contents

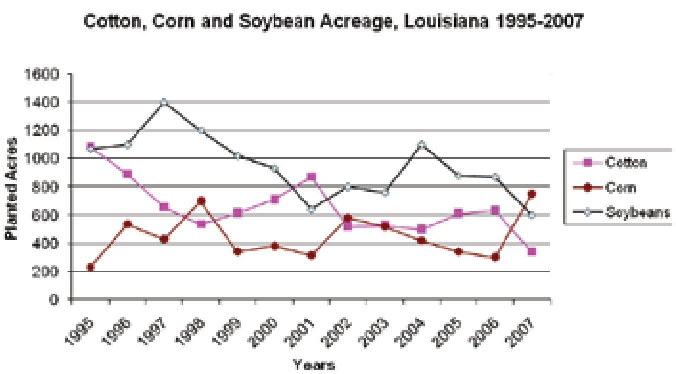
Executive Summary

- Cotton acres planted fell from over 600,000 acres in Louisiana in 2006 to less than 350,000 acres in 2007. At the same time more than 700,000 acres of corn were planted in 2007, a 150% increase from the previous year.
- Cotton is a relatively more expensive commodity to plant than corn. It costs almost $400 to grow and harvest an acre of cotton compared to just under $290 for the same acre of corn. Similarly it is more expensive to gin an acre's harvest of cotton than dry and handle an acre's harvest of corn.
- When considering an expected 295,000-acre switch from cotton production to corn production in Louisiana, the net effect is a projected increase in output of just under $700,000 on the state economy, or an increase of 0.57% above the impact if cotton were planted.
- The small increase in output is due to two counteracting factors. The switch from cotton to corn cost the state economy an estimated $23 million in output from lost farm input spending in cotton production. The reduction in ginning also contributed to a $5 million loss in net output.
- These reductions were offset by a net increase of $29 million in proprietary income earned by corn farmers, landowners and elevators that dry and handle corn.
- Value-added and labor income were mildly impacted by the switch from cotton to corn production. It is expected that value added would be reduced by $650,000, or 0.89%, and labor income reduced by $1.97 million, or 4.16%. The reason for these reductions is the relatively higher amount of labor used in the production and processing of cotton in the state relative to corn.
- The sectors expected to benefit the most from the switch from cotton include wholesale trade and transportation from increased corn production, and health and social services and accommodation and food services from increased spending of proprietary income earned by the farm household due to higher corn prices.
- Economic impacts in local regions of the state are likely to vary depending on where farmers purchase inputs and where farm households purchase consumer products. Rural communities selling a larger percentage of inputs to farmers are likely to be hurt by the switch to corn with fewer inputs per acre of production than cotton.
- Larger regions and urban areas that sell a greater diversity of consumer goods are likely to benefit from the spending of increased proprietary income generated in farm households.

Introduction

Cotton has traditionally been an important crop in Louisiana, not only in terms of acreage but also in terms of contribution to the local economy. Figure 1 illustrates the recent history of major row crop acreage in the state. As shown here, soybeans have traditionally occupied the largest acreage in the state. Cotton has been generally ranked second in terms of planted acreage. In 2007, these traditional relationships changed dramatically. Louisiana farmers planted an estimated 340,000 acres of cotton, a record low for the state (National Agricultural Statistics Service, 2007). Conversely, farmers planted an estimated 700,000 acres of corn, the largest acreage in recent history. As shown in Figure 1, corn had the largest planted acreage in 2007 among the leading row crops.

Figure 1. Planted Acreage, Cotton, Corn and Soybeans, Louisiana, 1995-2007.



These shifts in acreage were a response to changes in product prices and the resulting profit potential for cotton, soybeans and corn. Since the implementation of the 1996 Farm Bill, producers have had more flexibility in planting decisions because program payments have been decoupled from planting decisions. At planting time in 2007, corn prices were near record levels while cotton prices were near modern record lows. Given the price relationship between cotton and corn, producers elected to plant corn instead of cotton. This shift in acreage will leave a considerable amount of excess capacity in the single-use infrastructure supporting the cotton industry. At the same time, additional grain will place a burden on the existing infrastructure for grain handling in the state.

This dramatic shift in acreage away from a crop traditionally grown in many areas of the state raises a question regarding the impact of such a shift on local economies. Conventional wisdom holds that, since cotton is a more expensive crop to produce than corn, the shift to corn will mean fewer dollars spent in the local economy. Therefore, the shift to corn in place of cotton will have a negative impact on the economy of the state.

This study was designed to estimate the economic impact of the shift in acreage from cotton to corn. If conventional wisdom is correct, the shift will have a negative impact on the economy of the state. However, as stated above, conventional wisdom generally considers differences in expenditures and ignores the revenue side of the equation. Expenditures for production inputs have "ripple" effects through the economy. Similarly, income from agriculture has an impact on the economy as it is spent for goods and services.

Expenditure Profiles – Corn vs. Cotton

To better understand the tradeoffs from switching between cotton and corn, we must first identify the costs of producing both cotton and corn. Budgets for both corn and cotton are constructed based on an average of cost and returns budgets prepared by LSU AgCenter Ag Economist Dr. Kenneth Paxton in 2007.

The budget for producing an acre of corn is presented in Table 1 followed by the cost of producing an acre of cotton in Table 2. These budgets reflect costs incurred through harvest of the crop. As shown here, costs do not include charges for ginning or drying/handling. Processing costs are included as a separate section in this analysis and discussed below.

Table 1. Estimated Variable Costs for Producing an Acre of Corn in Louisiana, 2007.

Inputs	$ Per Acre
Custom Application	11.50
Fertilizer	94.20
Herbicides	10.98
Insecticides	24.68
Miscellaneous	6.60
Seed	45.76
Hauling	25.60
Fuel	28.39
Repair and Maintenance	14.49
Interest on Operating Capital	13.96
Hired Labor Costs	13.06
Total	**289.22**

Note: Estimated variable costs are an average of budgets with alternative production practices in different regions of the state and would not reflect the budget of an individual corn producer.

The corn budget assumes the variety contains a gene for herbicide resistance. The cotton budget assumes that the variety contains genes for herbicide tolerance and insect resistance. Yield levels assumed are 900 pounds of lint per acre for cotton and 150 bushels per acre for corn. Product prices used in this analysis were $0.55 per pound of lint for cotton and $3.25 per bushel for corn. These yields and prices were reasonable expectations for 2007 at the time of this analysis.

Table 2. Estimated Variable Costs for Producing an Acre of Cotton in Louisiana, 2007.

