Ethanol: Implications for Rural Communities

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Introduction

Ethanol is an alluring political solution for problems ranging from global warming and national energy security to local economic development. Ethanol burns cleaner than gasoline, is derived from renewable agricultural products, and creates local jobs and income. For farmers, ethanol offers a classic value-added strategy, and stories abound of farmers who joined together, started an ethanol plant, and made millions more by processing their corn into ethanol instead of selling it on the commodity market. For community leaders, there is the siren song of press releases touting the 120 jobs and $145 million to result from the latest plant announced elsewhere. Contributing to the frenzy of local interest is the pressure to act before the neighbors do because agricultural supply constraints limit the number of plants the immediate region can support. The pace is rapid. As of August 1, 2007, the Renewable Fuels Association listed 124 ethanol biorefineries with 76 more under construction. Those 76 new ones will double the national capacity to 12.8 billion gallons per year (http://www.ethanolrfa.org/).

This chapter answers three important questions: Where have ethanol plants been locating, what factors make a location attractive for an ethanol plant, and what are typical plants' local economic effects? Thus, this chapter is useful for people interested in ethanol and local economic development who want to know (1) what has been happening and why, (2) whether their county is a prospective ethanol plant location, and (3) what would happen in their local economy if a plant located there.

Like many investment booms that promise high returns, the ethanol strategy has risks and uncertainty. Questions abound regarding the long-term viability of corn as the feedstock for ethanol, the profitability of ethanol production, its resource use, particularly water and energy, and its net effects on the environment. An umbrella of government policy, including ethanol subsidies, required ethanol content, commodity support payments, and ethanol tariffs, covers the industry and plays strategic roles in its future.

The Ethanol Industry: An Overview

Policy Drivers of Ethanol Industry Growth

Energy security, global warming, and federal tax credits define much of the policy umbrella promoting recent growth in the ethanol industry, as discussed in more detail in Chapter 9. Oil imports represented 38 percent of the 2006 U.S. trade deficit (Cavallo 2006), and the domestic production of a substitute decreases the trade deficit and dependence on oil exporting countries. In his State of the Union Address in January 2007, President Bush set a national goal of reducing U.S. gasoline consumption by 20 percent over the next ten years, in part by reducing oil imports and using more renewable fuels like ethanol (White House 2007).The Energy Policy Act of 2005 amended the Clean Air Act to create a national Renewable Fuels Standard (RFS). The RFS program requires that 7.5 billion gallons of renewable fuels be used in the motor fuel supply by 2012, almost doubling the 4 billion used in 2006, the majority of which was ethanol. That goal is likely to be met by 2008 or 2009. The Environmental Protection Agency, which administers the program, now notes that 11 billion gallons are projected by 2012.

Environmental policy is a major driver of the ethanol industry. Use of a 10 percent ethanol blend reduces greenhouse gas emissions by 18 to 29 percent over conventional gasoline, and in 2006 ethanol use reduced auto emissions equivalent to removing 1.21 million cars from U.S. roads, according to Argonne National Laboratory (Wu 2007). Demand for ethanol derives in part from the federal mandate that an oxygenate be used to meet requirements of the Clean Air Act and from state government rules that require the use of ethanol blends. A far reaching, recent example of the latter occurred in June 2007 when the California Air Resources Board changed the rules under which refineries formulate gasoline for sale in California, noting "The greater use of ethanol in the formulas will also reduce global warming emissions." California, which uses more ethanol than any other state, anticipates its policy action will triple the size of the state's renewable fuels market by 2020 (www.arb.ca.gov/newsrel/nr061507.htm). Similarly, California and about 20 other states have banned methyl tertiary-butyl ether (MTBE), an oxygenate that contaminates drinking water, leaving ethanol as their only alternative. The federal EPA considered a nationwide ban, but the Bush administration withdrew the proposal, leaving the matter to Congress, which has considered but not passed provisions to phase-out MTBE. The situation remains fluid, but the strong regulatory role and potential of state governments in driving ethanol demand are now well established.

A federal tax credit also increases ethanol production. The Volumetric Ethanol Excise Tax Credit, part of the American Jobs Creation Act of 2004, provides ethanol blenders with 51 cents per pure gallon of ethanol blended or 0.51 cents per percentage point of ethanol blended. Thus, the common 10 percent ethanol blend qualifies for 5.1 cents per gallon and the 85 percent blend, E85, qualifies for 43.35 cents per gallon. The incentive is available until 2010 and comes out of the U.S. Treasury's General Fund (U.S. Department of Energy 2007). There is also a tax credit for small ethanol plants that produce no more than 60 million gallons of ethanol per year. As of March 2006, 15 states had producer incentive programs, 11 had retailer incentives for ethanol blends and E85, and 5 had their own renewable fuel standards (www.ethanolrfa.org/policy/). Several of the producer credits were 20 cents per gallon, and two states reached 40 cents.

Domestic ethanol production of ethanol is also protected by a 54-cent-per-gallon tariff on imported ethanol. In December 2006, Congress extended the tariff from October 2007 through January 1, 2009. Currently the tariff is aimed chiefly at Brazilian producers, who use sugar cane to make ethanol.

Ethanol Plant Inputs and Outputs

Under this policy umbrella and facilitated by technological improvements, a combination of high oil prices and low corn prices made ethanol an economically efficient way to provide renewable fuel for the first time (Doering 2006). Modern ethanol plants use a dry-mill technology that is much more efficient than the ethanol plants of 15 years ago and has allowed plant production capacity to soar. Plants producing 100 MGY (million gallons per year) are now common. As indicated in Chapter 4, modern ethanol plants are increasingly corporately owned, as opposed to farmer or cooperatively owned, and their main inputs are corn, natural gas, water, yeasts, chemicals, and enzymes, with labor a relatively minor input. Corn is generally purchased directly from producers who may or may not have a contract with the ethanol plant. Most plants pay a small per bushel price premium, 5 to 10 cents per bushel is most common (Schill 2007), over local elevator prices to ensure year-round supply. This price premium suffices to compensate producers to truck corn no more than 35 to 50 miles to the ethanol plant (Stueffen 2005), so ethanol plants tend to locate close to an adequate corn supply. Noteworthy exceptions include the California ethanol plants that import corn from the Midwest.

Both ethanol and its most important inputs are subject to volatile prices. Corn, natural gas, and electricity typically are more than half the cost of ethanol production. Whether a plant covers it costs in any given period depends on the relationships among corn and energy prices (Chapter 4).

