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FEASIBILITY AND DESIRABILITY OF ETHANOL PRODUCTION IN THE STATE OF LOUISIANA

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by

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CHAPTER 1: THESIS INTRODUCTION

Everywhere one looks, there are journalists, economists, and academic researchers discussing the present and future state of biofuels, along with the effect that increasing biofuel production is having on commodity prices. Generally, the discussion includes comments on corn-based ethanol, as this is the biofuel source that is currently receiving the most government support and that is the most blamed for the spike in commodity prices.

Yet, what is the effect that ethanol is really having on the U.S. economy, and more specifically the state of Louisiana? Is this industry really generating a large economic impact to local and state economies (Urbanchuck, 2007) or are these numbers often grossly overstated (Swenson, 2006)? Is there a real benefit from ethanol to an economy, rural or otherwise, and how much is this benefit? If ethanol is causing higher commodity prices, will these prices last long term? Will corn-based ethanol even last for the long term?

Additional research into these economic questions needs to be performed if states and local communities are to make rational economic decisions about recruiting these facilities. If the U.S. is going to substitute biofuels for gasoline, leaders at the federal, state, and local levels should be as informed as possible on the benefits and drawbacks of this change. They need to know not only which types of biofuels are available for production in general, but also which biofuels are available for production within their area. Ethanol production may be an option for the state of Louisiana, and whether it should be encouraged will be addressed by this study. This research will seek to accomplish two objectives, which are presented below.

Objectives

Objective 1: To determine how the development of an ethanol industry within the U.S. is affecting the economy of the state of Louisiana through the redistribution of planting acreage of historical agricultural commodities in the state.

Objective 2: To determine how a proposed distribution of ethanol plants within Louisiana would impact the state economy.

Overview of Chapters

The first objective will be accomplished through a study of a crop acreage switch that occurred in Louisiana between corn and cotton in 2007. The cost structures for cotton and corn production, as well as for cotton gins and grain elevators will be analyzed. These cost effects will next be run through a series of input-output multipliers. The net result of the acreage switch will then be measured on major variables of state economic activity.

The second objective will be achieved by an analysis of a hypothetical distribution of 50 million gallon per year (MGY) ethanol plants within the northeast region of Louisiana. The analysis will determine the number of plants that are sustainable along with their most cost-effective locations. A premium will be assigned to every supply point, and once the premiums are summed, the total will be run through an input-output model, determining the total impact on the state economy. In addition to direct impacts from premiums on price received by farmers, economic impacts from additional activity from the trucking industry will be estimated.

Chapter 2 will be a review of recent literature on the economics of the ethanol industry. Topics covered will be the government policies and programs that support increases in ethanol production in the coming years. Several studies of the impact of ethanol plants on their surrounding regions will be assessed. Additionally, literature on changes that are occurring in

commodity prices because of ethanol will be evaluated. Articles on impacts that accrue to transportation will also be appraised. Finally, misconceptions that are often circulated by less informed researchers will be examined.

Chapter 3 will examine the cotton acreage to corn acreage switch that occurred in 2007. Corn prices were at recent highs and famers chose to plant additional acres of corn in order to earn increased profits. This not only affected the revenue of the farmers, but also the revenue of the local cotton gins and corn elevators, not to mention the industries that supply farm inputs. Since revenue flows through the economy, the effect on all state industries can be shown using input-output multipliers. The total effect of this switch on the Louisiana economy will be meticulously analyzed.

Chapter 4 will determine the benefit to Louisiana from the creation of an ethanol industry within the state. Using a linear programming model, the least-cost distribution of ethanol plants that can completely utilize the existing corn production contained in the northeast region of Louisiana will be ascertained. Once the number and location of the ethanol plants are known, a farmer premium for each supply point will be calculated based upon the amount of output and the distance from its assigned plant. A premium for the trucking industry will also be determined based on whether there was a net increase in transport distance. The sum of the premium for the farmer and the sum of the trucking premium will be entered into an input-output model to determine the direct and total impacts on the state economy.

Finally, chapter 5 will provide a conclusion for the entire body of research contained in the chapters preceding it. It will review the objectives and describe how they were accomplished through the research. It will summarize all the results and will explain what relevance they have to the state and local policymakers and stakeholder groups. Last, it will provide areas where

further research should be undertaken in order to improve upon the findings that were indentified through this project.

CHAPTER 2: LITERATURE REVIEW

This chapter will be a review of recent literature regarding biofuels, and it will be divided into five sections. The first section will describe the public policy and government subsidies associated with biofuels. This will be followed by a section explaining the types of economic impacts that occur within an economy and the multipliers that result from them. It will review several studies that calculate economic impacts and multipliers for ethanol production facilities. The third section will describe rising crop prices, specifically the effect that ethanol production might be having on these prices. After this section, there will be a section covering transportation issues and impacts. The final section of the literature review will examine common misconceptions and errors that are found in articles on the effects of ethanol production.

Government Policy toward Ethanol

In recent years, The U.S. government has shown considerable interest in and support for biofuels research and production. The Energy Policy Act (EPAct) of 2005, for example, set specific guidelines for increasing the production and use of biofuels. This act included four notable provisions (Eidman, 2007). First, it created the renewable fuels standard (RFS), which required that 7.5 billion gallons of biofuels be used in the U.S. by 2012. By 2013, 250 million gallons of biofuels had to be cellulosic in origin. Next, the act removed the reformulated gasoline 2.0 wt. % standard, providing more flexibility for refiners; however, it augmented the air quality standards established by this program. Third, this act retained the federal winter oxygenate program. Lastly, the EPAct refrained from establishing liability protection or a remediation fund for firms using methyl tertiary butyl ether (MBTE) as an oxygenate, which motivated those firms to switch to producing reformulated gasoline with ethanol (Eidman, 2007).

Other provisions from EPAct 2005 were found on the United States Department of Energy website (United States Incentives and Laws, 2008). One was the Alternative Fuel Infrastructure Tax Credit, a credit that covered 30% of the cost of installing alternative fueling equipment, up to $30,000. Another provision was the Small Ethanol Producer Tax Credit, which gave firms producing less than 60 million gallons per year (MGY) an income tax credit of $.10 per gallon for the first 15 million gallons produced. Lastly, a Small Agri-Biodiesel Producer Tax Credit was created. This tax credit followed the same guidelines as the small ethanol producer one, but it was for entities producing diesel fuel exclusively from virgin oils and animal fats.

The U.S. has introduced several policies to support ethanol in particular. In 2004, the Volumetric Ethanol Excise Tax (VEETC) was passed. This tax credit provided a blender of ethanol and gasoline with a refund of $0.51 per gallon. This is one of the largest subsidies for ethanol production. The major U.S. protectionist policies for ethanol production are an ad valorem tariff of 2.5% of the product value on imported ethanol and a secondary duty of $.54 per gallon (Eidman, 2007).

Two additional tax incentives from United States Incentives and Laws (2008) were the Biodiesel Mixture Excise Tax Credit and the Biodiesel Income Tax Credit. The mixture tax credit gave eligible biodiesel blenders $1.00 per gallon of pure agri-biodiesel (soybean based) blended with petroleum diesel or $0.50 per gallon of other pure biodiesel (waste grease based) blended. Alternatively, the income tax credit offered $1.00 per gallon of pure agri-biodiesel or $0.50 per gallon of other pure biodiesel to any entity which either delivered pure, unblended biodiesel (B100) into the tank of a vehicle or used B100 as an on-road fuel in their trade or business.

In December 2007, the Energy Independence and Security Act of 2007 enlarged the requirements of the RFS program (United States Incentives and Laws, 2008). Nine billion gallons of renewable fuels must now be used in 2008, and 36 billion gallons must be used by 2022. A yet to be determined percentage of biofuels must be advanced and/or come from cellulosic sources by 2013. Advanced biofuel was defined as “any renewable fuel, other than ethanol derived from corn, derived from renewable biomass that achieves a 50% greenhouse gas (GHG) emissions reduction. Cellulosic biofuel was defined as “any renewable fuel derived from cellulose, hemicellulose, or lignin that achieves a 60% GHG emissions reduction.”

The state of Louisiana has also implemented policies for biofuels production and use (Louisiana Incentives and Laws, 2007). One incentive that exists is the Alternative Fuel Vehicle (AFV) and Refueling Infrastructure Tax Credit. This tax credit will cover 20% of the cost of either converting a vehicle to operate on an alternative fuel, purchasing an Original Equipment Manufacturer (OEM) AFV, or constructing an alternative fuel refueling station. The tax credit cannot exceed 2% of the total cost of the vehicle or $1,500, whichever is less, for the purchase of an OEM AFV.

A number of laws were passed in recent Louisiana legislative sessions. Some examples of these laws are the Biofuels Feedstock Requirements and the Renewable Fuels Standard (Louisiana Incentives and Laws, 2007). The Biofuels Feedstock Requirements are that a renewable fuels plant operating in Louisiana and deriving ethanol from corn must use Louisiana corn crops for at least 20% of the facility’s total feedstock for the first year. After the first year, the percentage of Louisiana corn used by the plant must be at least as much as the percentage of corn used nationally to produce renewable fuel as reported by the U.S. Department of Agriculture's (USDA) Office of the Chief Economist. This law also requires that a Louisiana

plant creating biodiesel from soybeans and other crops must use Louisiana soybean crops for at least 2.5% of the facility's total feedstock for the first year. After the first year, the percentage of Louisiana soybeans used by the plant must be at least as much as the percentage of soybeans used nationally to produce renewable fuel as reported by the USDA Office of the Chief Economist.