Inputs	$ Per Acre
Custom Application	18.50
Fertilizer	35.10
Herbicides	71.41
Insecticides	72.25
Miscellaneous	9.00
Seed	85.10
Hauling	18.00
Fuel	35.32
Repair and Maintenance	19.73
Interest on Operating Capital	16.43
Hired Labor Costs	15.32
Total	**396.16**

Note: Estimated variable costs are an average of budgets with alternative production practices in different regions of the state and would not reflect the budget of an individual cotton producer.

A number of differences are evident in production practices for cotton and corn from these tables. First, the overall costs to produce an acre of cotton are measurably higher than to produce an acre of corn. It costs almost 37% more to produce an acre of cotton versus the corresponding acre of corn. We notice these higher expenses in a number of categories. For example, custom application costs are more than 60% higher for cotton than corn. Expenditure costs for herbicides and insecticides are also much higher for cotton than corn. Over 300% more is spent on herbicides and insecticides to grow an acre of cotton as compared to corn. Likewise, seed costs for cotton exceed corn seed costs by 86%. The only major input category where corn costs measurably exceed cotton costs is in fertilizer. Just over $94.20 is spent to grow an acre of corn, or more than 250% of the $35.10 spent per acre on cotton.

Land costs were accounted for by assuming a share lease agreement on the tenant farmer's gross margins. That is, 80% of the gross margin accrued to the tenant farmer and 20% accrued to the landowner. (It was assumed that 90% of landowners were Louisiana residents and 10% were out-of-state residents). Both tenant farmer and Louisiana resident landowner gross margins were also adjusted for self-employment taxes (15.3%).

In addition to input costs used to grow corn and cotton, a switch in acreage planted also impacts value-added processing that occurs in the region from the production of these two commodities. In addition to hauling costs at harvest time (which are included in production costs), further costs are incurred at local elevators for drying and handling corn and local cotton gins for ginning cotton. In Tables 3 and 4, we have estimated the costs of drying and handling the equivalent bushels of corn produced per acre of planted corn and the costs to gin the equivalent bales harvested per planted acre of cotton.

As can be seen from the tables, total input costs for ginning an acre of harvested cotton ($32.58) are more than 150% the inputs costs for drying an acre of harvested corn ($20.48). The largest single category differentiating the two cost budgets is wages and salaries. More than $10 is paid to labor to gin an acre of cotton–over twice the same labor costs to dry an acre of corn.

Table 3. Elevator Costs for Drying an Acre's Corn Harvest.

Inputs	$ Per Acre of Harvested Corn
Electricity	1.42
Fuel (Natural Gas and LPG)	4.94
Repair and Maintenance	6.25
Insurance	0.21
Inspection	0.63
Interest on Working Capital	0.89
Miscellaneous	1.68
Wages and Salaries	4.46
Total	**20.48**

Table 4. Ginning Costs on an Acre's Cotton Harvest.

Inputs	$ Per Acre of Harvested Cotton
Bagging and Ties	6.44
Repairs and Maintenance	6.68
Electricity	5.67
Dryer Fuel	2.93
Wages and Salaries	10.85
Total	**32.58**

In addition to these specific labor and nonlabor input costs, operating margins (returns above variable costs) are also earned by the farmers as well as by the proprietors of the cotton gins and local elevators. Both the purchasing of the inputs and spending of incomes earned from hired labor, farmers and proprietors have impacts on the local economies in which these commodities are produced as well as the state as a whole. The next section focuses on measuring the impacts on the larger regional economy.

Estimating Additional Spending Effects

In estimating additional spending effects, we must understand how expenditures on the production and processing of corn and cotton impact the Louisiana economy. First, we must identify how much spending occurs on production and processing inputs within the borders of Louisiana. Second, we must identify how the sectors from which these inputs are purchased interact with other sectors within the Louisiana economy.

Local Spending

There are three key categories of in-state spending. The first includes those material inputs that only impact the Louisiana economy because the input is retailed or wholesaled within the state. This localized impact is referred to as the wholesale or retail margin. In our analysis, inputs such as fertilizer, herbicides, insecticides and seed are considered a part of this input class. For example, almost all fertilizer for Louisiana cotton and corn production is purchased from in-state retailers or wholesalers; however, the raw fertilizer materials come from outside Louisiana and, in many cases, outside the United States altogether.[1]

The second category includes those material inputs that create demand directly or indirectly for a manufactured product produced in Louisiana. Inputs in this category include fuel. Diesel and gasoline purchased by farmers impact both the Louisiana economy through the margins received by retailers, wholesalers and haulers (truck, barge, and rail) and the refineries within the state that produce the manufactured product.

The third category includes services purchased by farmers to produce agricultural commodities. Sectors included in this category include Repair and Maintenance Services, Custom Application and Interest on Operating Capital serviced by the banking sector. Every dollar of service inputs purchased within Louisiana initially will stay within the state.

In addition to the material inputs and services, both production and post-harvest processing activities generate a gross operating margin that accrues to farmers, landowners and gin and elevator operators. A portion of these operating margins are treated as net disposable income that is spent by these households according to their household income classifications. Hence, changes in gross operating margin impact total spending within Louisiana on such items as groceries, clothing, housing, car and truck purchases, etc.

Indirect Spending and Multiplier Effects

The initial change in demand for a commodity that results in increased (decreased) acres planted of that commodity is known as the *initial effect* (Miller and Blair 1985). The purchasing of inputs by farmers used to plant and grow a commodity from local (in-state) establishments is known as the *direct effect*. Consequently, any nonlocal (out-of-state) spending on farm inputs is described as *leakages* to the economy.

When direct effect spending occurs, the beneficiaries of this spending (local business establishments) have a reduction in inventories that must be replenished. Any spending by these establishments to replenish these inventories is known as *indirect effect* spending. The size of the indirect effects varies based on the percentage of local (in-state) products that are purchased to replenish inventories of business establishments receiving direct effect spending. The higher the percentage of local products used to replenish inventories, the larger the size of these indirect effects. Sectors such as fertilizer in this analysis have lower indirect effect spending than fuel since almost the entire fertilizer product sold by retailers and wholesalers is purchased from suppliers outside Louisiana. Since fuel is refined in Louisiana, wholesalers and retailers of agricultural fuels are likely to spend more dollars on products from in-state manufacturers.[2] There are multiple rounds of indirect effect spending as indirect effect spending creates additional inventory reduction in sectors that must purchase inputs to create new products to replenish their inventories and so on. Indirect effects may be generated over several rounds and will continue to be generated until leakages in the local economy diminish these indirect effects to essentially zero.