Ethanol, which is sold to blenders who combine it with gasoline for retail, represents 90 percent of a typical plant's revenue, with two by-products, distiller's grains and carbon dioxide, also providing revenues (Stueffen 2005). Distiller's grains are primarily fed to beef cattle, either wet to nearby herds or dried and sold commercially (Chapter 6). Some plants sell the carbon dioxide, but many have no market for the gas so they simply release it, which is the dominant practice in the Midwest (Pierce et al. 2006).

Ethanol Industry Output Growth

The ethanol industry in the U.S. has grown steadily from the cottage industry that produced 175 million gallons in 1980 (Urbankchuk 2006). By 1990, 35 ethanol plants made 865 millions gallons (RFA 2006). The big take-off began after 2002 to reach a production capacity of 6.5 billion gallons in 124 plants by August 2007 (Figure 1), and now an additional 6.4 billion capacity is under construction (RFA 2007).

Other countries are increasing ethanol production, too (RFA 2006a). Until recently Brazil, the lowest cost producer, was the world's leader (Figure 2). According to de Moraes (2007), producing ethanol in Brazil from sugarcane costs half as much as producing it in the U.S. from corn. Despite the U.S. tax credits to induce domestic ethanol production, the 54 cent per gallon tariff, and a 2.5 percent ad valorem tax, the U.S. imports a small amount of ethanol from Brazil. Qualifying Caribbean countries can send ethanol to the U.S. tariff-free, and a small portion of U.S. ethanol consumption (six million gallons in 2005) comes from Jamaica and Costa Rica.

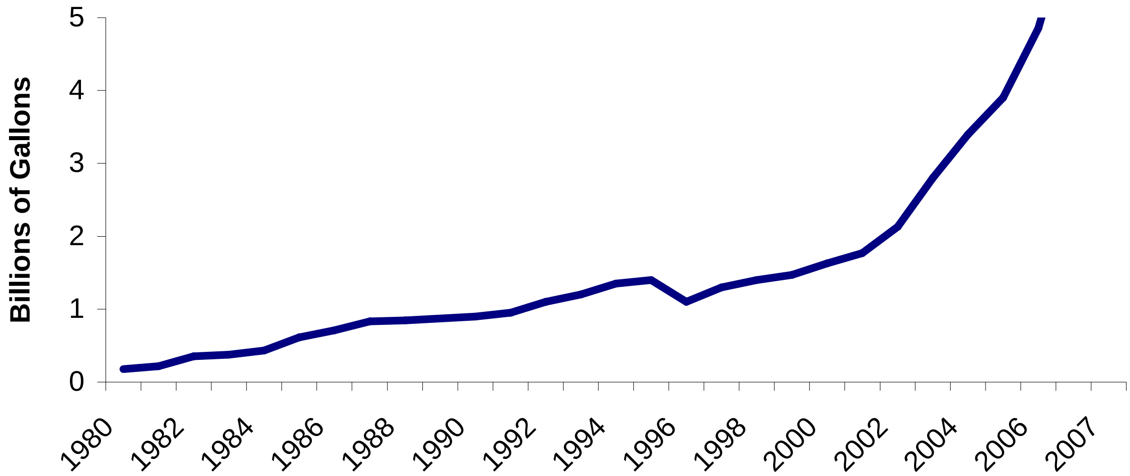

Figure 1. Ethanol Production Capacity in the U.S.

Data Source: Renewable Fuel Association, Historic U.S. Fuel Ethanol Production

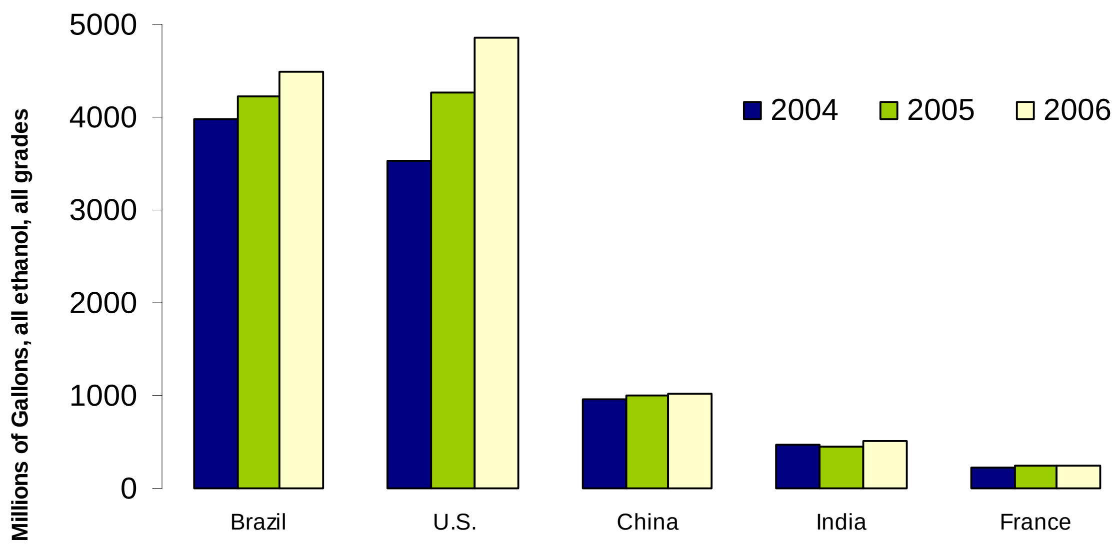

Figure 2. Top Five Ethanol Producing Countries and Production

Data Source: Renewable Fuels Association, Industry Statistics

Market Penetration

The U.S. ethanol industry has its roots in the Midwest, particularly in states which were among the first to recognize the economic value ethanol production adds to locally produced crops. Illinois, Iowa, Minnesota, and Nebraska are the top ethanol users when measured as a percentage of motor fuel consumption (Figure 3). Minnesota has the highest percentage, 10 percent, and Illinois has reached 7 percent (U.S. Dept. of Transportation).

California and Nevada had each reached 4 percent ethanol by 2003 (Figure 3). Los Angeles and Las Vegas are required by the Clean Air Act to use fuel additives to reduce carbon monoxide emissions. California's percentage must have increased since 2003 because it discontinued use of methyl tertiary-butyl ether (MTBE) on January 1, 2004, but no numbers seem to be available after the 2003 ones.