The Renewable Fuels Standard states three conditions. First, if at some future date the cumulative monthly production of denatured ethanol produced in the state equals or exceeds an annual production volume of at least 50 million gallons, within six months, 2% of the total gasoline sold by volume in the state must be denatured ethanol produced from domestically grown feedstock or other biomass materials. Second, if at some future date the cumulative monthly production of denatured biodiesel produced in the state equals or exceeds an annual production volume of at least 10 million gallons, within six months, 2% of the total diesel sold by volume in the state must be biodiesel produced from domestically grown feedstock. Last, if at some future date the monthly production of an alternate renewable fuel capable of substituting for ethanol and biodiesel produced in the state equals or exceeds an annual production volume of at least 20 million gallons, within six months, 2% of the total motor fuel sold by volume in the state must be the alternate renewable fuel produced from domestically grown feedstock.

The previous section discussed the support that exists at the federal and state levels for increased biofuels production. So far, corn-based ethanol has been favored, but policy makers believe that cellulosic ethanol should replace corn in the future, and they have legislated accordingly. The next segment will review literature on the effects that ethanol production has on the economy.

Economic Impacts and Multipliers

This section will begin by defining terms used when discussing economic impacts, and then it will review research conducted in this area. An economic impact is an "instance where it is clear that a change in industrial production in a region either enhances regional economic product (i.e. value added) or reduces regional economic product" (Swenson 2006). Economic impacts are often measured as *direct effects*, those that involve the production process and the output of the product; *indirect effects*, those that originate from the industries supplying inputs for the product; and *induced effects*, those that result from the individuals involved in the production process and the input supply process spending the proceeds that they earned. These three effects added together provide us with the amount of *total effect* that the industry has on the economy.

The effect of an industry on an economy is often measured by the multiplier ratio associated with that industry. To calculate a multiplier ratio, one must divide total economic activity by direct activity. Multipliers show the relationships that exist between the original and the subsequent effects, and they are generally calculated in the measurable areas of industrial output, value added, and jobs. The many studies reviewed for this paper provided different multipliers for each study region (Fortenberry and Deller, 2006; Swenson and Eathington, 2006; Low and Isserman, 2007; (Kebede, Duffy, Zabawa, 2006); Urbanchuck, 2007).

Fortenberry and Deller (2006) from the University of Wisconsin-Madison/Extension developed a computer program that would estimate the impacts that biofuels production would have on their state. Since the software commonly used to conduct input-output calculations, IMPLAN (Minnesota IMPLAN Group 2004), does not contain a biofuels sector, the researchers developed their own program using impact ratios for each of the sectors that they believed

biofuels production would affect. The program allowed for three plant configurations, a 4 MGY biodiesel plant, a 10 MGY biodiesel plant, and a 40 MGY ethanol plant. It was designed to take the direct effects from the plants in the areas of jobs, industry output and total income and to calculate the subsequent effects.

The multipliers that they found for the 4 MGY biodiesel plant were 1.70 for jobs, 1.11 for industry output, and 2.08 for total income. The first 1.0 of the multiplier is the direct effect, and the remainder represents the additional effects. In other words, for this plant, for every one job created within the plant another 0.70 jobs was created outside the plant. For the 10 MGY biodiesel plant, the multipliers were 2.55 for jobs, 1.09 for industry output, and 3.41 for total income. Finally, for the ethanol plant, the multipliers were 4.40 for jobs, 1.68 for industry output, and 1.75 for total income. This research found that the biodiesel plants had a greater additional effect on income for the economy, but it found that the ethanol plant had a larger additional impact on jobs.

One quality set of multipliers came from the research done by a team from Iowa State University (Swenson and Eathington, 2006). These multipliers should have been more reliable than the multipliers created by other researchers because a greater level of critical analysis was put into the research. This was represented by the researchers removing ethanol production's effect on corn production from the input-output software's calculations. The software would have assumed that there would be additional corn production caused by the ethanol industry, but the corn used by the ethanol industry came from the existing supplies. Therefore, the multiplier would have been inflated and the estimated effects would have been exaggerated. Many other studies do not clarify whether or not they accounted for this effect.

The ISU researchers placed a hypothetical 50 MGY dry-mill ethanol plant in a three-county region in Iowa that did not contain a plant at the time. The study found the total effect on regional output to be $133.5 million with a multiplier of 1.13, the total effect on value added to be $25 million with and multiplier of 1.38, and the increase in jobs to be 133 with a multiplier of 3.79. The study then went further and empirically showed that increasing the amount of local ownership of the plant would produce an increase in the output, value added, and jobs and their corresponding multipliers.

Another study conducted by researchers from the University of Illinois examined the sites for three ethanol plants that have yet to become operational (Low and Isserman, 2007). The first site was for a proposed 100 MGY facility in the mixed rural, metropolitan Kanakee County. The second site was for a proposed 60 MGY facility in the mixed rural, micropolitan Cole's County. The last site was for a proposed 100 MGY facility in the rural Hamilton County. The research found that the 100 MGY plants produced $214.6 million in sales and created 39 jobs (direct effects) and that the 60 MGY plant produced $128.8 million in sales and created 35 jobs. However, the differences in location caused there to be large differences in the subsequent effects. Due to its larger population and economy, Kanakee had total output of $247.6 million and total jobs creation of 248 when compared to Hamilton, which had total output of $230.8 million and total jobs creation of 153. Cole's had total output of $147.2 million and total jobs creation of 152, nearly that of Hamilton. The more complex economies within Kanakee and Cole's allowed larger multiplier effects to occur within their local economies. This study did not calculate the actual demand multipliers, so they were computed here. For Kanakee, the output multiplier was 1.15 and the jobs multiplier was 6.41; for Cole's, the multipliers were 1.14 and 4.35; and for Hamilton, the multipliers were 1.08 and 3.92.

This study also calculated the effect of the price premium received by farmers, assuming that it would be capitalized into the farmland value within one year. The researchers assumed 45% local land ownership, 3.5% of the land value as rent, and a price premium of $0.05 per bushel, which converted to a 1.4% increase in the land value. The land rent charges that resulted from the price premium added $331,000 and 2.2 jobs to Kanakee, $153,000 and 1.0 job to Cole's, and $75,700 and 0.2 job to Hamilton (Low and Isserman, 2007).

Additionally, the researchers from Illinois calculated the effect of farmers planting additional acres of corn and reduced acres of soybeans. They assumed that there would be negligible increase in labor associated with changing crops, as could be expected. The output multipliers were 1.60, 1.33, and 1.13 for Kanakee, Cole's, and Hamilton respectively. Since the direct effect on jobs was negligible, multipliers cannot be calculated. However, the more developed counties had proportionately higher indirect and induced effects.

Finally, the study attempted to predict the effect of cattle production moving to the area to feed on the distillers dried grains with solubles (DDGS), a by-product of the ethanol production process. Hamilton was the only county studied because it was the only one where the opportunity cost of raising cattle was low enough. They postulated that cattle raising would triple from 3,000 to 9,000 head (there would be enough DDGS to feed 100,000 head, but the change would not be immediate). The effect was additional total output of $8.3 million and jobs of 59.4.

Some researchers from Tuskegee and Auburn prepared a report on ethanol feasibility for the state of Alabama (Kebede, Duffy, Zabawa, 2006). Their report studied two hypothetical plant sizes, 15 MGY and 30 MGY. The larger plant was found to be more cost efficient, but the corn crop land was considered to be insufficient for that level of production, so the 15 MGY size was

chosen. Using an IMPLAN input-output model, the plant was found to create an additional $30 million in total output and $23 million in total value added.

A study conducted by a director for the LECG LLC (Urbanchuk, 2007) measured the economic impacts from the ethanol industry at the national level. The ethanol related impacts it found were proportionately larger than those of the other studies. In some cases, the impacts almost seem too large. According to this research, the gross output from ethanol in terms of operations costs, transportation costs, and capital costs for construction was $41.9 billion, which was an increase in GDP of $23.1 billion. Additionally, the study stated that 163,034 jobs were created in all sectors of the economy because of ethanol operations and construction.

If one examines the jobs number and divides it by the number of existing ethanol plants, 163,034 / 113 = 1443 total jobs supported on average by each plant (Urbanchuck, 2007). Swenson (2006) states that for a 100 MGY ethanol plant, the most jobs within the plant would be 60. Therefore, 1443 / 60 = 24, (total jobs / direct jobs = jobs multiplier). A jobs multiplier of 24 is five times larger than the other studies calculated, and that is using high-end estimates.

Other amounts from the Urbanchuck study were an increase in labor income of $6.7 billion, $2.7 billion in Federal taxes, $2.5 billion from the VEETC, and $2.2 billion in additional taxes to local and state governments.

Table 2.1 summarizes the plant sizes, total impacts, study regions, and multipliers for the previously discussed research. Output multipliers ranged from 1.08 to 1.68, and jobs multipliers ranged from 3.79 to 24.04.

Table 2.1 Summary of Impact Studies

Reference	Plant Size(s)	Total Impact	Region	Multiplier
Fortenberry and Deller, 2006	4 MGY Biodiesel, 10 MGY Biodiesel, 40 MGY Ethanol	NA	Wisconsin	Ethanol: Output: 1.68, Labor Income:1.75, Jobs: 4.4
Swenson and Eathington, 2006	50 MGY Ethanol	Output:$133.5 million, Value Added: $25 million, 133 Jobs	Three county region, Iowa	Output: 1.38 Value Added: 1.13 Jobs: 3.79
Low and Isserman, 2007	60 MGY Ethanol,	Output:$147.2 million, 152 Jobs	Cole's, IL	Output: 1.14, Jobs: 4.35
	100 MGY Ethanol	Output:$230.8 million, 153 Jobs	Hamilton, IL	Output: 1.08, Jobs: 3.92
	100 MGY Ethanol	Output:$247.6 million 248 Jobs	Kanakee, IL	Output: 1.15, Jobs: 6.41
Kebede, Duffy, Zabawa, 2006	15 MGY Ethanol	Output: $30 million Value Added: $23 million	Alabama	NA
Urbanchuck, 2007	NA	Labor Income: $6.7 billion, 163,034 Jobs	United States	Jobs: 24.04

Commodity Price Effects

This section will review another area that is being affected by increasing ethanol production, crop prices, specifically corn prices. Historical data show that the price of corn has increased substantially, as ethanol production has increased, but this trend may not be indicative of the long-term effects.