Another category of indirect spending occurs when direct effect spending is used to pay the wages and salaries of employees. This is known as *induced effect* spending. For example, when a farmer makes a direct purchase of fertilizer from a wholesale distributor, the net income the wholesaler receives is the wholesale margin. Part of this margin is used to pay the wages and salaries of employees of the wholesaler. The spending of these wages and salaries by employee households on goods and services in the local economy is considered an induced effect.

When direct, indirect and induced spending effects are summed together, this total is called *total effect* spending. Total effect spending is typically divided by either the initial effect or the direct effect to estimate a *total multiplier* (Miller and Blair, 1985). A multiplier is a value indicating how often initial effect or direct effect spending turns over in the local economy. For example, a multiplier of 3 for corn would be interpreted as for every $1 of change in demand for corn, there is a total change of $3 in spending in the local economy. Spending effects are typically referred to as output effects and their corresponding multipliers as output multipliers. One can also similarly calculate effects and multipliers

[1] As late as a decade ago, Louisiana was a major fertilizer producer generating such products as ammonium nitrate and anhydrous ammonia. The loss of these manufacturers resulted in a loss of multiplier effects from agricultural spending on these materials.

[2] In some cases, a wholesaler or retailer may not directly purchase from an in-state refiner; however, because overall demand for fuel has increased and Louisiana refines a measurable percentage of domestic fuel in the United States, Louisiana will indirectly receive this overall increase in demand for refined fuel resulting in additional indirect effects.

for such variables as value-added, labor income and employment (Miller and Blair, 1985).

The calculation of indirect and induced effect spending typically occurs through a general equilibrium model known as an input-output model (Isard et al., 1998; Miller and Blair, 1985). This modeling system was first created by Nobel prize-winning economist Wassily Leontief and first came to prominence in World War II to address indirect demands from interlinkages between industries to minimize bottlenecks in military production (Isard et al., 1998). Further advancements occurred through the incorporation of household and other institutional demands and transfers in a general equilibrium framework through the development of the Social Accounting Matrix (SAM) system (Pyatt and Round, 1988). A mathematical reduced form model of the Social Accounting Matrix system is presented in the Appendix.

Estimating Net Impacts of Switching Cotton Acreage to Corn

Approach

A very basic approach commonly used to measure economic contributions/impacts for agricultural commodities is to use a single scalar multiplier. This approach typically takes the change in demand (a reduction in the value of the agricultural commodity harvested) and multiplies it by the appropriate multiplier (output multiplier, value-added multiplier, etc). A recent application of this approach to a switch in a state's agricultural production can be found in Brandon (2007). This approach has its strengths and weaknesses. The strengths of this approach are 1) the multiplier is based on aggregation of often hundreds of interlinkages within a regional economy (when constructed from a multiplier matrix from a SAM/I-O model) and 2) the total effect on the economy can be quickly calculated. The typical weaknesses of this approach include 1) loss of accuracy due to a multiplier calculated from a dated model or from a model from an inappropriate region and 2) the inability to provide detailed industry impacts.

The first weakness occurs because the SAM/I-O models typically used for modern impact analysis in the United States come from private companies constructing these models for individual states and parishes. Because of the enormity of the data required and the lag time that it takes for federal statistical agencies to report the data, these companies typically have two- to four- year lags in the release of their models. Hence, using a dated model may result in production relationships and inter-industry linkages that are much different today than they were in the year the model was constructed resulting in reduced accuracy of the estimation. The second weakness is simply the result of using only a single aggregated multiplier versus an entire matrix of multipliers when applying detailed changes in demand to a complete model. See the Appendix for details.

Hence, our strategy is to take advantage of the "matrix of multipliers" provided in the SAM/I-O framework and at the same time mitigate potential inaccuracies caused by using older models. Our approach is to develop new sectors outside the model, treat them as changes in final demand, and apply them to the multiplier matrix. Since the two sectors of interest – cotton production and corn production – both exist inside the model, their aggregate multipliers are based on production functions (the recipe of inputs and value added necessary to produce output) that are two- to four-years old. We recreated production functions from 2007 cost and returns estimates for both cotton and corn. Total changes in the demand for material inputs, services and labor required to produce projected output levels of the two commodities were calculated from these present-year production functions. Further, we improved on the distribution of one of the key value-added elements of production, gross margin, by specifying the farm household consumption function based on household income levels. Finally, we took a similar strategy by recreating two of the post-processing production functions – cotton ginning and corn drying/handling – based on the most recently available production-function data. The specific details of this approach are presented below.

Details

To estimate the net economic impact to Louisiana from the switching of cotton acreage to corn in 2007, we first created a development scenario based on the approach of the previous section. The scenario is like a "what if" analysis, where we ask ourselves what happens when we simultaneously reduce production of one commodity and increase production of another commodity.

In this case, we first identified how much cotton acreage was transferred to corn acreage. Based on visits with numerous LSU AgCenter faculty and cotton farmers, an overwhelming percentage of reduced cotton acres planted in Louisiana could be attributed to increased corn plantings. Hence for simplicity in this scenario, we assumed that 100% of the reduced cotton acreage (295,000 acres) was transferred into corn acreage for 2007.

To estimate the net impact from the acreage transfer, we first estimated the total local expenditures by detailed category to plant an acre of cotton and an acre of corn. We applied the budgets in Table 1 for corn and Table 2 for cotton. We assumed 100% of the material inputs and services would be purchased in Louisiana with some sectors as

presented in the previous section having impacts both at the manufacturing as well as at the wholesale and retail levels. Net disposable income for farm employees was calculated by subtracting FICA (7.65%) from gross wages and salaries. This income was assumed to be spent according to average American households earning $15,000 - $25,000 annually. Similarly, self-employment tax (15.30%) was subtracted from gross operating margins to estimate disposable proprietor income. It was further assumed that these farmers were tenant farmers with 20% of proprietor income accruing to the landowner and 80% to the tenant farmer. Ten percent of landowners were assumed to be non-Louisiana residents and their portion of disposable proprietor income was assumed to be a leakage on the state economy. The remaining 90% of landowners and 100% of tenant farmers were assumed to be Louisiana residents and spent their disposable proprietor income based on average American households earning $75,000 - $100,000 annually. [3]

In addition to production activities, we also estimated the net effect on the switch from cotton to corn on post production activities in Louisiana. While it is difficult to identify exactly in the post-production process equivalent processing points across the two commodities, it was assumed that ginning of cotton and the drying and handling of corn by the elevator to be equivalent in the processing supply chain.