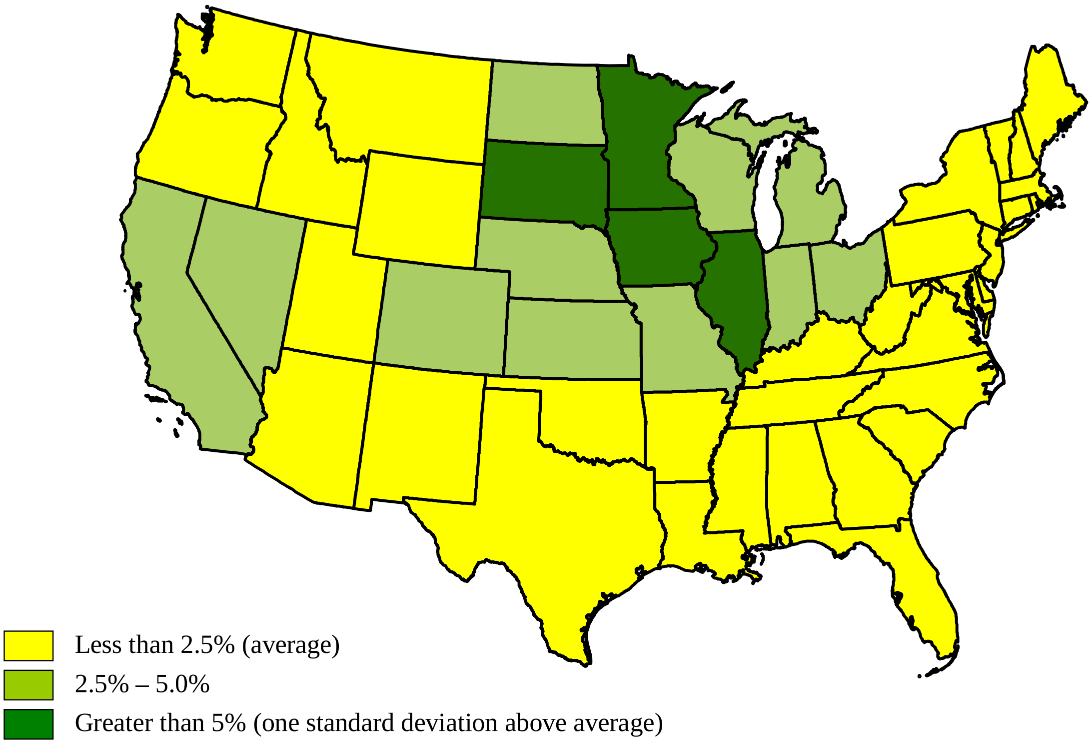

Figure 3. Ethanol Use as Percent of Total Gasoline Consumption, 2003

Data Source: U.S. Department of Transportation, Federal Highway Administration, 2003

Consumption numbers even for 2003 suffice to demonstrate the importance of California as an ethanol market. California used over 20 percent of U.S. ethanol, while Illinois used 14 percent. Four states consumed over half the U.S. ethanol supply, and ten states consumed over three-quarters (Table 1). Absent from the list are several of the most populous states, Texas, New York, Florida, and Pennsylvania, suggesting that ethanol demand could grow considerably higher if policy mandates, such as the MTBE ban, become nationwide.

Table 1. Top Ten States' Share of Consumption of U.S. Ethanol Supply, 2003

State	Share	State	Share
California	21%	Indiana	5%
Illinois	14%	Wisconsin	4%
Minnesota	10%	Iowa	4%
Ohio	7%	Missouri	3%
Michigan	6%	North Carolina	3%

Data Source: U.S. Department of Transportation, Federal Highway Administration, 2003

Location and Employment of U.S. Ethanol Plants

Employment Data by County and Establishment

This study examines county-level ethanol industry employment using annual federal government statistics from the U.S. Bureau of the Census. To protect the confidentiality of business information, the Census Bureau suppresses employment and payroll data, although it provides establishment employment by size category, for example, 20-49 employees. The precise employment number can be estimated using an algorithm described in Isserman and Westervelt (2006), and we use those estimates here. The most recent data available are *County Business Patterns* (CBP) for the mid-March pay period of 2005, but the industry has continued to grow rapidly since then, so we supplement the 1998-2005 CBP data with plant location information from the Renewable Fuels Association.

CBP data depend on establishments being designated correctly under the six-digit North American Industrial Classification System (NAICS). The modern dry-mill ethanol industry is part of NAICS code 325193, "non-potable ethyl alcohol (ethanol) production," which includes some firms that do not interest us, such as small distilleries. Therefore, we investigated all suspicious observations, including those with fewer than 10 or more than 50 employees and those that did not appear consistently within the 1998-2005 data, and modified the 2004 CBP data.[2] Establishments found not to be ethanol plants, including a cheese factory and an organic chemistry laboratory, were deleted from the analysis.

Employment Growth and Locations

Total employment in the ethanol industry is growing. Employment increased by 50 percent between 2000 and 2005, and the number of ethanol plants doubled between 2000 and 2007, rising from 54 to 124 (Figure 4).

[2] We sought each suspicious establishment on the internet, comparing the county of interest from CBP with lists of ethanol establishments from the Renewable Fuels Association and ethanol.org. When this step identified a firm's name, we googled it. When no firm name was found, we googled the county name, ethanol, distill, and so on, until we found a firm. Firm websites usually give history including construction and beginning operation dates. One website stated the plant had been closed down. Local news articles also provided information about the type of establishment, estimated employment, and the like. This time intensive exercise was not repeated when the 2005 data were released.