One study on the effect of corn prices was conducted by a team of researchers from South Dakota State University (Olsen, Klein, and Taylor, 2007). This research attempted to use linear regression to measure the ethanol's effect on the corn basis, which is the difference between a commodity's future price and local cash price. The findings were a $0.24 impact in 2005 on the corn basis for a region that represented the major corn producing districts in South Dakota.

Within the individual districts, the impact on the corn basis varied between $0.04 and $0.27. If an additional 40 MGY plant were constructed, the impact on the individual districts would vary between $0.06 and $0.16, and the impact on the "State" would be $0.03. A 100 MGY plant would produce an impact of $0.16 to $0.40, depending on the district, and the "State" would experience and increase of $0.08.

Two researchers from Montana State University completed a slightly different study that examined the effect on the corn basis (McNew and Griffith, 2005). Their study considered twelve ethanol plants located in the U.S. Midwest and focused on three topics. First, they planned to determine whether the price received by producers affected the opening of a new ethanol plant and by how much. Next, they wanted to determine whether the producer received a different price depending on his/her distance from the plant. Lastly, they tried to determine whether the producer received a different price for his/her product depending upon whether he/she was upstream from the ethanol plant (the plant was between the producer and his previous end market) or downstream from the plant (the producer was between the plant and his previous end market). They discovered that the regions around the plants that they studied had, on average, a $0.059 increase in the corn price basis. Additionally, the average price at each plant site was $0.125 higher than the price for the entire surrounding region, suggesting that the price impact was clustered around each plant. Finally, eight of the twelve plant/regions were consistent with the upstream/downstream theory. This meant that upstream producers would receive an equal price impact due to the distance to the end market decreasing by an equal amount. The downstream producers, however, would receive a price impact that changed depending on how far the producer was from the plant. Distant producers would receive a smaller price impact than the nearby ones would. Distance and transportation will be further examined in the next section.

Transportation Industry Impacts

Gallagher, Wisner, and Brubaker (2005) developed three alternative spatial models of corn price determination at the ethanol plant and in the market area surrounding the plant. The research showed that the farmer's corn price changed proportionately to the change in transport costs. Transport costs are an important factor when examining the effects of ethanol production, but they can easily be misused to show effects that are not actually occurring, which will be further discussed in the following section.

Limitations to Ethanol Impact Studies

Certain individuals and organizations have produced analyses on the effects of biofuels production that may not be accurate portrayals of these effects. If they fail to apply a substantial level of scrutiny to their own work, they could be putting the policy makers at the national, state, and local levels at risk of making decisions that have the potential to influence the U.S. economy negatively in the years to come. Therefore, an increasingly common subject for researchers is inspecting and sometimes discrediting studies they consider flawed.

One study conducted by an economist from Iowa State University specifically targeted the topics within biofuels research that typically have had the greatest chance for errors or logical inconsistencies (Swenson, 2006). The first topic was cause and effect, which was represented by researchers using the final demand multipliers to predict marginal changes in the economy. Since multipliers assume fixed prices and times, they cannot necessarily predict what will occur if prices change.

The second topic discussed was the nature of an economic impact, using the corn production and trucking industries as examples. An "impact" is considered an external agent that is increasing final demand, which can then be met by increased output. In input-output analysis,

it is assumed that final demand can be met by an industry sector obtaining an unlimited supply of inputs. However, in ethanol production, there is only a finite supply of corn, which does not change measurably with the increase in demand. Demand from ethanol simply shifts the corn production from export or domestic food/feed supply to itself. Therefore, no new impacts occur on the corn production side. Likewise, the trucking and transport sector will not experience dramatic change because the total amount of corn bushels being shipped does not change. Both cases would be considered double counting if we were to assume that ethanol final demand created new economic impacts.

Another topic from Swenson (2006) is declining cost industries. For the electric, natural gas, and water industries, the creation of an ethanol plant in the region would produce a small marginal increase in utility industrial output, not an average increase in output. A large increase in resources demanded would actually produce a minimal change to the industries. The Urbanchuck (2007) research aforementioned does not follow this idea; however, it stated that ethanol supported 19,712 jobs in the electric, natural gas, and water industries.

Producer premium estimates were also a topic that was discussed. According to Swenson (2006), early studies claimed that producers saved $0.10-$0.12 per bushel of corn on shipping, but this researcher found the current average price increase was at most $0.05 for a 30-mile radius around the ethanol plant. Additionally, the savings would not necessarily be considered as income by the farmers. The benefit may not accrue to the farmer at all since the premium would eventually become capitalized into the farmland value, thus reducing the benefit to those farmers who are renting.

Conclusion

This chapter reviewed recent literature on biofuels. It described how the government had created laws and policies, such as EPAct 2005, the Volumetric Ethanol Excise Tax, and the Energy Independence and Security Act of 2007, to support progress in and production of biofuels. Next, this chapter reviewed studies on the impacts that biofuels production, specifically ethanol production, had on the economy. All studies that were presented stated that ethanol production had a positive impact on the economy where it was located, although the studies did not always agree on the magnitude of the impact. Additionally, an economy tended to receive a larger impact if the plant was locally owned or if the plant was located in an urban area. This chapter also found that ethanol production has had a statistically significant effect on commodity prices. The research reviewed in this chapter showed that the farmer's corn price changed proportionately to the change in transport costs. This chapter ended with a meta-analysis of the ways that ethanol research can be distorted. The next chapter will examine the effects of an acreage switch between cotton and corn on the Louisiana economy.

CHAPTER 3: IMPACTS FROM A CROP ACREAGE SWITCH[1]

Introduction

This chapter will accomplish Objective 1, which was to determine how the development of an ethanol industry within the U.S. is affecting the economy of the state of Louisiana through the redistribution of planting acreage of historical agricultural commodities in the state. The following research will describe the recent changes regarding farmers' choices on which row crops to produce and it will discuss the economic effects that have resulted from this switching. Figure 3.1 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 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 3.1, corn had the largest planted acreage in 2007 among the leading row crops.

Figure 3.2 displays farm-plot level data on the changes that occurred in cotton production. In 2007, a 49% reduction in cotton acreage planted occurred within 10 miles of the average cotton gin in Northeast Louisiana compared to 2006. Total acreage within 10 miles of a cotton gin was reduced from almost 27,300 acres to just over 14,000 acres. Similarly, cotton acreage within 20 miles of the average cotton gin fell from almost 89,800 acres to just under 43,900 acres, a 51% reduction. As can be seen from Figure 3.2, larger reductions in cotton acreage occurred as the distance from the Mississippi River increased.

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[1] Adapted from Fannin, J.M., A.K. Paxton, and J.D. Barreca (2008). Evaluating the Switch from Cotton to Corn: Impacts on the Louisiana Economy, *Louisiana Agricultural Experiment Station Bulletin*..

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 less 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.

Figure 3.1 Planted Acreage, Cotton, Corn, and Soybeans, Louisiana, 1995-2007.

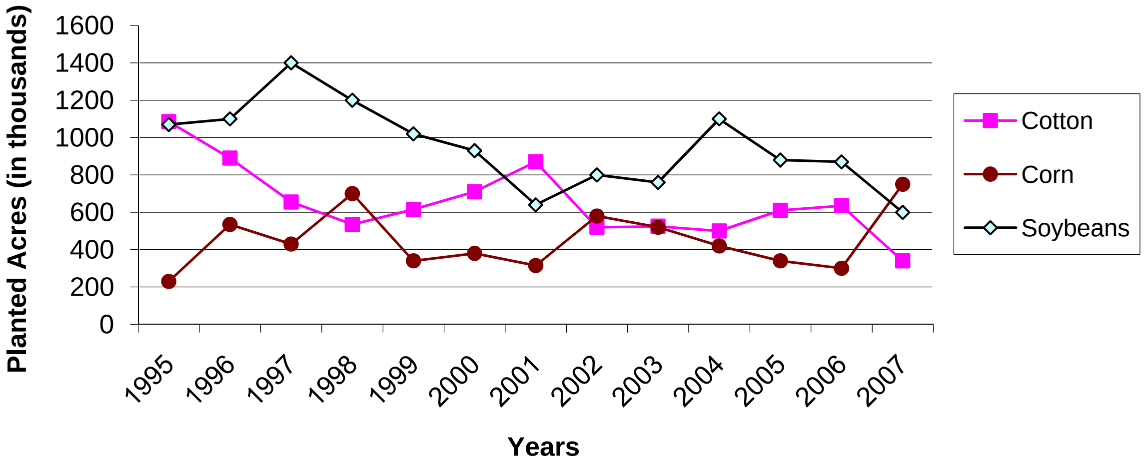
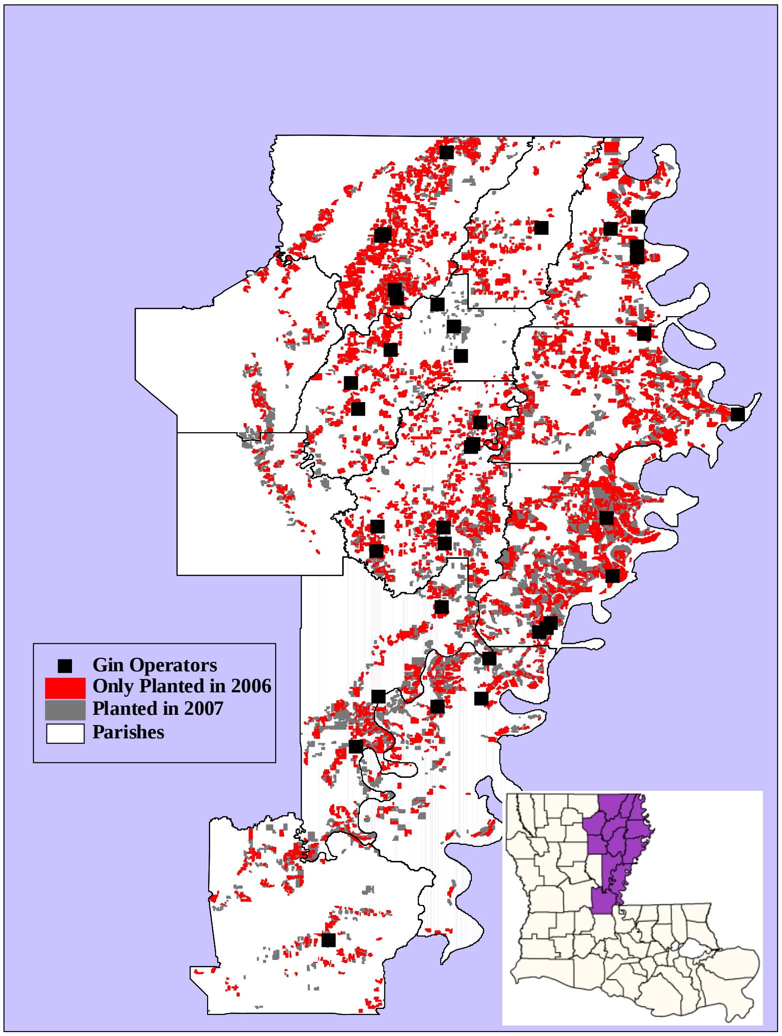