For cotton, input demands required to gin cotton were identified (Table 4). One hundred percent of material inputs and services for ginning cotton were assumed to occur within Louisiana. Since a portion of the employees hired to work in Louisiana gins are nonresident transient workers, it was assumed that 80% of the wages and salaries earned would be spent by Louisiana employees according to a $15,000 - $25,000 annual household income profile. Gross operating margins for ginning were assumed to be spent according to $75,000 - $100,000 annual spending profiles.[4] Similarly for corn, elevator costs for drying were distributed across multiple input categories (Table 3), and gross operating margins were spent in a similar fashion to operating margins for gins.

IMPLAN™ Pro Input-Output modeling software (Minnesota IMPLAN Group 2004) was used to calculate indirect and induced effects from the scenario spending profiles for cotton and corn. Detailed industry spending sectors for the two commodities as well as for post-production processing were mapped to specific IMPLAN sectors. All household and proprietor income spending profiles were applied to IMPLAN, and the proportion of these incomes that were spent in Louisiana was calculated based on IMPLAN household regional purchase coefficients.

[3]One may also make the argument that additional equipment was purchased by farmers who did not traditionally grow cotton. In the short-run, this is less likely to be the case as farmers outsource services such as custom harvesting. However, if the increased corn acreage becomes a multiyear phenomenon in the state, we would expect more equipment to be purchased in the long run. The authors thank the reviewers for bringing out this point.

[4]It should be noted that we assumed 100% of the proprietary income would be treated as household income and spent according to a household consumption function. We do recognize that farmers are likely to have outstanding farm debts outside of traditional interest on operating capital and will not spend this entire amount. However, since we treat both corn and cotton proprietary income the same, the net effects should be the same with or without an adjustment for debt payments.

Results

In this section, we present the main economic impacts measured in terms of output, value added and employment. Please note these impacts are the result of a switch of 295,000 acres from cotton production to corn production – not the total economic impact of the production and value-added processing of these commodities on the state's economy. The differences shown in the following tables results from subtracting the economic impacts lost from a reduction of 295,000 acres of cotton planted (and harvested) and an increase of 295,000 acres of corn planted (and harvested). The section begins with a presentation of economic impacts from the material inputs and labor consumed to produce corn and cotton. These impacts are followed by impacts from inputs purchased to dry corn and gin cotton. Next, an assessment of how increased proprietary incomes earned from farmers and owners of elevators and gins impact the state economy. Finally, we present an industry breakdown of the economic impacts including the net effect on the state economy.

Corn Production vs. Cotton Production

In this section, we evaluate the net impacts of the consumption of labor and nonlabor inputs from corn and cotton production on the Louisiana economy. Table 5 indicates that the switch from cotton to corn results in a direct net loss of more than $13 million from reduced consumption of Louisiana materials and services. When considering the additional reduced spinoff effects from this lost consumption, the total economic output loss exceeds $21 million. This loss also results in a loss of almost $15 million in value added and $10 million in labor income (lost wages and salaries).

Similarly, we can see that the switch from cotton to corn also reduces the labor incomes earned from hired farm labor, and their reduced purchasing power ripples throughout the state economy. In Table 6, reduced spending from fewer hours of farm labor purchased producing corn results in a direct loss in output of just under $400,000 and a total output loss (including indirect and induced effects) of over $600,000. This reduced spending translates into more than $350,000 in reduced value added and over $200,000 in additional reduced labor income.

Value-added Processing Impacts

In Table 7, we see the net effect of switching cotton acreage to corn acreage on additional commodity processing in the state. The losses from nonlabor inputs on cotton ginning more than cancel out the positive economic impacts from increased elevator drying and handling. The direct net effect is approximately a $1.7 million loss in output on the state economy. When counting additional indirect and induced effects, total output loss would be in excess of $3.5 million. This output loss also reduces total value added by almost $900,000 and labor income by just under $250,000.

Table 5. Projected Effects on the Louisiana Economy from the Switch of Non-Labor Inputs Used to Produce Corn and Cotton.

Commodity	Output		Value Added		Labor Income	
(Dollars)	Direct	Total	Direct	Total	Direct	Total
Corn	42,105,355	71,093,065	26,236,637	42,462,322	18,207,654	27,528,790
Cotton	55,594,834	92,847,403	36,306,378	57,338,054	25,423,595	37,396,203
Difference	**-13,489,479**	**-21,754,338**	**-10,123,741**	**-14,875,732**	**-7,215,941**	**-9,867,413**

Source: IMPLAN™.

Table 6. Projected Effects on the Louisiana Economy from the Switch of Hired Farm Labor Inputs Used to Produce Corn and Cotton.

Commodity	Output		Value Added		Labor Income	
(Dollars)	Direct	Total	Direct	Total	Direct	Total
Corn	2,282,576	3,647,972	1,313,189	2,086,356	740,778	1,183,915
Cotton	2,677,570	4,279,245	1,540,433	2,447,395	868,967	1,388,788
Difference	**-394,994**	**-631,273**	**-227,244**	**-361,039**	**-128,189**	**-204,873**

Source: IMPLAN™.

Table 7. Projected Effects on the Louisiana Economy from Non-Labor Inputs Purchased between Drying/Handling Corn and Ginning Cotton.

Activity	Output		Value Added		Labor Income	
(Dollars)	Direct	Total	Direct	Total	Direct	Total
Elevator Drying	4,723,687	7,420,079	2,374,350	3,871,046	1,343,878	2,195,576
Cotton Ginning	6,409,170	11,011,154	2,720,240	4,752,418	1,294,086	2,444,217
Difference	**-1,685,483**	**-3,591,075**	**-345,890**	**-881,372**	**49,792**	**-248,641**

Source: IMPLAN™.

We see further evidence of the reduced processing impacts from labor inputs used in Table 8. Since elevator drying uses less labor to dry the equivalent output from an acre of corn than does ginning the output of an acre of cotton (Tables 3 and 4), both direct and total effects are reduced. The net effect from labor paid from increased elevator drying and reduced cotton ginning results in a direct loss of $1.1 million and total loss (including indirect and induced effects) of more than $1.7 million. Value-added losses total more than $1 million and labor income losses exceed $500,000.