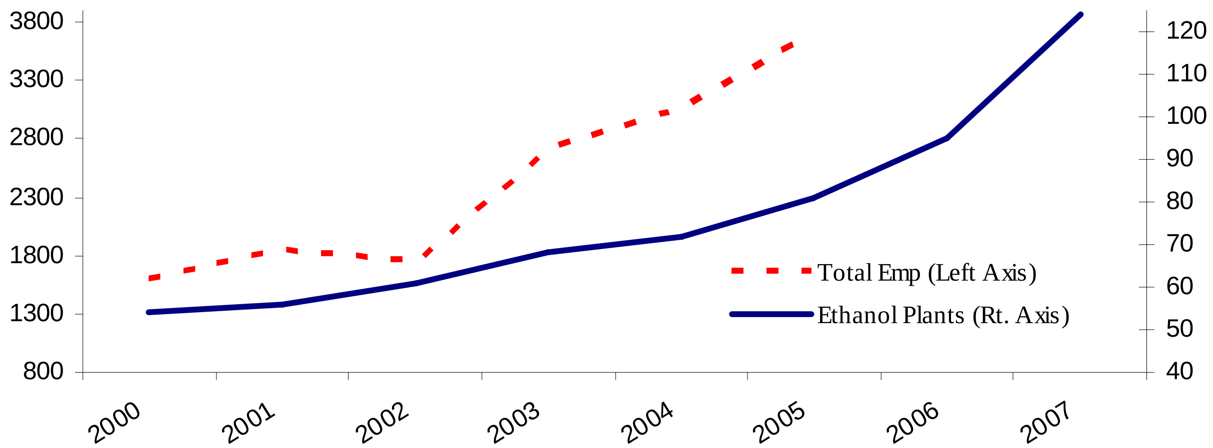

Figure 4. Ethanol Plants and Total Employment

Data Source: County Business Patterns (employment); Renewable Fuels Association (plants), as of August 2007.

Over half the plants now have 20 to 49 employees (Figure 5). Ethanol plants are not large employers relative to their county's economic base. Only one ethanol plant provides more than 2 percent of its county's jobs. In Calhoun, Arkansas, it employs 210 people, approximately 5 percent of the county's jobs.

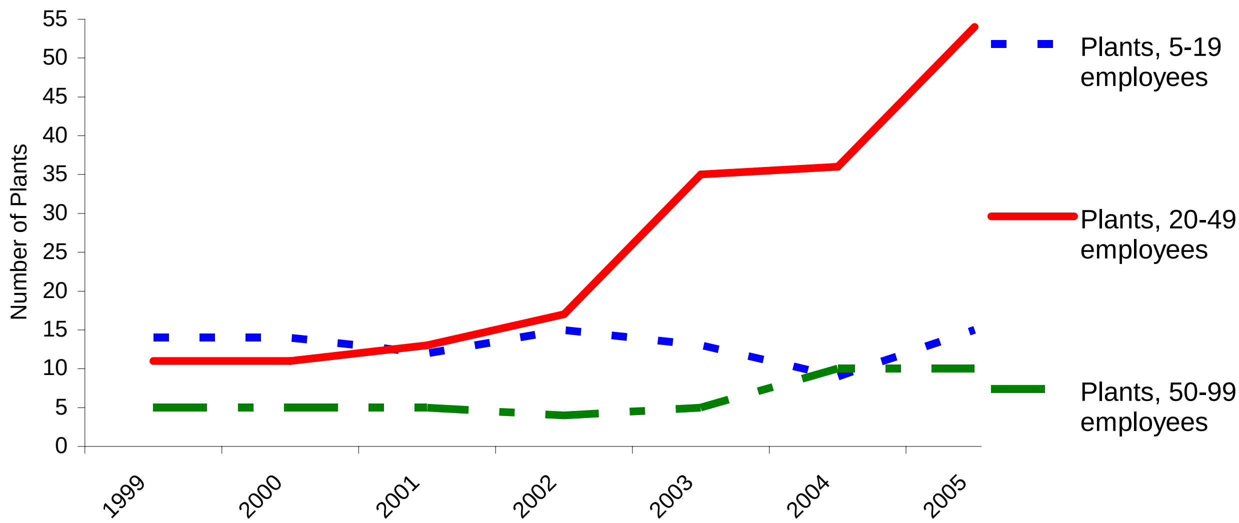

Figure 5. Number of Plants by Employment Size

Data Source: Renewable Fuels Association, Industry Statistics, County Business Patterns

The clustering of ethanol plants in the nation's corn-belt is evident, but there are exceptions in addition to the California plants (Figure 6). Many midsize plants (30-50 MGY) are in Minnesota, South Dakota, Iowa, and Nebraska. Nationally, the average plant capacity is 51 million gallons, and the median is 42 million, but plants that began production between June 2006 and May 2007 are larger, averaging 78 million gallons with a median of 50 million (RFA 2007).