Figure 3.2 Difference in Cotton Acreage Planted for Years 2006 and 2007



Expenditure Profiles – Corn vs. Cotton

To understand better the tradeoffs from switching between cotton and corn, the costs of producing both cotton and corn must first be identified. Budgets for both corn and cotton are constructed based on an average of cost and returns budgets prepared by Paxton (2007). The budget for producing an acre of corn is presented in Table 3.1, followed by the cost of producing an acre of cotton in Table 3.2. 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 are discussed below.

Table 3.1 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	15.32
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 3.2 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. These higher expenses occur in a number of categories. For example, custom application costs are over 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 over 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 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 3.3 and 3.4, the cost 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 have been estimated.

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

Table 3.3 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 3.4 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 non-labor input costs, operating margins (returns above variable costs) are also earned by the farmers as well as the proprietors of the cotton gins and local elevators. Both the purchasing of the inputs as well as 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, how the Louisiana economy is impacted by expenditures on the production and processing of corn and cotton must be understood. What first needs to be indentified is how much spending occurs on production and processing inputs within the borders of Louisiana. What next needs to be identified is how the sectors to which these inputs are purchased interact with other sectors within the Louisiana economy.

Local spending

There are three main key categories of in-state spending. The first includes those material inputs, which 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 this analysis, inputs such as fertilizer, herbicides, insecticides, and seed are considered a part of this input class. For example, almost all fertilizer in Louisiana for cotton and corn production is purchased from in-state retailers or wholesalers; however, the raw fertilizer materials come from outside of Louisiana, and in many cases, outside the United States altogether[2].

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.

[2] 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.

Diesel and gasoline purchased by farmers include both an impact to the Louisiana economy through the margins received by retailers, wholesalers, and haulers (truck, barge, and rail) as well as refineries that produce the manufactured product within the state.

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 will initially stay within the state.

In addition to the material inputs and services, both production and post-harvest processing activities generate a gross operating margin, which 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 non-local (out-of-state) spending on farm inputs are 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[3]. 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

[3] 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.

example, a multiplier of 3.0 for corn would be interpreted as for every one dollar of change in demand for corn, there is a total change of three dollars 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 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 U.S. 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, the strategy used here 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. The approach used is to develop new sectors outside the model, treat them as changes in final demand, and then 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. The production functions from 2007 cost and returns estimates for both cotton and corn were recreated. 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, the distribution of gross margin, one of the key value-added elements of production, was improved by specifying the farm household consumption function based on household income levels. Finally, a similar strategy was taken by re-recreating two of the post-processing activities 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

In order to estimate the net economic impact to Louisiana from the switching of cotton acreage to corn in 2007, a development scenario based on the approach of the previous section was first created. The scenario was like a "what if" analysis where it was asked what happens when the production of one commodity is reduced as the production of another commodity is increased.

In this case, the first item to be identified was 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, it was assumed that 100% of the reduced cotton acreage (295,000 acres) is transferred into corn acreage for 2007.

To estimate the net impact from the acreage transfer, the total local expenditures by detailed category to plant an acre of cotton and corn was first estimated by applying the budgets in Table 3.1 for corn and Table 3.2 for cotton. It was assumed that 100 percent 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 level. 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 percent of landowners and 100 percent 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.[4] In addition to production activities, the net effect on the switch from cotton to corn on postproduction activities in Louisiana was also estimated. While it is difficult to identify exactly in the postproduction 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 3.4). 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 non-resident transient workers, it was assumed that 80 percent 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 -

[4] One may also make the argument that additional equipment was purchased by farmers that 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 multi-year phenomenon in the state, it would be expected that more equipment would be purchased in the long run. The authors thank the reviewers for bringing out this point.

$100,000 annual spending profiles[5]. Similarly for corn, elevator costs for drying were distributed across multiple input categories (Table 3.3) and gross operating margins 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.

Results

In this section, the main economic impacts measured in terms of output, value added, and employment are presented. 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 difference 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 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.

[5] It should be noted that it was assumed that 100% of the proprietary income would be treated as household income and spent according to a household consumption function. It is recognized 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 both corn and cotton proprietary income are treated the same, the net effects should be the same with or without an adjustment for debt payments.

Finally, an industry breakdown of the economic impacts including the net effect on the state economy is presented.

Corn Production vs. Cotton Production

In this section, the net impacts of the consumption of labor and non-labor inputs from corn and cotton production on the Louisiana economy are evaluated. Table 3.5 indicates that the switch from cotton to corn results in a direct net loss of over $13 million from reduced consumption of Louisiana materials and services. When considering the additional reduced spin-off 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).

Table 3.5 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™.

Similarly, 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 3.6, 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 over $350,000 in reduced value added and over $200,000 in additional reduced labor income.

Table 3.6 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™.

Value Added Processing Impacts

Table 3.7 shows the net effect of switching cotton acreage to corn acreage on additional commodity processing in the state. The losses from non-labor 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 dollar 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 3.7 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™.

Further evidence of the reduced processing impacts from labor inputs used is visible in Table 3.8. 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 3.3 and 3.4), 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 over $1.7 million. Value added losses total over $1 million and labor income losses exceed $500,000.

Table 3.8 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™.

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. Table 3.9 displays 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 over $16.4 million and labor income of $8.9 million.

Table 3.9 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**

Source: IMPLAN™.

Combined Effects

In Tables 3.10 – 3.12, the combined effects on output, value added and employment from the switch of 295,000 acres from cotton production to corn production are presented. According to Table 3.10, 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 spin-off effects, the net total effects are slightly under $750,000, or 0.57% above the impact when the same acreage was in cotton.

Table 3.10 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**

Source: IMPLAN™

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 planted. 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 in this scenario. The cotton multiplier can be interpreted as for every one dollar of increase in the inputs purchased or incomes earned in Louisiana to grow, harvest, or process cotton, there is a $1.66 increase in total output across all sectors of the Louisiana economy. The corn multiplier is interpreted similarly. Hence, in this scenario, for every one-dollar increase in direct spending or incomes earned in the cotton sector, there is a two cent greater overall multiplier effect on output in Louisiana than a similar increase in direct spending in the corn sector.

In Table 3.11, it should be noted 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 $0.62 cents out of every dollar of output was value added in the cotton scenario compared to only $0.60 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. Interpreted, for every one dollar 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 $0.60 of indirect and induced (or multiplier) effects.

In Table 3.12, results indicate that a similar situation exists for labor income effects as was experienced for value added. The net direct effect of replacing 295,000 acres of cotton with a corresponding 295,000 acres of corn is reduction in labor income created of $2.1 million. 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 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.

Table 3.11 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**

Source: IMPLAN™.

Table 3.12 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	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**

Source: IMPLAN™.

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 pay-off. Existing secondary data sources such as 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 no known research previously conducted that has analyzed this issue. Hence, a sensitivity analysis was performed by varying two key variables in the model: price and debt reduction. A range of corn prices and a range of debt reduction scenarios are provided which are the percentages of total proprietary income that is 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 and individual farmer's corn crop. These costs are accounted for in the corn budgets presented in Table 3.3. These various net proprietary income levels are then applied to the IMPLAN model to estimate alternative output effects in Table 3.13.

Table 3.13 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

Source: IMPLAN™.

The baseline scenario used in the previous tables was a corn price of $3.25/bu and a 0% debt reduction level (See Table 3.9). 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 a $2.50 average price per bushel growing season with a 10% debt reduction level is compared to a $3.50 average price per bushel with the same level of debt reduction, a 270% increase in output on the state economy occurs. Using the same example

scenario (tables not shown), value added increases from $7.44 million to $27.62 million and labor income increasing from $4.04 million to $14.98 million.

Table 3.13 shows that a small change in prices/debt reduction assumption can have measurable impacts on the state economy. If it were assumed that 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 3.10 to over $5 million. The same scenario would switch the negative net effect on value added to a positive effect and would reduce almost half of 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 over 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 that 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 from 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 locations where they purchase farm inputs and the locations where their households spend disposable income 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 re-circulate 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 are likely to occur in regional trade centers. For Northeast and Central Louisiana where the overwhelming proportion of cotton and corn are grown, these trade centers are likely to include Monroe and Alexandria to the west, and Greenville, MS, Vicksburg, MS, and Natchez, MS, to the east. Hence, a measurable proportion of retail trade and service items purchased by farm households are likely to "leak" into urban centers of Louisiana or outside of 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 increased 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 of 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 received 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 their cotton base. These forces led to over 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 have been historically 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 level. 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, then a lack of ginning infrastructure created by a short-term multi-year 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 product.