Proprietary Income Impacts

One of the primary reasons corn acreage increased in Louisiana in 2007 was the response by farmers to increased corn prices. Despite increases in input prices heavily used by corn farmers such as fertilizer, output prices in 2007 are at near historic levels in real terms. The increased potential profits to farmers are likely to be applied to pay off farm debt as well as increase farm household consumption. In Table 9, we see the net effect of changes in proprietary income for farmers and processors on the larger state economy. With significantly higher profit margins, the increased corn production is expected to more than offset losses associated with lower cotton production and result in an increase in direct proprietary income to the state economy. For example, direct output in the state economy driven by the increased corn acreage, $27.6 million, more than offsets the $10.8 million of reduced output from proprietary income from cotton farming. When including the processing sectors, the direct net effect from increasing corn production is an increased $18.1 million in output, or $28.4 million when including indirect and induced effects. These net effects also include an increase in total value added of more than $16.4 million and labor income of $8.9 million.

Combined Effects

In tables 10–12, we present the combined effects on output, value added and employment from the switch of 295,000 acres from cotton production to corn production. According to Table 10, the net direct effects on output from the switch total just over $1.4 million, or only a 1.85% increase in total output when these acres were originally in cotton. When considering the additional spinoff effects, the net total effects are slightly under $750,000, or 0.57% above the impact when the same acreage was in cotton.

Table 8. Projected Effects on the Louisiana Economy from Labor Inputs Purchased between Drying/Handling Corn and Ginning Cotton.

Activity	Output		Value Added		Labor Income	
(Dollars)	Direct	Total	Direct	Total	Direct	Total
Elevator Drying	779,939	1,246,484	448,707	712,892	253,118	404,534
Cotton Ginning	1,897,020	3,031,783	1,091,375	1,733,944	615,651	983,936
Difference	**-1,117,081**	**-1,785,299**	**-642,668**	**-1,021,052**	**-362,533**	**-579,402**

Source: IMPLAN™.

Table 9. Projected Effects on the Louisiana Economy from Changes in Proprietary Income Earned between Drying/Handling Corn and Ginning Cotton.

Proprietary Income Category	Output		Value Added		Labor Income	
(Dollars)	Direct	Total	Direct	Total	Direct	Total
Corn Farmer	27,609,760	43,424,175	16,102,010	25,088,289	8,445,486	13,605,391
Elevator Drying	1,258,633	1,979,557	734,034	1,143,688	385,000	620,222
Corn Subtotal	**28,868,393**	**45,403,732**	**16,836,044**	**26,231,977**	**8,830,486**	**14,225,613**
Cotton Farmer	6,219,926	9,782,596	3,627,460	5,651,889	1,902,599	3,065,022
Cotton Ginning	4,531,076	7,126,402	2,642,523	4,117,274	1,386,001	2,232,800
Cotton Subtotal	**10,751,002**	**16,908,998**	**6,269,983**	**9,769,163**	**3,288,600**	**5,297,822**
Difference	**18,117,391**	**28,494,734**	**10,566,061**	**16,462,814**	**5,541,886**	**8,927,791**

Table 10. Combined Output Effects on the Louisiana Economy from the Corn/Cotton Switching Scenario.

Sector	Corn Direct Combined ($)	Cotton Direct Combined ($)	Difference ($)	Corn Total Combined ($)	Cotton Total Combined ($)	Difference ($)
Ag., Forestry, Fishing, Hunting	5,099,769	7,668,022	-2,568,253	5,619,056	8,160,105	-2,541,049
Mining	86,203	99,519	-13,316	1,752,146	1,939,783	-187,638
Utilities	2,284,076	2,646,666	-362,591	3,496,095	3,921,700	-425,605
Construction	0	0	0	754,165	688,887	65,278
Manufacturing	4,832,592	6,735,869	-1,903,278	10,492,835	13,421,104	-2,928,269
Wholesale Trade	9,790,408	6,421,201	3,369,206	11,983,725	8,607,361	3,376,364
Transport and Warehousing	8,333,444	5,844,869	2,488,575	11,720,847	8,888,438	2,832,409
Retail Trade	12,917,372	23,330,281	-10,412,909	16,811,150	27,318,723	-10,507,574
Information	786,694	391,394	395,300	3,063,389	2,638,313	425,076
Finance and Insurance	6,170,577	5,650,049	520,528	9,790,856	8,985,420	805,436
Real Estate and Rental	758,937	478,811	280,126	4,347,319	3,916,793	430,527
Professional and Scientific Services	1,038,000	273,740	764,260	4,448,903	3,586,778	862,125
Management of Companies	0	0	0	1,110,852	1,267,713	-156,861
Administrative Services	116,355	53,773	62,582	2,085,031	1,858,291	226,739
Educational Services	810,952	353,876	457,077	1,325,492	883,157	442,334
Health and Social Services	6,259,762	3,102,723	3,157,039	10,857,133	7,876,897	2,980,236
Arts, Entertainment, and Recreation	703,910	326,022	377,889	1,314,047	954,328	359,719
Accommodation and Food Services	2,446,249	1,121,830	1,324,419	4,858,140	3,567,437	1,290,703
Other Services	8,043,230	8,676,367	-633,137	10,231,652	10,825,152	-593,499
Government	6,458,469	2,964,891	3,493,578	10,925,546	7,582,510	3,343,037
Institutions	1,822,954	1,189,694	633,260	1,822,954	1,189,694	633,260
Total	**78,759,950**	**77,329,596**	**1,430,353**	**128,811,332**	**128,087,584**	**732,748**

We see the net effects of the switch vary depending on the sector of the economy. For example, sectors such as wholesale trade and transportation are more positively impacted by increased corn production primarily due to purchases of major inputs such as fertilizer. Similarly, sectors highly dependent on household consumption such as health and social services, arts, entertainment and recreation, and accommodation and food services are more positively impacted by increased corn production due to the direct household spending of additional proprietary income earned by farmers and landowners from higher corn prices.

Other sectors such as manufacturing, utilities and retail trade are negatively impacted by the reduced cotton acreage. These sectors are impacted by reduced levels of herbicides and pesticide purchases as well as reduced inputs used in ginning. Furthermore, lower net levels of custom application resulted in lower direct effects on the agriculture, forestry, fishing and hunting sector.

Typically, net total effects (which include the indirect and induced effects) are expected to be higher than direct effect spending. However, in this case, results indicate that the net total effect ($732,000) was roughly half the net direct effect ($1.4 million). One logical explanation for this situation is the difference in the output multipliers for cotton and corn.

The total output multiplier for cotton in this analysis is 1.66, or .02 greater than the 1.64 multiplier for corn. The cotton multiplier can be interpreted as for every $1 of increase in the inputs purchased or incomes earned in Louisiana to grow, harvest and process cotton, there is a $1.66 increase in total output across all sectors of the Louisiana

Table 11. Combined Value-added Effects on the Louisiana Economy from the Corn/Cotton Switching Scenario.