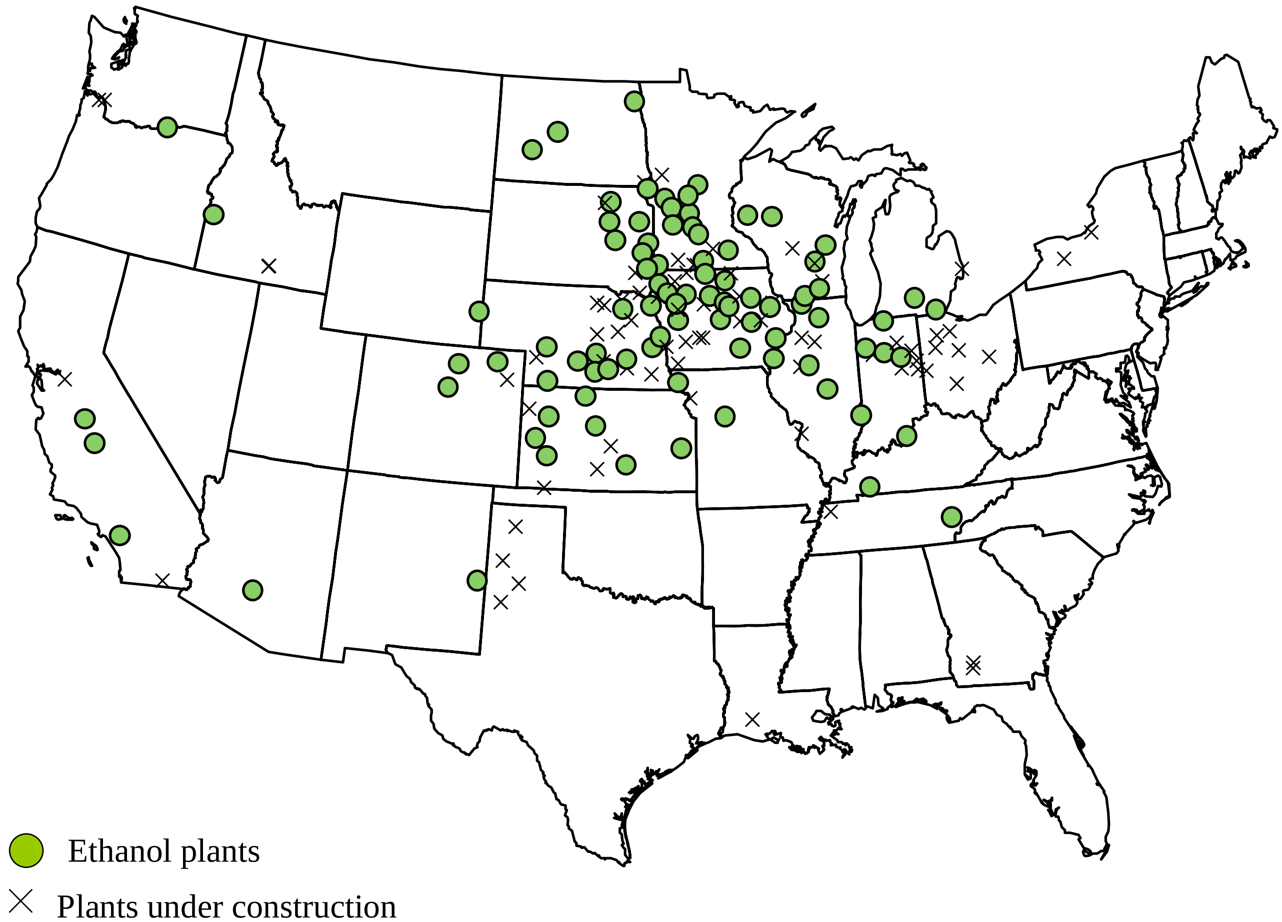

Figure 6. Ethanol Plants and Plants under Construction, August 2007
Plant data from Renewable Fuels Association, August 22, 2007

Location Factors

Most ethanol plants are in rural America. Rural and mixed rural counties[3] contain 86 percent of ethanol plants, likely due to proximity to input suppliers (corn) and by-product users (livestock). Railroad access to the plant site is almost a necessity, as are adequate highways for truck transportation of inputs and distiller's grains. Access to abundant water and power are also essential. According to Swenson and Eathington (2006), transporting corn to an ethanol plant is only cost-effective up to 50 miles within corn growing regions. Therefore, the largest plants are

[3] Rural counties have either 90 percent of their population in rural areas or no urban area with a population of 10,000 or more. Mixed rural counties have a population density less than 320 people per square mile and an urban area with 10,000 or more residents. For a more complete discussion of these definitions and the distinctions among rural, mixed rural, mixed urban, and urban counties, see Isserman (2005).

adjacent to major grain distribution terminals. Nearby cattle feeding facilities can make the best use of distiller's grains, the main by-product.

Spatial Proximity to Inputs

The optimal plant location is close to inputs, including corn or another feedstock, energy, and water, and important infrastructure, including railroad and highway transportation. Two-thirds of ethanol plants are in the Midwest, where corn is a predominant crop and supplying corn is relatively cheap and easy. The center of the Midwest cluster is in northwest Iowa.[4] Figure 7 shows ethanol plants and their location with regard to the percent of nearby land in corn production. Ethanol plants without a nearby supply must ship in feedstock, which is costly, but so is shipping ethanol to blenders. California ethanol plants do import corn, but they anticipate that more corn will be grown in the state and non-corn cellulosic ethanol will eventually become viable (*San Francisco Chronicle*, August 5, 2007).

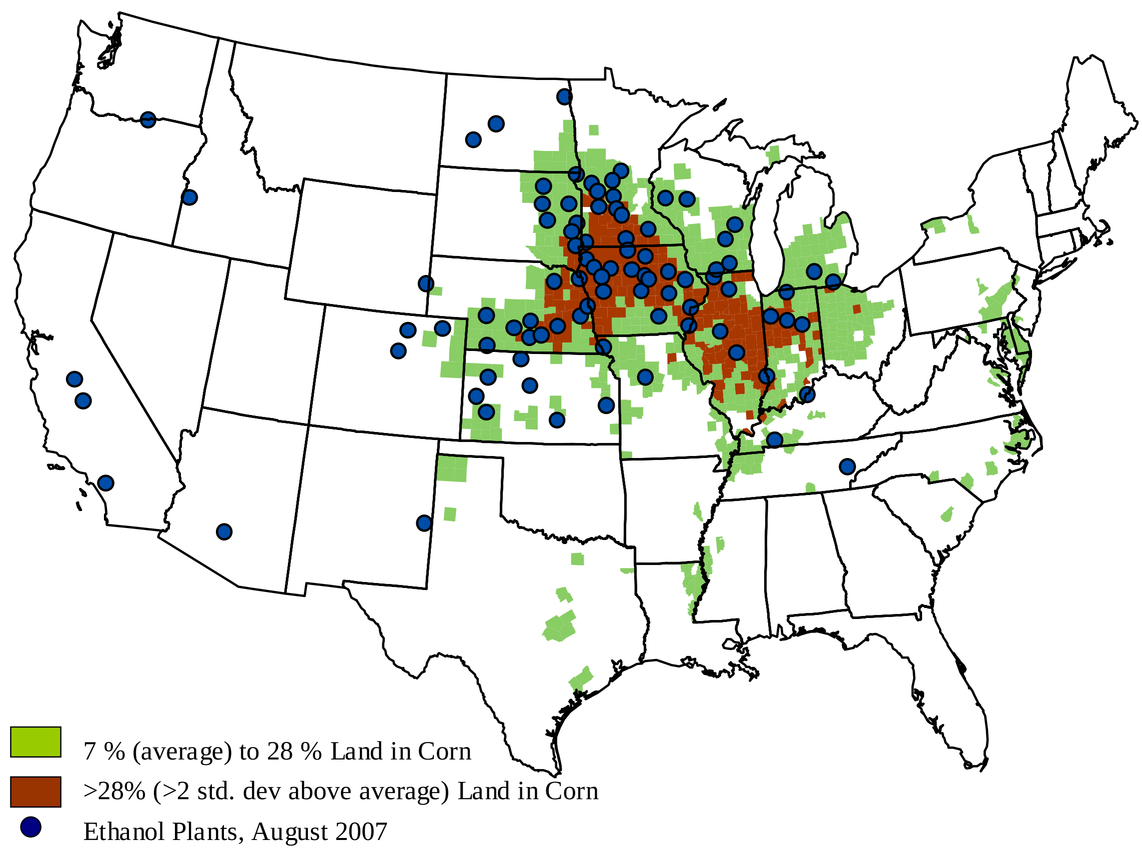

Figure 7. Percent of Land in Corn Production and Plant Location
Data Source: U.S. Census of Agriculture, Renewable Fuels Association

[4] U.S. Census Bureau definition of Midwest, 2006 county ethanol plant data.