Conclusion

This chapter evaluated the economic impact to the Louisiana economy from a switch of 295,000 acres of cotton production to corn production. In particular, it improved on existing research strategies to measure these effects by creating new 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 SAM 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 was planted and harvested on the same acreage. Value added is expected to decrease by slightly over $650,000, or a reduction of 0.89% in value added if cotton was planted and harvested. A $1.97 million dollar loss in labor income is expected from the switch from cotton to corn, an expected reduction of 4.16% compared if the same land was planted only 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 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 conducted to identify the geographic distribution of farm and farm household spending to better project which regions are more positively or more negatively impacted within the state.

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 farm households. This research has the two-fold effect of estimating regional (individual parish or multi-parish) economic impacts as well as providing individuals and businesses a guide as to gaps in locally available or economic affordable farm inputs. Second, a technical efficiency analysis should be conducted of cotton ginners 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 giving varying output levels of cotton production in the state and varying transportation costs. These studies will better help the ginning industry assess their long-term viability and make strategic investment decisions in a more uncertain cotton production environment.

The research contained in this chapter assumed that the value added processing impacts for Louisiana for corn ended with the grain elevators and that any further value added activities occurred elsewhere. However, if additional processing took place within the state, such as converting the corn to ethanol, the economic impacts could be significantly greater. An ethanol plant or a series of ethanol plants would bid up the price for corn that LA farmers were receiving, providing additional income to farmers. This additional income could then trickle down to other industries through indirect and induced effects. The effects on farmer income from the development of ethanol production will be the topic of research for the next chapter.

CHAPTER 4: IMPACTS FROM AN ETHANOL INDUSTRY

Introduction

This chapter will accomplish Objective 2, which was to determine how a proposed distribution of ethanol plants within Louisiana would impact the state economy. A linear programming model will be used to establish the distribution, and input-output analysis will be used to measure the impacts. Chapter 3 compared the impacts of a loss in cotton production and in ginning to a gain in corn production and drying/handling. It determined that there would be a gain in output, but a loss in value added and labor income. This chapter seeks to go further into evaluating the impact that higher corn prices can have on the Louisiana economy. The previous chapter determined the passive impact that ethanol was having on the state. However, this chapter will ascertain the impacts that would result from an active Louisiana ethanol industry.

To start the research, two items needed to be decided regarding location. The first was in what region of the state the ethanol industry should locate itself. The northeast region of Louisiana was chosen since it is where corn production is concentrated (2007 Louisiana Summary). The next item that needed to be decided was how to determine where ethanol plants would locate themselves within the region. The locations of the region's seventeen riverside grain elevators were chosen since these locations would already have a substantial water and road transportation infrastructure. Corn drying/handling and ethanol production are weight-losing processes, meaning the input is bulkier than the output. Therefore, these industries position themselves nearest the input base, allowing transport costs to be minimized (Shaffer, Deller, Marcoullier, 2004).

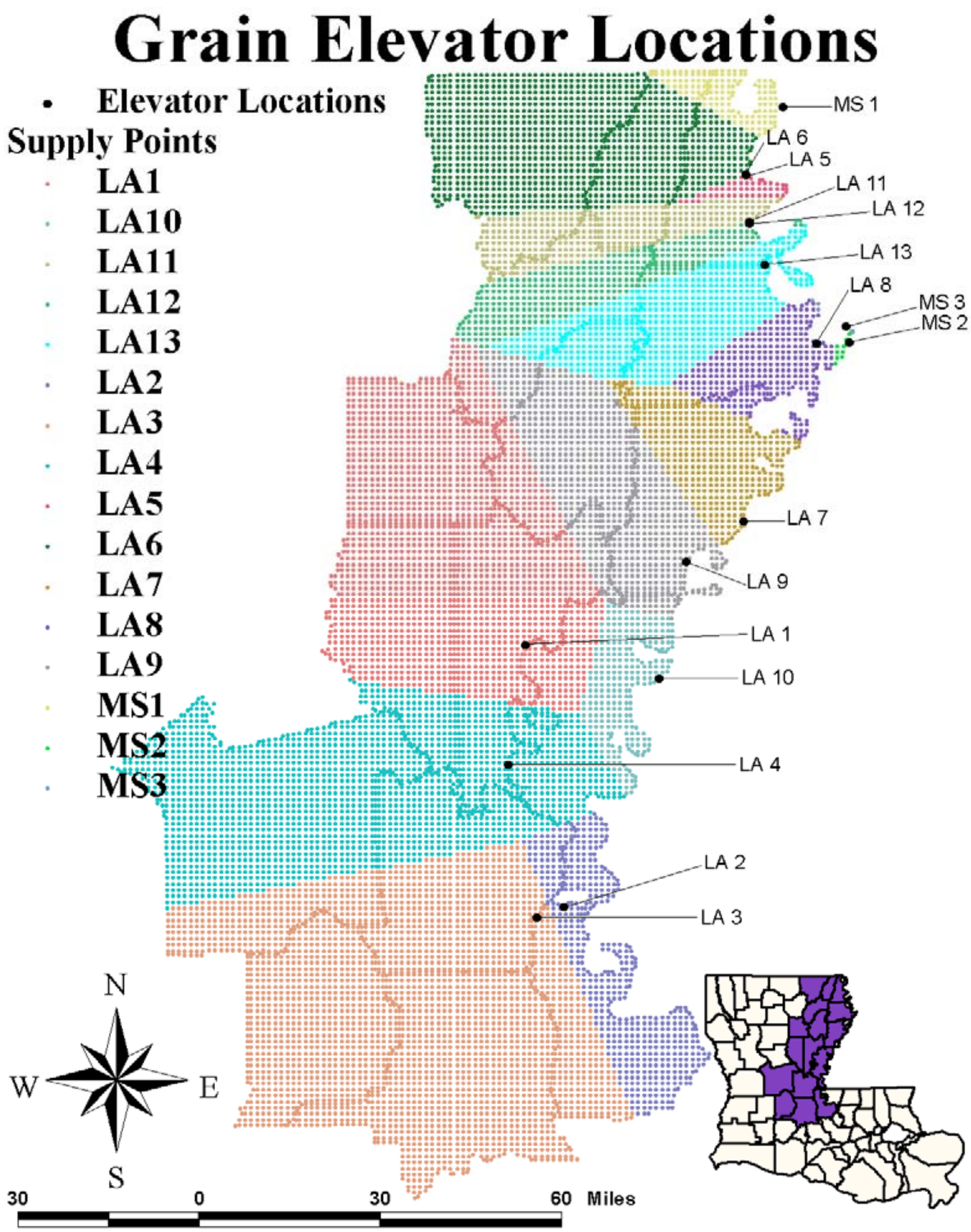
Data collection methods

There were seventeen ports with grain elevators on the Atchafalaya, Black, Mississippi, Old, and Ouachita Rivers and their river systems (Port Series 68, 2000; Port Series 72, 2003). Two ports had the same longitude and latitude, so one was excluded bringing the total to sixteen. The locations of the ports were then imported into the Arcview 3.3 geographic information system (GIS) software (Arcview, 2002).

In 2007, the state of Louisiana produced almost 122 million bushels of corn (2007 Louisiana Summary). However, the region being analyzed only produced slightly more than 107 million bushels of corn. At a conversion ratio of 2.5 gallons of ethanol to one bushel of corn, a 50 million gallon per year (MGY) facility would require 20 million bushels of corn to operate over an entire 12 month period. Therefore, this region could potentially support only five 50 MGY plants if all corn went into ethanol production. Since corn production data at the farm plot level was unavailable, an assumption was made that each parish's corn production would be evenly distributed across the entire geographic surface of the parish. To operationalize this assumption, corn production for each parish was divided by the total acres within the parish.

Using Arcview, each of the parishes was overlaid with one square-mile grids. Then, the grids were cut using the parish lines. Grids split between two parishes were adjusted based on the number of acres of the grid in the respective parish times the average yield per acre. After this, the centroid point was found for each grid or partial grid, producing 12,723 supply points. Finally, the distance was calculated from each supply point to each potential plant location. At this point, having determined the production quantity and distance for each supply point, the data could be entered into the statistical model (Figure 4.1).

Figure 4.1 Grain Elevator Locations with Nearest Supply Points Assigned



Source: Arcview™.

The Statistical Model

To start, this optimization problem was an excess demand problem. The sixteen potential plant locations had to be reduced to five. Then, once the locations were reduced to five, the

model became an excess supply problem in order to account for all of the existing production contained within the region.

There were sixteen ethanol plant locations being considered or demand points (j = 1, … , 16) and 12,723 supply points (i = 1, … , 12723). The two variables were the distance from a supply point to an ethanol plant (D) and the amount of output at a supply point (X). Therefore, the linear programming (LP) formula was the following:

$$
\begin{aligned}
(4.1)\ \text{Min } Z = \ & D_{11}X_{11} + D_{12}X_{12} + \ldots + D_{1j}X_{1j} \\
& D_{21}X_{21} + D_{22}X_{22} + \ldots + D_{2j}X_{2j} \\
& \ldots \\
& D_{i1}X_{i1} + D_{i2}X_{i2} + \ldots + D_{ii}X_{ii}
\end{aligned}
$$

The first subscript denotes the supply point (i), and the second subscript denotes the demand point (j). This formula was subject to two constraints. The first was that the amount of corn originating from each supply point could not exceed the total supply for that point.

$$
\begin{aligned}
(4.2)\quad & X_{11} + X_{12} + \ldots + X_{1j} \leq X_1 \text{ bushel supply} \\
& X_{21} + X_{22} + \ldots + X_{2j} \leq X_2 \text{ bushel supply} \\
& \ldots \\
& X_{i1} + X_{i2} + \ldots + X_{ij} \leq X_i \text{ bushel supply}
\end{aligned}
$$