Sector	Corn Direct Combined ($)	Cotton Direct Combined ($)	Difference ($)	Corn Total Combined ($)	Cotton Direct Combined ($)	Difference ($)
Ag., Forestry, Fishing, Hunting	3,962,741	5,981,119	-2,018,379	4,154,466	6,168,537	-2,014,071
Mining	45,333	52,334	-7,001	935,649	1,036,048	-100,399
Utilities	1,148,316	1,611,135	-462,819	1,945,746	2,446,428	-500,683
Construction	0	0	0	352,821	326,638	26,182
Manufacturing	583,494	783,984	-200,489	1,778,630	2,075,369	-296,739
Wholesale Trade	7,446,466	4,883,888	2,562,578	9,114,676	6,546,655	2,568,022
Transport and Warehousing	3,861,267	2,696,644	1,164,623	5,805,080	4,446,287	1,358,793
Retail Trade	9,889,957	18,039,625	-8,149,668	12,813,573	21,034,348	-8,220,775
Information	339,698	173,077	166,621	1,358,703	1,179,877	178,826
Finance and Insurance	4,179,747	4,059,270	120,477	6,339,504	6,035,570	303,933
Real Estate and Rental	482,047	311,331	170,717	2,879,052	2,607,580	271,472
Professional and Scientific Services	635,164	169,766	465,398	2,622,367	2,094,159	528,208
Management of Companies	0	0	0	596,310	680,514	-84,204
Administrative Services	52,762	24,609	28,153	1,225,661	1,104,471	121,191
Educational Services	442,845	192,857	249,988	715,697	474,591	241,106
Health and Social Services	3,775,103	1,865,768	1,909,335	6,556,130	4,758,611	1,797,519
Arts, Entertainment, and Recreation	443,513	206,048	237,465	837,592	612,515	225,077
Accommodation and Food Services	1,170,328	535,140	635,188	2,336,240	1,715,526	620,713
Other Services	3,948,567	4,211,993	-263,425	5,042,057	5,289,620	-247,563
Government	4,801,579	2,129,822	2,671,758	7,954,639	5,407,629	2,547,010
Institutions	0	0	0	0	0	0
Total	**47,208,927**	**47,928,409**	**-719,482**	**75,364,592**	**76,040,973**	**-676,381**

economy. The corn multiplier is interpreted similarly. Hence, in this scenario, for every $1 increase in direct spending or incomes earned in the cotton sector, there is a 2-cent greater overall multiplier effect on output in Louisiana than a similar increase in direct spending in the corn sector.

In Table 11, we see that the value-added effects are slightly negative when switching from cotton to corn in this scenario. In particular, the direct net effect on value added was a loss of just over $719,000 and a net loss of total value added of $676,000. Two countervailing factors explain these differing effects. First, the direct value-added negative effect can be explained by a higher percentage of each dollar of input spent to grow, harvest and process cotton generating a higher value-added contribution than corn. Specifically 62 cents out of every dollar of output was value-added in the cotton scenario compared to only 60 cents for corn. On the other hand, the reduced total value-added effect of $676,000 was due to a higher value-added multiplier for corn, 1.60, compared to cotton, 1.59. This means that for every $1 of additional value added created from additional outputs purchased, there is a total increase in value added of $1.60 across all sectors of the Louisiana economy. This includes the original direct dollar of value added created plus an additional 60 cents of indirect and induced (or multiplier) effects.

In Table 12, results indicate that a similar situation exists for labor income effects as for value added. The net direct effect of replacing 295,000 acres of cotton with a corresponding 295,000 acres of corn is a reduction of $2.1 million in labor income. The total net effect on labor income was a reduction of just under $2 million. A larger percentage of every input purchased used to grow, harvest and process

Table 12. Combined Labor Income Effects on the Louisiana Economy from the Corn/Cotton Switching Scenario.

Sector	Corn Direct Combined ($)	Cotton Direct Combined ($)	Difference ($)	Corn Total Combined ($)	Cotton Direct Combined ($)	Difference ($)
Ag., Forestry, Fishing, Hunting	4,868,271	7,369,821	-2,501,550	5,001,242 5,001,242	7,505,883	-2,504,641
Mining	15,468	17,853	-2,386	328,957	364,842	-35,884
Utilities	384,678	500,038	-115,361	634,467	761,563	-127,096
Construction		0	0	302,538	283,352	19,185
Manufacturing	345,806	439,167	-93,962	1,122,500	1,247,068	-124,568
Wholesale Trade	4,172,487	2,736,595	1,435,892	5,107,238	3,668,295	1,438,943
Transport and Warehousing	2,870,001	2,002,590	867,411	4,336,335	3,313,954	1,022,381
Retail Trade	6,046,506	10,859,625	-4,813,120	7,878,512	12,736,179	4,857,667
Information	140,751	71,921	68,830	699,645	631,213	68,432
Finance and Insurance	1,961,141	1,855,846	105,295	3,123,721	2,906,816	216,905
Real Estate and Rental	154,439	90,902	63,537	782,361	691,817	90,544
Professional and Scientific Services	521,498	135,240	386,258	2,132,228	1,696,515	435,713
Management of Companies	0	0	0	458,227	522,932	-64,705
Administrative Services	39,997	18,552	21,445	993,400	896,626	96,773
Educational Services	435,534	189,741	245,792	702,893	465,972	236,921
Health and Social Services	3,289,035	1,628,472	1,660,562	5,709,770	4,146,580	1,563,189
Arts, Entertainment, and Recreation	287,157	134,540	152,617	559,366	413,906	145,460
Accommodation and Food Services	801,548	367,202	434,346	1,597,331	1,173,470	423,861
Other Services	2,823,620	2,963,851	-140,231	3,648,728	3,776,895	-128,167
Government	217,997	108,939	109,038	418,970	307,087	111,883
Institutions	0	0	0	0	0	0
Total	**29,375,914**	**31,490,898**	**-2,114,984**	**45,538,428**	**47,510,966**	**-1,972,539**

cotton in Louisiana goes to pay for labor relative to the same dollar for corn. Likewise, the reduced negative total labor income effect is due to a larger labor income multiplier for corn relative to cotton. The labor income multiplier for corn is 1.55 compared to 1.41 for cotton.

Sensitivity Analysis

One of the challenges in measuring farm household impacts on a regional economy is determining what proportion of gross margin is retained by the farm business to pay off outstanding debt obligations. Understanding this relationship is important given conventional wisdom that argues during good harvest seasons (high yields, high prices or both) farmers will accelerate debt payoff. Existing secondary data sources such as the ARMS survey from ERS are not structured to address this question through traditional research methods.