Spatial Proximity to Cattle

In 2005, nine million metric tons of distiller's dried grains with solubles (DDGS) were by-products of ethanol production. Approximately 80 percent of the spent grain is dried and sold, generally out of the region (RFA 2006). If livestock are close enough to an ethanol plant (within 50 miles), cattle can eat the spent grain wet, which is much cheaper. Beef cattle being finished can eat 17 pounds per day of this wet material, so one 100 MGY plant can feed over 100,000 head to maturity twice per year (Pierce et al. 2006). Illinois counties have fewer than 25,000 head of beef cattle each, many less than the feeding capacity of an ethanol plant (Figure 8). Without the nearby cattle, ethanol plants face the cost of drying the distiller grains or transporting it by truck to end users or disposal. The cost of drying wet grain is high, but the wet distillers' grains have only a five-to-seven day shelf life and are expensive to transport due to the large volume.

The Renewable Fuels Association has noted an increase in livestock production near ethanol plants, likely due to availability of the relatively inexpensive feed. This trend is also discussed in Chapter 6. Nationally, 54 percent of counties with an ethanol plant have an above average density of cattle on feed, and 87 percent of plants are within 50 miles of a county with an above average density, even when using data from the 2002 Census of Agriculture with current plant locations.

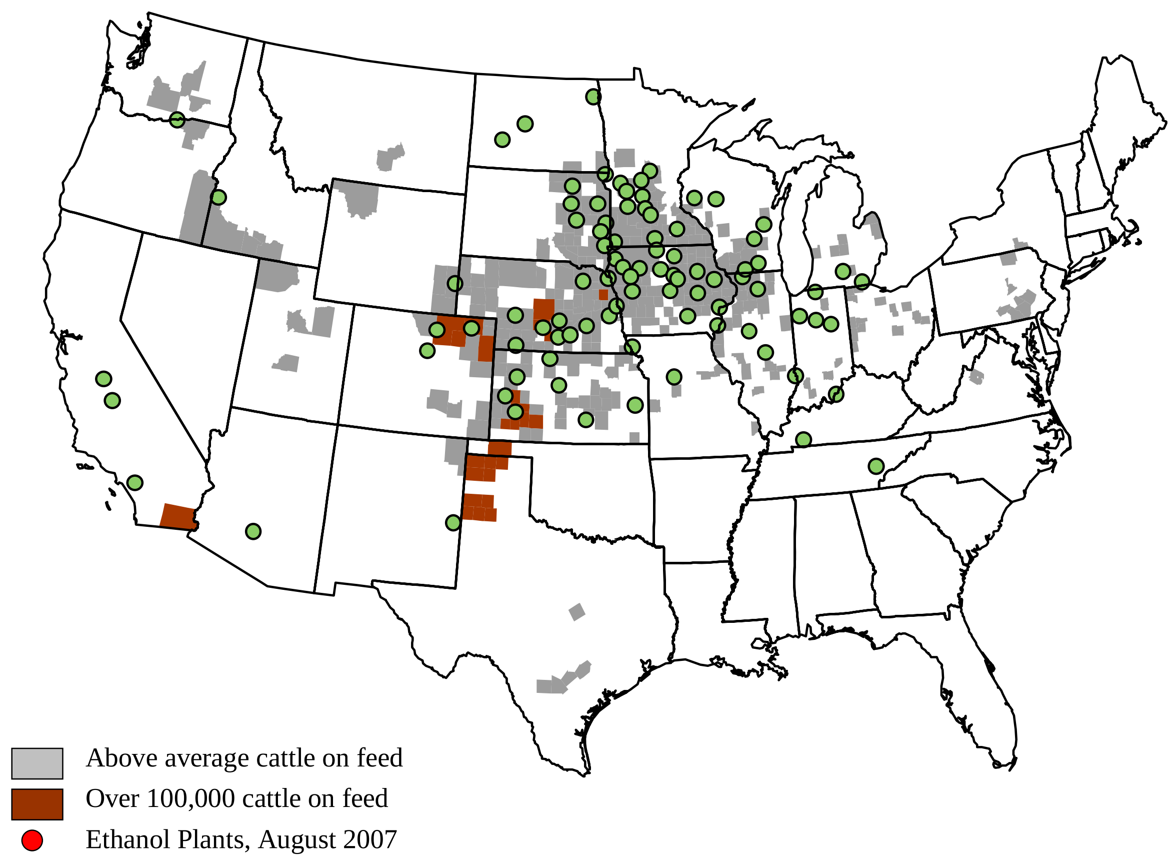

Figure 8. Cattle on Feed by County and Location of Ethanol Plants

Data Source: U.S. Census of Agriculture, Renewable Fuels Association

A commercial feed lot in eastern Nebraska is testing the use of a closed-loop ethanol plant (Klopfenstein 2007). An existing feedlot, with a 30,000 head capacity, is the base for the experiment; cattle are fed wet distillers grains produced at an adjacent ethanol-plant, and cattle manure feeds an anaerobic digester which produces all the natural gas used to power the ethanol plant. This closed-loop system, if economically efficient, might become the ultimate model for ethanol and livestock production.

Energy and Water

Energy and water are also major inputs in ethanol production. Modern ethanol plants use a substantial amount of natural gas: $30.1 million of natural gas for a 100 MGY plant in one year, accounting for 14 percent of total costs at mid-2007 cornbelt prices. Water and water treatment costs vary tremendously among plants based upon the water source, pre-treatment of water, and waste management. $600,000 annually is consistent with Chapter 4, but other studies suggest almost $3 million per year (Swenson 2006).

A 100 MGY plant uses more than 300 million gallons of water per year, an amount that can strain many watersheds and local waste water processing facilities. Plants able to draw and return water to a river often raise less environmental concern than those drawing water from an aquifer. Plant construction in the western United States has already complicated local water use (Barrett 2007). Some water districts in Nebraska are offsetting ethanol plant water use by reducing farmers' water allocation for irrigation or restricting nearby well use.