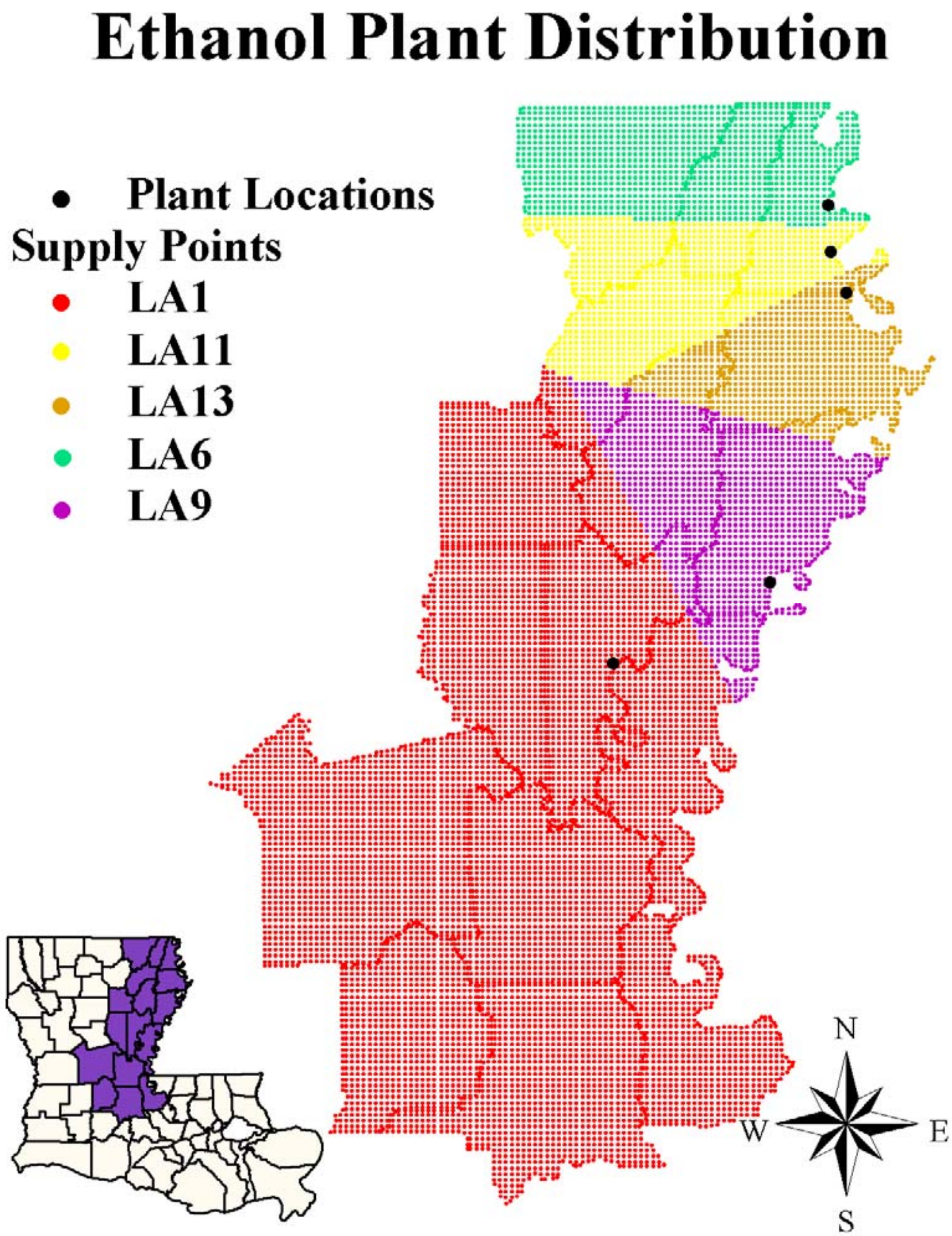
The second constraint was that each plant location had to have its demand fully met.

$$
\begin{aligned}
(4.3)\quad & X_{11} + X_{21} + \ldots + X_{i1} \geq X_1 \text{ port demand 1} \\
& X_{12} + X_{22} + \ldots + X_{i2} \geq X_2 \text{ port demand 2} \\
& \ldots \\
& X_{1i} + X_{2i} + \ldots + X_{ii} \geq X_i \text{ port demand j}
\end{aligned}
$$

The model was run using SAS analytical software as a PROC NETFLOW transportation problem. PROC NETFLOW (The NETFOW Procedure, 2008) is an LP module within SAS that was designed to handle transportation problems specifically. This type of LP model allows one to determine the least cost setup that fully supplies each demand point. The program needed to be run several times, each iteration identifying the highest cost shipment location. This location was then dropped and another iteration run. Eleven iterations occurred until our problem became an excess supply problem.

The output from the model was then placed back into Arcview for further analysis. First, using Arcview, a GIS map was created displaying the demand points and the supply points assigned to each demand point (Figure 4.2). Then, the locations of the demand and supply points were mapped. Next, the distance from each supply point to its assigned plant was calculated, along with the distance from each supply point to what had previously been the nearest port-based grain elevator. Additionally, the distance from each ethanol plant to its farthest supply point was determined. This information was used as follows to determine the premium that a farmer would receive by delivering his produce to the plant instead of the grain elevator.

Figure 4.2 Ethanol Plant Locations with Supply Points Assigned Using a Statistical Model



Source: Arcview™.

Estimating the Premium

Several assumptions were made for this portion of the chapter. First, an elevator is assumed to offer the same price to each of its customers (Gallagher, Wisner, Brubaker, 2005). That is, the grain elevators would offer a single market price for corn. Lastly, the ethanol plants

would offer cargo, insurance, and freight pricing (CIF), that is, the farmer pays to ship the grain from the field to the elevator.

Since we assume the ethanol plant cannot price discriminate (i.e. cannot offer different prices to different farmers), the profit that a farmer would receive for delivering his corn to a grain elevator ($Profit_G$) would be the price received at the elevator (P_G) minus his cost to deliver to his closest elevator (T_G).

$$(4.4)\ Profit_G = P_G - T_G$$

Likewise, the profit for the farmer if the corn is delivered to the ethanol plant ($Profit_E$) would be the price at ethanol plant (P_E) minus farmer's transport cost to deliver to the plant (T_E).

$$(4.5)\ Profit_E = P_E - T_E$$

Since the ethanol plant must bid away the corn from the elevator, the plant's price would need to include a premium.

$$(4.6)\ P_E = P_G + Premium$$

Because the plant must meet its supply requirements, the price must be high enough to bid away the product coming from the farthest supply point, which means that the transportation cost for that maximum distance point (T_{MD}) must be added to whatever price the elevators are paying. Since the price is the same for all suppliers, that transportation cost becomes the premium.

$$(4.7)\ Premium = T_{MD}$$

Using algebra to combine (4.5) and (4.6), the profit formula for delivering to the plant becomes the following:

$$(4.8)\ Profit_E = P_G + Premium - T_E$$

Substituting (4.7) into (4.8), the formula becomes:

$$(4.9)\ \text{Profit}_E = P_G + T_{MD} - T_E$$

Now, what needs to be determined is difference in profit for the farmer between delivering to the plant and the elevator. Summing (4.9) and (4.4), the result is:

$$(4.10)\ \text{Net Profit}_{E\text{-}G} = (P_G + T_{MD} - T_E) - (P_G - T_G)$$

Now the term for price at the elevator can be zeroed out, which reduces to:

$$(4.11)\ \text{Net Profit}_{E\text{-}G} = T_{MD} - T_E + T_G$$

These calculations conclude that the net profit for a farmer who delivers to the plant is the transportation cost for that maximum distance point minus the farmer's transport cost to deliver to the plant plus the farmer's transport cost to deliver to the closest elevator.

The transportation cost per mile came from Truck Transportation (2007). It was found to be $4.68 for a truck with a gross weight of 80,000 lbs. This size vehicle carries 890 bushels of corn (Vachal, 2001), resulting in a cost of $.0053 per bushel per mile.

Results

This section discusses the impacts to the state economy resulting from the corn price premium and the transportation premium. Descriptive statistics of the corn price premium offered by each ethanol plant are presented in Table 1. Since the premium was calculated using the cost of delivering from the farthest supply point, plants with larger supply regions had larger premiums. Plant LA 1 had the highest average premium at $0.39 per bushel since it had the biggest supply region.

Table 4.2 displays the descriptive statistics of the corn price premium at the parish level. The highest premium per bushel was $0.49 and the lowest was $0.12. Caldwell Parish and La

Salle Parish had the highest average premium since the supply points contained by the parish were all far from plant LA 1, their assigned plant.

Table 4.1 Descriptive Statistics of Premium per Bushel Offered by Each Ethanol Plant

	Mean	Std Dev.	Min	Max
LA 1	$ 0.39	$ 0.0878	$ 0.25	$ 0.49
LA 6	$ 0.29	$ 0.0096	$ 0.23	$ 0.29
LA 9	$ 0.24	$ 0.0201	$ 0.15	$ 0.25
LA 11	$ 0.27	$ 0.0013	$ 0.27	$ 0.28
LA 13	$ 0.20	$ 0.0252	$ 0.12	$ 0.22

Table 4.2 Descriptive Statistics of Parish-Level Premium per Bushel for Farmers

	Mean	Std. Dev.	Min	Max
Avoyelles	$ 0.35	$ 0.048	$ 0.25	$ 0.43
Caldwell	$ 0.49	$ 0.000	$ 0.49	$ 0.49
Catahoula	$ 0.45	$ 0.073	$ 0.25	$ 0.49
Concordia	$ 0.40	$ 0.089	$ 0.15	$ 0.49
East Carroll	$ 0.27	$ 0.021	$ 0.22	$ 0.29
Evangeline	$ 0.33	$ 0.025	$ 0.29	$ 0.39
Franklin	$ 0.30	$ 0.102	$ 0.21	$ 0.49
La Salle	$ 0.49	$ 0.016	$ 0.41	$ 0.49
Madison	$ 0.20	$ 0.033	$ 0.12	$ 0.28
Morehouse	$ 0.28	$ 0.006	$ 0.27	$ 0.29
Pointe Coupee	$ 0.26	$ 0.008	$ 0.25	$ 0.28
Rapides	$ 0.43	$ 0.025	$ 0.35	$ 0.48
Richland	$ 0.30	$ 0.080	$ 0.22	$ 0.49
St. Landry	$ 0.27	$ 0.015	$ 0.25	$ 0.32
Tensas	$ 0.23	$ 0.025	$ 0.17	$ 0.25
West Carroll	$ 0.28	$ 0.007	$ 0.26	$ 0.29

The economic impacts of the farmer premium from the price of corn are now discussed. It should be noted that these amounts are not the total impacts of corn production and processing within the economy, but simply the net increase from the creation of a state ethanol industry. The impacts are displayed along three areas – output, value added, and labor income.