The approach used here is to present a range of projections given that no known previously conducted research has analyzed this issue. Hence, we performed a sensitivity analysis by varying two key variables in the model: price and debt reduction. We provide a range of corn prices and a range of debt reduction scenarios that vary the percentage of total proprietary income used to pay off existing farm debts. These debts would include outstanding debt for infrastructure investments such as equipment and buildings. Debt payoff in this table does not include the payoff of loans taken out to plant, grow and harvest an individual farmer's corn crop. These costs are accounted for in the corn budgets presented in Table 3. These various net proprietary income levels are then applied to the IMPLAN model to estimate alternative output effects in Table 13.

Table 13. Sensitivity Analysis of Corn Farmer's Proprietary Income to Alternative Corn Price and Debt Reduction Levels – Total Output Effects.

	% of Proprietary Income Applied to Debt Reduction			
Price/Bushel	**0%**	**10%**	**25%**	**50%**
$2.50	$14,324,701	$12,892,231	$10,743,526	$7,162,351
$3.00	$33,724,353	$30,351,916	$25,293,264	$16,862,175
$3.25	$43,424,175	$39,081,761	$32,568,133	$21,712,089
$3.50	$53,124,000	$47,811,602	$39,843,001	$26,562,000
$4.00	$72,523,654	$65,271,285	$54,392,739	$36,261,827

The baseline scenario used in the previous tables was a corn price of $3.25/bu and a 0% debt reduction level (See Table 9). What can easily be drawn from this table is that the current surge in corn prices is having a measurable impact on the economy at whatever average price and debt reduction level is applied. If we compare a $2.50 average-price-per-bushel growing season with a 10% debt reduction level to a $3.50 average-price-per-bushel with the same level of debt reduction, we see a 270% increase in output on the state economy. Using the same example scenario (tables not shown), we see value added increasing from $7.44 million to $27.62 million and labor income increasing from $4.04 million to $14.98 million.

Table 13 shows that a small change in prices/debt reduction assumptions can have measurable impacts on the state economy. If we assume no additional impacts from corn drying/handling, a $3.50/bu corn price/10% debt reduction scenario would increase the net output effect from the switch from cotton to corn from the $732,000 reported in Table 10 to more than $5 million. The same scenario would switch the negative net effect on value added to a positive effect and would reduce to almost half the approximately $2 million lost in labor income due to the switch.

Discussion

The results from the previous section bring to light a relevant economic reality of this switch – the benefits and costs of the switch vary depending on the economic actor. From the viewpoint of the overall state economy, there are no measurable economic benefits or consequences. Output, value added and labor income all increase or decrease by less than 5% when the 295,000 acres in the scenario are switched from cotton production to corn production.

The major economic actor measurably impacted by the switch in a positive way is the farmer. Proprietary income for the farmer increases more than 300% from approximately $10 million in output with land planted in cotton to over $43 million in output for the same acreage planted in corn. These income benefits also accrue to rural landowners who rent their farmland on share arrangements with farmers who planted corn.

The major economic sectors that are negatively impacted are the retail and, to a lesser extent, wholesale sectors that sell inputs directly to farmers. Since farmers spend more dollars to grow an acre of cotton than corn, then farm supply stores and other enterprises that sell relatively more expensive inputs to cotton farmers such as herbicides, insecticides and other miscellaneous inputs, will be hurt by the switch.

An additional element of the impact is the geographic distribution of the economic impact due to the switch. Whereas farmers may be somewhat evenly distributed geographically across most of the agricultural lands of rural Louisiana, the location where they purchase farm inputs and the location where their households spend disposable incomes on goods and services are not as evenly distributed. For example, many of the farm inputs purchased from the retail sector may come from local and rural region suppliers. Money spent on these inputs is much more likely to recirculate and ripple through the local economy. On the other hand, while some disposable household income is spent locally, given the lower transportation costs provided by improved roads and highways and the selection of local goods available, a measurable proportion of household purchases is likely to occur in regional trade centers. For Northeast and Central Louisiana, where the overwhelming proportion of cotton and corn is grown, these trade centers are likely to include Monroe and Alexandria to the west and Greenville,Vicksburg and Natchez, Mississippi, to the east. Hence, a measurable proportion of retail trade and service items purchased by farm households is likely to "leak" into urban centers of Louisiana or outside Louisiana altogether.

From a jobs perspective, a number of jobs and/or hours worked in rural areas are likely to be lost due to partial or complete shutdown of gins. The job gains are not likely to be made up from increased activity at local or terminal elevators in these same communities. On the other hand, increased disposable income is likely to increase jobs and/or hours worked in regional trade centers to support the in-

creased retail trade and services consumed by farm households.

Yet, the geographic distribution of these inputs is mostly an assertion based on conventional wisdom about the geographic spending patterns for farm inputs and consumption by farm households. A more detailed analysis should be conducted to ascertain where the spending of these inputs occur and if the switch from cotton to corn production has a net negative impact on rural communities in Louisiana.

In addition to the sectoral and geographic distributions of the impact, the timing or the dynamics of these impacts should be analyzed in the context of both commodity markets and public policy. In 2007, the primary factor driving the switch was historically high corn prices immediately prior to and during the corn-planting season. The switch to planting corn was made easier by commodity price support programs that were decoupled. That is, land historically planted in cotton and receiving federal commodity support payments from a base level of cotton acreage could be planted in any agricultural commodity and still receive the commodity payment from the cotton base. These forces led to more than 700,000 acres of corn being planted in Louisiana and cotton acreage being reduced by almost 50% from 2006 levels.

What are the long-run implications of higher than historical average corn acreage planted and lower levels of cotton acreage grown in Louisiana? One concern is the value-added processing infrastructure in the state, i.e., cotton ginning. Cotton gins historically have been located very close to the location of cotton production as suggested by location theory (Shaffer, et al., 2004). That is, a bulky input such as cotton has a relatively higher transportation cost to ship the raw product to be processed than shipping the processed product to its next stage of processing or to an end consumer.

While it is expected that some cotton gins will not operate during 2007, all gins that do operate will do so at reduced output levels. On average, the 2007 output is expected to be about one half the 2006 output. Some ginners as well as producers are concerned a prolonged reduction in cotton acreage planted may result in the permanent shutdown of some gins and a loss of ginning capacity for the state. These same ginners and producers warn that if higher corn prices turn out to be a temporary phenomenon created by speculative activity in corn consumption markets such as ethanol, a lack of ginning infrastructure created by a short-term multiyear price spike in corn will eliminate much of the capacity for Louisiana farmers to switch back to cotton.