Waste water treatment also varies considerably in cost and availability. Often the treatment infrastructure is provided by the municipality or other local government. Many plant sites require significant waste water investments, whose cost may be borne by the community or jointly with the plant. Sometimes sufficient water and waste infrastructure is already present. The ethanol plant in Rochelle, Illinois, tapped into unused water infrastructure built for factories that had left the community.

Transportation

Transportation infrastructure is vital to the ethanol industry. Vast amounts of corn and millions of gallons of ethanol are shipped via truck, train, and barge. Over 35 million bushels of corn are delivered annually to a 100 MGY plant. Much of the locally produced corn arrives by truck, so highway access is important. The heavy trucks carrying corn to the plant and wet distillers grains from the plant can quickly wear down secondary roads. Three quarters of ethanol plants are located within ten miles of a major U.S. highway or interstate highway. The majority of counties not connected with a major U.S. highway are in northwest Iowa, which has good state highways.

The 100 million gallons of ethanol generally are shipped directly from the plant by rail and barge because existing pipelines easily contaminate ethanol and it has a limited shelf-life. Railroad access is almost a necessity to market ethanol, and all but one ethanol plant is located on a railroad (Figure 9). The exception, a midsize plant in southeast Minnesota, probably trucks ethanol to the nearest rail terminal. Transportation costs rise every time the good is transferred or loaded; indeed loading fees can be 5 cents per gallon[5], so using multiple transportation modes adds up quickly. Transportation costs are higher if the ethanol plant is not located on a main line railroad, only a short line. Additionally, due to the corrosive nature of ethanol, some railroads are requiring the plant to purchase dedicated rail cars to transport ethanol.

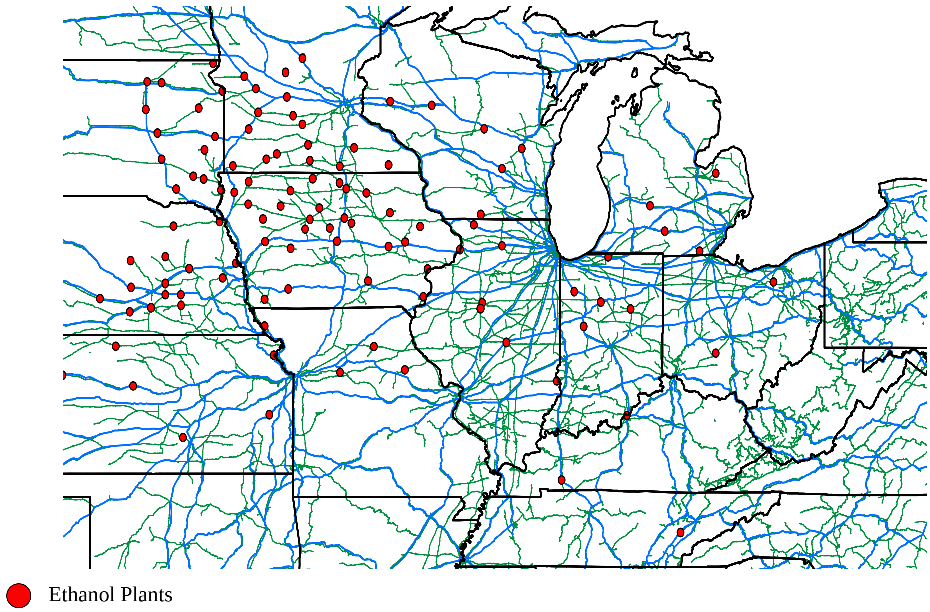

Figure 9. Rail Roads and Ethanol Plants
Data Source: Renewable Fuels Association, 2006

Marketing

Marketing firms are important in the industrial organization of ethanol. Transporting ethanol is costly and risky, so many ethanol plants contract with a marketing firm to provide transportation logistics, market development, and risk management. The marketing firms can play a variety of roles. They have direct sales connections to ethanol blenders and bulk storage and transportation infrastructure of their own.

Contracts between producers and marketers vary on a case-by-case basis. No practice is standard in this industry. Many ethanol plant business plans include a sales and marketing plan to be able to attract financing. Ethanol producers sell their product in a variety of manners; some have on-site pumps and sell an 85 percent ethanol blend, many sell on spot markets, and some have contracted out the sale of all their ethanol.

Ethanol production is becoming vertically integrated with marketing, transportation, and blending. Ethanol production is competitive and, like all competitive industries, margins are thin and risk is high. The industry is experiencing both tremendous growth and rapid change in how the product is marketed. For example, Center Oil Company of St. Louis is planning to build a moderately sized ethanol plant in southwestern Illinois this year and is already a fairly sizeable

[5] We thank Dr. Mike Mazzocco, University of Illinois, for his sharing marketing and transportation information with us.

purchaser and blender of ethanol. The president of its ethanol subsidiary stated, “I think it’s a natural extension of our business. It provides us some control over a component that we’re going to have to purchase anyway with the mandates that were announced last year in the new energy bill. (Ortbals 2007).” Center Oil’s decision to integrate and become an ethanol producer may indicate the future direction of the ethanol industry. By integrating, Center Oil can reap profits that would go to the ethanol producer, marketer, and transporter.

Illinois Ethanol Plants

Seven ethanol plants are operating in Illinois, four are under construction, and many more are at various proposal stages. By June 2007, 57 air permit applications for ethanol plants had been submitted to the Illinois Environmental Protection Agency. The 11 plants in operation or under construction mirror the key location characteristics. All are in corn producing counties with cattle on feed, and all have rail service (Table 2). The host counties are diverse, ranging from a rural one with 6,000 people to a mixed urban metropolitan one with population 261,000.