The net profit was found for every supply point using the formula presented above. Then, the net profits were summed, adjusted for a 2% out-of-state landowner leakage, and charged a self-employment tax rate of 15.3%. The result was $26.1 million in disposable farm income, which was the initial effect of the price premium. This initial effect was then entered into

IMPLAN as an increase to the $75,000-$100,000 household income bracket (Minnesota IMPLAN Group 2004). This bracket best represents Louisiana corn farmers.

The data displayed in Table 4.3 are presented in terms of direct effects and total effects. Direct effects are those that involve the production process and the output of the product. Total effects are the sum of the direct effects, the indirect effects, which are the effects from the industries supplying inputs for the product, and the induced effects, which are the effects that result from the individuals involved in the production process and the input supply process spending the wages and salaries that they earned (Swenson, 2006).

The direct impact on output was $17.5 million, and the total effect was nearly $27.6 million. The sectors that showed the greatest change were retail trade, health and social services, and government. This could likely be attributed to farmers spending more on discretionary items and the government collecting additional tax revenues. The output multiplier was 1.57, which means that for every direct effect dollar of output, these activities produced an additional $0.57 of output in the LA economy.

As Table 4.3 shows, the direct effect on value added was $10.2 million, while the total effect was just under $16 million. Value added is the difference between the costs of inputs and the revenues from the output created by those inputs for a firm. Value added estimates were included because they show the true additional contribution to the economy and avoid the double counting problem from simply using output. The multiplier for value added was 1.56.

Labor income impacts are also included in Table 4.3. Labor income is a subset of value added measuring the change in wages, salaries, and proprietary income (income to non-incorporated businesses). The direct effect was $5.3 million, and the total effect was $8.6 million. The labor income multiplier was 1.61.

Table 4.3 Economic Impacts in Dollars ($) for a Corn Price Premium Received by Farmers

Sector	Output		Value Added		Labor Income	
	Direct	Total	Direct	Total	Direct	Total
Ag, Forestry, Fishing, and Hunting	42,400	185,325	20,929	70,578	14,119	45,690
Mining	5,629	160,590	2,961	85,854	1,013	30,416
Utilities	285,112	545,943	183,071	356,074	59,047	113,140
Construction	-	214,431	-	98,726	-	82,912
Manufacturing	855,684	1,894,549	179,404	425,011	113,748	275,668
Wholesale Trade	575,096	977,789	437,411	743,694	245,095	416,715
Transportation and Warehousing	313,698	751,437	157,210	415,886	112,311	309,425
Retail trade	2,370,752	3,137,592	1,780,186	2,355,952	1,115,466	1,476,258
Information	424,636	938,414	181,154	406,706	74,947	199,521
Finance and Insurance	962,649	1,832,379	439,501	969,724	248,169	539,309
Real Estate and Rental	354,807	1,236,456	221,454	815,672	75,741	226,524
Professional, Scientific, and Tech Services	291,678	1,037,818	177,789	615,826	142,209	495,670
Management of Companies	-	219,045	-	117,584	-	90,356
Administrative and Waste Services	64,023	552,953	28,879	317,171	21,975	256,650
Educational Services	464,597	566,799	253,917	307,488	249,688	302,081
Health and Social Services	3,385,143	4,269,993	2,044,422	2,576,895	1,779,600	2,243,065
Arts, Entertainment, and Recreation	393,056	516,242	247,311	326,793	159,510	215,418
Accomodation and Food Services	1,372,011	1,865,730	657,241	895,842	449,766	612,674
Other Services	1,078,459	1,510,664	562,304	777,931	435,340	599,880
Government and Non NAICs	3,490,798	4,362,227	2,653,697	3,257,991	67,274	111,485
Institutions	808,940	808,940	-	-	-	-
Total	17,539,167	27,585,313	10,228,841	15,937,397	5,365,016	8,642,858

Source: IMPLAN™.

Trucking Impact

The change in shipping by farmers also provides a net increase in revenue for the trucking industry. Since farmers are now hauling corn an increased distance in order to reach the nearest

ethanol plant, the trucking industry would experience a net positive effect from the additional miles hauled[6]. This premium can be calculated as the distance in miles from a supply point to its assigned ethanol plant ($Dist_E$) minus the distance from the supply point to the nearest grain elevator ($Dist_{NG}$). This sum is multiplied by the transport cost per bushel per mile (T) to find the premium to deliver from that supply point.

$$\text{Trucking Industry Impact} = (Dist_E - Dist_{NG}) * T$$

All of the premiums were summed, amounting to $2.25 million. This additional income was then added to the transportation and warehousing sector in IMPLAN, becoming the direct effect for output. As displayed in Table 4.4, the total effect to output was $4.3 million. The direct effect on value added was slightly over $1.0 million, and the total effect was $2.1 million. For labor income, the direct effect was $750,000, with total effects coming to $1.4 million. The output, value added, and labor income multipliers were 1.93, 2.11, and 1.91, suggesting that every dollar added in direct effects approximately doubled its effect on the state.

[6] It is recognized that some farmers own their own hauling trucks. After paying for diesel and wear and tear on their trucks, the farmers are assumed to treat the remainder as net income.

Table 4.4 Economic Impacts in Dollars ($) from an Increase in Hauling Distance for Trucking Industry

Sector	Output		Value Added		Labor Income	
	Direct	Total	Direct	Total	Direct	Total
Ag, Forestry, Fishing, and Hunting	-	7,226	-	2,756	-	1,757
Mining	-	49,288	-	26,309	-	9,220
Utilities	-	31,084	-	20,170	-	6,356
Construction	-	16,845	-	7,835	-	6,842
Manufacturing	-	287,796	-	43,133	-	28,651
Wholesale Trade	-	106,784	-	81,219	-	45,509
Transportation and Warehousing	2,252,966	2,700,576	1,009,863	1,264,437	748,807	940,616
Retail trade	-	135,991	-	102,103	-	63,982
Information	-	70,519	-	32,789	-	16,926
Finance and Insurance	-	136,434	-	77,220	-	42,545
Real Estate and Rental	-	105,615	-	67,737	-	20,285
Professional, Scientific, and Tech Services	-	108,354	-	61,773	-	49,634
Management of Companies	-	40,508	-	21,745	-	16,710
Administrative and Waste Services	-	45,830	-	26,065	-	20,263
Educational Services	-	15,650	-	8,353	-	8,193
Health and Social Services	-	144,198	-	87,267	-	75,961
Arts, Entertainment, and Recreation	-	17,277	-	11,143	-	7,626
Accomodation and Food Services	-	69,234	-	33,333	-	22,794
Other Services	-	108,229	-	53,228	-	38,980
Government and Non NAICs	-	140,589	-	99,024	-	6,310
Total	2,252,966	4,338,026	1,009,863	2,127,640	748,807	1,429,161

Source: IMPLAN™.

Conclusion

This chapter determined the impacts that would result from an ethanol industry developing in northeast Louisiana. Using Arcview, the locations of 16 existing grain elevators

and over 12,000 supply points were mapped within the region. Next, the amount of output for each supply point and the distance from it to all of the grain elevators were ascertained. Using a cost-minimizing linear programming transportation model, each supply point was assigned to one of five grain elevator sites. These five sites were chosen for the ethanol plants.

A formula was developed to determine the premium that a farmer would receive for bringing his corn crop to the nearest ethanol plant. Summing all of these premiums allowed the increase in farmer income of $26.1 million to be found, the initial effect. This initial effect was entered into an input-output model, which provided the impacts to the state economy.

The direct effect to output was $17.5 million, and the total output effect was $27.6 million, an output multiplier of 1.57. As for value added, the direct effect was $10.2 million and the total effect was $15.9 million, a value added multiplier of 1.56. Lastly, the labor income direct effects and total effects were $5.3 million and $8.6 million, respectively. The multiplier for labor income was 1.61.

This increase in distance that the corn would be hauled also had a positive impact on the state economy. Output received a direct impact of $2.25 million and a total impact of $4.3 million. Value added also increased. The direct effect was $1.0 million, while the total effect was $2.1 million. Finally, the direct impact on labor income was $750,000, and the total effect was 1.4 million. The multiplier for all three of these metrics was approximately 2.0.

Table 4.5 compares the increase in farmer disposable income from the corn price premium to the amounts of personal income and farm proprietor income for 2006. At the state personal income level, the there was a negligible change of 0.019%, but at the state proprietor income level, there was a noticeable change of 8.9%. For the combined parish region, personal income increased by an average of 0.21% and proprietor income increased by an average of

15.85%. The individual parishes that saw the greatest percent increase in personal income were East Carroll (1.58%), Madison (1.33%), and Tensas (1.33%). These parishes are major corn producing regions, and they are otherwise comparatively rural. In terms of farm proprietor income, seven parishes saw increases exceeding 20%, which suggests that the farmers in these parishes would certainly benefit. Overall, the effect at the state level would not be nearly as noticeable as the effect within certain parishes.