These concerns suggest a research agenda on ginning infrastructure within Louisiana is warranted. Technological improvements such as the cotton module have changed both harvesting practice and transportation costs for raw cotton. These changes suggest a technical efficiency analysis should be conducted for cotton ginning to identify those ginning activities that are most efficient. In tandem, a sensitivity analysis should be conducted to identify how many gins the state could support long-term at various output prices for corn and other substitute commodities. This sensitivity analysis could also be used to identify optimal locations for gins given different transportation cost structures for the raw and processed products.

Conclusion

In this bulletin, we evaluated the economic impact to the Louisiana economy from a switch of 295,000 acres from cotton production to corn production. In particular, we improved on existing research strategies to measure these effects by creating new present-year production functions for corn, cotton and processing sectors outside the IMPLAN model. Production levels were combined with the production function data to create alternative final demand scenarios that were applied to the matrix of multipliers in the IMPLAN model.

The switch in commodities is expected to have only minimal impacts on overall economic activity in the state. Total output is expected to increase by just over $700,000, or 0.57% greater than if cotton were planted and harvested on the same acreage. Value added is expected to decrease by slightly more than $650,000, or a reduction of 0.89% in value added if cotton were planted and harvested. A $1.97 million loss in labor income is expected from the switch from cotton to corn, an expected reduction of 4.16% if the same land were planted in cotton.

The distribution of these effects impacted some sectors positively while others were more negatively impacted. The output of the largest private sectors positively impacted included health and social services ($3.0 million), wholesale trade ($3.4 million), transportation and warehousing ($2.8 million) and accommodation and food services ($1.3 million). The health and food services sectors increased primarily from the increased spending of proprietary income in farm households due to higher corn prices. Wholesale trade and transportation increased due to the increased demand for these inputs in planting corn relative to cotton. Sectors most negatively impacted by the switch include retail trade (-$10.5 million), manufacturing (-$2.9 million) and the agriculture, forestry, fishing and hunter sector (-$2.5 million). These sectors declined because of the reduced demand for their inputs primarily used to grow and gin cotton. Similar sector-based effects occurred for value added and labor income.

The geographic distribution of these effects is more difficult to predict. It can be argued that much of the inputs used to grow and harvest both corn and cotton are purchased locally or from within the region from retailers or wholesalers. At the same time, a measurable proportion of proprietary income is spent by the farm household on general household purchases. It is expected a measurable proportion of these household purchases will occur in regional trade centers that are in urban areas outside the primary rural agricultural regions of the state. Additional research should be conduced to identify the geographic distribution of farm and farm-household spending to better project which regions within the state are more positively and negatively impacted.

A few key limitations should be recognized in this research. First, the impact projections are based on assumptions regarding the prices and yield levels of corn and cotton. Given how sensitive proprietary income impacts are to the net effects in the scenario, minor changes in the average price received or yield levels for corn can have a measurable impact on whether larger positive or negative economic impacts result from this switch in production. Second, as discussed previously, the geographic location of spending has a major impact on the size of the state impacts. Higher or lower proportions of in-state spending on farm inputs or household consumption than what has been modeled will change the size of the economic impacts.

Future research should be focused in a number of areas. First, as mentioned previously, research should focus on identifying the location of spending for farm inputs as well as by farm households. This research has the two-fold effect of estimating regional (individual parish or multiparish) economic impacts as well as providing individuals and businesses a guide to gaps in locally available or economically affordable farm inputs. Second, a technical efficiency analysis should be conducted of cotton gins to understand which gins are operating efficiently and what output levels are required to maintain cost efficiency. In tandem, an optimal firm location analysis should be conducted reflecting varying output levels of cotton production in the state and varying transportation costs. These studies will better help the ginning industry assess its long-term viability and make strategic investment decisions in a more uncertain cotton-production environment.

Cotton was "king" in Louisiana agriculture in the 19th century and remained an important crop in the state throughout the 20th century. Changing short-term domestic demands for agricultural commodities have impacted the cotton sector in today's economy. Major leaders and stakeholders in Louisiana agriculture should maintain an awareness of the dynamics of this individual commodity and its companion industries as they face short-term and possibly long-term challenges.

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Appendix. Mathematical Description of Reduced-Form Social Accounting Matrix System

Define:

S = matrix of SAM coefficients
A = matrix of technical coefficients
V = matrix of factors of production coefficients
Y = matrix of factors of production distribution coefficients
C = matrix of institutional and capital account expenditure coefficients
H = matrix of institutional and household distribution coefficients.

The supply and demand equations can be written as:

$$\begin{bmatrix} X \\ V \\ Y \end{bmatrix} = S \begin{bmatrix} X \\ V \\ Y \end{bmatrix} + \begin{bmatrix} ex \\ ev \\ ey \end{bmatrix} \qquad (1)$$

where

X = vector of sectoral supply
V = vector of factors of production by categories
Y = vector of institutional receipts
Ex = vector of exogenous commodity demand
Ev = vector of exogenous factors of production receipts
Ey = vector of exogenous institutional receipts.

Equation (1) can be rearranged

$$\begin{bmatrix} X \\ V \\ Y \end{bmatrix} - S \begin{bmatrix} X \\ V \\ Y \end{bmatrix} = \begin{bmatrix} ex \\ ev \\ ey \end{bmatrix} \qquad (2)$$

$$(I - S) \begin{bmatrix} X \\ V \\ Y \end{bmatrix} = \begin{bmatrix} ex \\ ev \\ ey \end{bmatrix}$$

where I is an identity matrix.

Now by inverting the (I-S) matrix,

$$\begin{bmatrix} X \\ V \\ Y \end{bmatrix} = (I-S)^{-1} \begin{bmatrix} ex \\ ev \\ ey \end{bmatrix} \qquad (3)$$

the reduced form model is achieved. The $(I\text{-}S)^{-1}$ matrix is the SAM multiplier matrix. Changes in the right hand side exogenous final demand and receipt vector results in changes in sectoral output, factors of production and institutional receipts.

Authors

J. Matthew Fannin

Assistant Professor

Kenneth W. Paxton

Professor

John D. Barreca

Undergraduate Research Assistant

Department of Agricultural Economics and Agribusiness, LSU AgCenter

www.lsuagcenter.com

Louisiana State University Agricultural Center

William B. Richardson, Chancellor

Louisiana Agricultural Experiment Station

David Boethel, Vice Chancellor and Director

Louisiana Cooperative Extension Service

Paul D. Coreil, Vice Chancellor and Director

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