Table 4.5 Increases in Disposable Farmer Income Compared to 2006 Personal Income and 2006 Farm Proprietor Income

	Increase to Farmers	2006 Personal Income	Growth Over 2006 Personal Income	2006 Farm Proprietor Income	Growth Over 2006 Farm Proprietor Income
Avoyelles	$ 438,710	$ 943,396,000	0.047%	$ 17,718,000	2.48%
Caldwell	$ 236,796	$ 239,978,000	0.099%	$ 1,155,000	20.50%
Catahoula	$ 1,854,711	$ 238,812,000	0.777%	$ 13,005,000	14.26%
Concordia	$ 2,107,102	$ 449,736,000	0.469%	$ 14,252,000	14.78%
East Carroll	$ 2,887,701	$ 183,192,000	1.576%	$ 10,043,000	28.75%
Evangeline	$ 50,143	$ 721,208,000	0.007%	$ 4,647,000	1.08%
Franklin	$ 3,502,021	$ 458,639,000	0.764%	$ 27,280,000	12.84%
La Salle	$ 18,154	$ 344,081,000	0.005%	$ 351,000	5.17%
Madison	$ 3,222,360	$ 241,487,000	1.334%	$ 10,414,000	30.94%
Morehouse	$ 4,323,480	$ 665,916,000	0.649%	$ 17,567,000	24.61%
Pointe Coupee	$ 541,400	$ 605,348,000	0.089%	$ 3,437,000	15.75%
Rapides	$ 799,110	$ 4,156,855,000	0.019%	$ 15,904,000	5.02%
Richland	$ 2,375,421	$ 469,585,000	0.506%	$ 10,643,000	22.32%
St. Landry	$ 376,486	$ 2,244,640,000	0.017%	$ 6,092,000	6.18%
Tensas	$ 2,078,887	$ 156,577,000	1.328%	$ 6,784,000	30.64%
West Carroll	$ 1,301,722	$ 259,221,000	0.502%	$ 5,467,000	23.81%
Combined Parishes	$ 26,114,204	$ 12,378,671,000	0.211%	$ 164,759,000	15.85%
Lousiana	$ 26,114,204	$ 135,026,187,000	0.019%	$ 293,292,000	8.90%

In summary, the net increase in income to the state was small, but the increase to certain parishes was considerable. It should be noted that the operating revenues and cost structures of the ethanol plants themselves were not determined. Therefore, a decision by state leaders on whether to facilitate the development on an ethanol industry within Louisiana should not be based on this research alone.

CHAPTER 5: SUMMARY AND CONCLUSION

Biofuels have become a widely discussed and researched topic in recent years. The U.S. government has created laws and incentives to support biofuels research and production so that the nation decreases its reliance on foreign oil, decreases the consumption of non-renewable fossil fuels, and decreases the addition of CO_2 into the atmosphere, among other criteria. The most supported alternative fuel source has been corn-based ethanol, and this support has led to an increase in demand for corn (a shift in the demand curve) and an increase in corn prices.

This research sought to determine the effect that ethanol production would have specifically on the state of Louisiana. States and local communities need to make rational economic decisions about recruiting these facilities, so sufficient research into these economic questions must be performed. The U.S. is attempting to substitute biofuels for gasoline, and the leaders at the federal, state, and local levels need to be as informed as possible on the benefits and drawbacks of this change. These leaders need to know not only which types of biofuels are available for production, but also which biofuels are available for production within each of their areas. Ethanol production may or may not be an option for the state of Louisiana, so this study addressed two objectives, listed below, regarding whether or not its in-state production should be encouraged.

Chapter 2 reviewed recent literature on biofuels. It described how the government had created laws and policies, such as EPAct 2005, the Volumetric Ethanol Excise Tax, and the Energy Independence and Security Act of 2007, to support progress in and production of biofuels. Next, this chapter reviewed studies on the impacts that biofuels production, specifically ethanol production, had on the economy. All studies that were presented stated that ethanol production had a positive impact on the economy where it was located, although the studies did

not always agree on the magnitude of the impact. Additionally, an economy tended to receive a larger impact if the plant was locally owned or if the plant was located in an urban area. This chapter also found that ethanol production has had a statistically significant effect on commodity prices. Finally, the research reviewed in this chapter showed that the farmer's corn price changed proportionately to the change in transport costs.

Review of Objectives

The first objective of this research was to determine how the development of an ethanol industry within the U.S. is affecting the economy of the state of Louisiana through the redistribution of planting acreage of historical agricultural commodities in the state. The first objective was accomplished through a study of a crop acreage switch that occurred in Louisiana between corn and cotton in 2007. Cost structures for cotton and corn production, as well as for cotton gins and grain elevators were analyzed. These cost effects were run through a series of input-output multipliers, which allowed the net result of the acreage switch to be measured on major variables of state economic activity.

Chapter 3 evaluated the economic impact to the Louisiana economy from a switch of 295,000 acres of cotton production to corn production. This switch in commodities had minimal impacts on overall economic activity in the state. Total output increased by just over $700,000, or 0.57%. Value added decreased by slightly over $650,000, or a reduction of 0.89%. Lastly, labor income decreased by $1.97 million, a reduction of 4.16%.

The distribution of these effects impacted some sectors positively and other sectors negatively. 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. However, retail trade, manufacturing, and the agriculture, forestry, fishing, and hunter sector declined because of the reduced demand for their inputs primarily used to grow and gin cotton. Value added and labor income showed similar sector-based effects.

The second objective was to determine how a proposed distribution of ethanol plants within Louisiana would impact the state economy. The second objective was achieved by an analysis of a hypothetical distribution of 50 million gallon per year (MGY) ethanol plants within the northeast region of Louisiana. The analysis determined the sustainable number of plants along with the most cost-effective location for each one. A premium was assigned to every supply point, and once the premiums were summed, the total was run through an input-output model, determining the total impact on the state economy. In addition to direct impacts from premiums on the price received by farmers, economic impacts from additional activity from the trucking industry were estimated.

Finally, Chapter 4 sought to build on the research from Chapter 3 by further evaluating the impact that higher corn prices can have on the Louisiana economy. Whereas Chapter 3 determined the passive impact that ethanol was having on the state, Chapter 4 ascertained the impacts that would result from ethanol industry establishments within the state of Louisiana.

Arcview Geographical Information System software was used to map the locations of 16 existing grain elevators and over 12,000 supply points and to determine the amount of output for each supply point and the distance from it to all of the grain elevators. Five sites were chosen for the ethanol plants using a cost-minimizing linear programming transportation model to assign each supply point to one of the elevator sites. Next, a formula was developed to determine the premium that a farmer would receive for bringing his corn crop to the nearest ethanol plant. The increase in farmer income of $26.1 million, the initial effect, was found by summing all of these

premiums. This initial effect was entered into an input-output model, which provided the impacts to the state economy.

The direct effect to output was $17.5 million, and the total output effect was $27.6 million, an output multiplier of 1.57. As for value added, the direct effect was $10.2 million and the total effect was $15.9 million, resulting in a value added multiplier of 1.56. Lastly, the labor income direct effects and total effects were $5.3 million and $8.6 million, respectively. The multiplier for labor income was 1.61.

This increased corn hauling distance also had a positive impact on the state economy. Output received a direct impact of $2.25 million and a total impact of $4.3 million. Value added also increased. The direct effect was $1.0 million, while the total effect was $2.1 million. Finally, the direct impact on labor income was $750,000, and the total effect was 1.4 million. The multiplier for all three of these metrics was approximately 2.0.

The corn price premium had a much more noticeable impact on income at the parish level than it did at the state level. The percent increase in personal income at the state level was 0.019%; however, three parishes saw personal income increase by more than 1%. Louisiana farm proprietor income increased by 8.9%, but seven parishes saw increases of over 20%. For the combined sixteen parish region, personal income increased by an average of 0.21%, and farm proprietor income increased by an average of 15.85%. How should all of these results be interpreted for policy makers and stakeholders in biofuels?

Implications for Policy Makers and Stakeholders

The implications for policy makers and stakeholders are four-fold. First, the research previously reviewed found that a local economy receives a positive impact if it develops an ethanol industry, as long as the major inputs come from that economy (i.e. local corn) and as

long as most of the income remains within that economy (local ownership). Second, the biofuels industry is highly subsidized and protected. If these subsidies are eliminated, biofuel producers input and location preferences may shift, or biofuels may lose profitability in the near term. Third, as commodity prices are rising due in large measure to biofuels production, cropping patterns may shift drastically as different commodities become relatively more profitable. This has ramifications for both the farmers planting the crops and the industries that rely on these certain crops for their inputs. Finally, encouraging a biofuels plant to enter one's area would raise income noticeably at a parish (county) level, but the effects might not be as easily visible at the state level. This increase would be particularly noticeable to farmers that own their own land. However, these conclusions do not come without substantial limitations.

Limitations of Research

Some important limitations should be recognized in this research. First, the impact projections were based on assumptions regarding the prices and yield levels of corn and cotton. In Chapter 3, small variations in the average price received or yield levels for crops, particularly corn, would have had a considerable impact on whether larger positive or negative economic impacts resulted from the switch in production. For both Chapters 3 and 4, the geographic location of spending would have had 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 had been modeled would have changed the size of the economic impacts. Finally, for chapter 4, only the farmer side of creating a state ethanol industry was examined. If corn-based ethanol is going to be considered, the costs and benefits of the ethanol plants operation need to be examined. This leads the discussion to the areas for further research.

Areas for Further Research

Future research should be focused in a number of areas. First, as previously mentioned, identifying the location of spending for farm inputs as well as farm households should be a research priority. Additionally, to attain a more precise analysis of the price premium received by farmers delivering to an ethanol plant, a comprehensive survey of the Louisiana's corn production at the farm plot level should be conducted. Lastly, if Louisiana policy makers are going to make informed decisions regarding whether to encourage corn-based ethanol production, a cost-benefit analysis of an ethanol plant or plants operating in the state would need to be performed.

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APPENDIX

Mathematical Description of Reduced-Form Social Accounting Matrix System[7]

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

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

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

[7] Taken from Fannin (2000) and Holland and Wyeth (1993).

where I is an identity matrix.

Now by inverting the (I-S) matrix,

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

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.