Table 2. Illinois Ethanol Plants, August 2007

Owner	County	City	Capacity (MGY)	County Character	County Population 2006	Corn (millions of bushels)	Cattle on Feed	Rail/ Interstate
Adkins Energy	Stephenson	Lena	40	Mixed Rural	47,388	19.9	12,120	Yes/No
ADM	Macon	Decatur	290	Mixed Rural	109,309	21	1,441	Yes/Yes
Aventine Renewable Energy	Tazewell	Pekin	207	Mixed Rural	130,559	22.3	2,246	Yes/Yes
Illinois River Energy	Ogle	Rochelle	50	Mixed Rural	54,826	25.7	18,458	Yes/Yes
ADM	Peoria	Peoria	100	Mixed Rural	182,495	15.9	1,979	Yes/Yes
Lincolnland Agri-Energy	Crawford	Palestine	48	Rural	19,825	7.6	273	Yes/No
MGP Ingredients	Tazewell	Pekin	78	Mixed Rural	130,559	22.3	2,246	Yes/Yes
Plants Under Construction								
Patriot Renewable Fuels	Henry	Annawan	100	Mixed Rural	50,339	36.2	20,645	Yes/Yes
Central Illinois Energy	Fulton	Canton	37	Mixed Rural	37,378	19.2	3,295	Yes/No
Marquis Energy	Putnam	Hennepin	100	Rural	6,005	4.5	298	Yes/Yes
Center Ethanol Co.	St. Clair	Sauget	54	Mixed Urban	260,919	18.6	1,435	Yes/Yes

Data Source: Renewable Fuels Association, August 2007, for plant information.

Local Economic Effects of an Ethanol Plant

Measuring the local economic effects of an ethanol plant is a painstaking two-step process. The first step, scenario building, entails carefully thinking through what happens when a plant locates in a county. The scenario includes the plant hiring a labor force and purchasing corn, but quickly gets far more complex, involving local agricultural land ownership, substitution among crops, capitalization of corn price premiums into land values and rents, and possibly cattle production. The second step, economic modeling, traces the effects of the plant operation and other aspects of the scenario on all the sectors of the economy. The challenge is to modify an input-output model of the local economy and its basic assumptions so that they reflect reality better and the model matches up successfully with the scenario. Both steps, scenario building and economic modeling, involve considerable judgment, specifically, an understanding of how the economy works, assumptions about key parameters, and estimates for data that are not available. To avoid the mysterious black box syndrome and to facilitate future studies by others, those judgments are presented in considerable detail here, so they can be discussed and replaced, if possible, with better decisions based on either new evidence or more compelling logic.

The Three Study Areas

The scenario and local economic effects are not the same for all places, even with an identical plant. The reasons are simple. Places vary in their capacities to increase corn production and utilize grain by-products, in local ownership of farmland, and in the ability of the local economy to supply the goods and services demanded by the ethanol plants, agricultural producers, land owners, and others receiving income directly or indirectly as a result of the ethanol plant coming into the county.

Three Illinois counties are explored here, each with a proposed ethanol plant. Their different levels of urbanization and the varied sizes of their local economies illustrate how the local effects of an ethanol plant depend on local conditions. Kankakee is the northern most, a mixed rural metropolitan county, roughly 60 miles south of Chicago, whereas Coles is a mixed rural micropolitan county in east central Illinois and Hamilton is a rural county in southern Illinois with fewer than 9,000 residents (Table 3, Figure 10).

Table 3. Hypothetical Illinois Ethanol Plants and Study Counties

County	Capacity (MGY)	County Character	County Population 2006	Corn (millions of bushels, 2006)	Cattle & Calves (2005)	Rail/ Interstate
Coles	60	Mixed Rural	50,949	19.2	5,900	Yes/Yes
Hamilton	100	Rural	8,835	8.2	2,700	Yes/No
Kankakee	100	Mixed Rural	109,090	32.2	6,300	Yes/Yes

Data Source: BEA-REIS, NASS Illinois Ag Stats

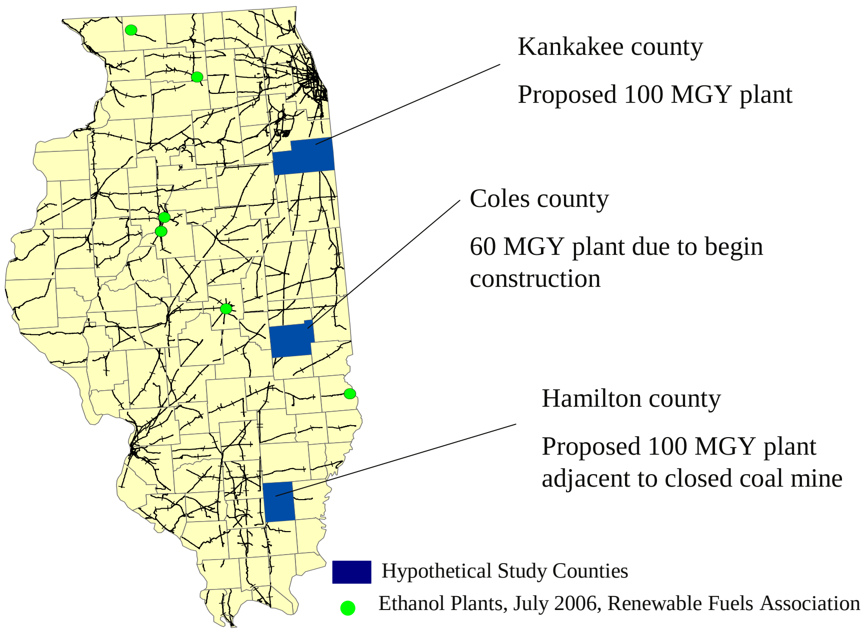

Figure 10. Illinois Ethanol Plants and Study Areas

Data Source: U.S. Census Tiger, Renewable Fuels Association

Kankakee County is the site of a proposed 100 MGY plant to be operational in 2008. It makes an interesting case study because of its proximity to Chicago and the main East-West railroad and Interstate 57 and its relatively high land values, but the county is rural enough to produce the corn utilized by the plant. Half the existing Illinois ethanol plants are in metropolitan counties that are mixed rural in character, like Kankakee.

Coles County is the site of a proposed 60 MGY plant, whose construction is to begin in 2007 (Stroud 2007). Also a mixed rural county, Coles is micropolitan, not metropolitan, meaning that its largest urban area has fewer than 50,000 people. (The precise numbers are 65,073 residents for the Kankakee urban area, and 21,200 for the Charleston urban area in Coles County.)

Hamilton County is an unusual ethanol case. It has a proposed 100 MGY plant, despite being south of the intensive corn producing area. The site is adjacent to an old coal mine that has been converted into a state-of-the-art, operating 1.5 million bushel grain elevator. No other abandoned coal silo has been converted into grain storage. The proposed plant would source grain from the adjacent elevator. It has an on-site 90-car rail loop and a recently resurfaced road it will share with the grain storage facility**.**

Ethanol Production Assumptions

Ethanol is such a new industry that it is not identified separately in national input-output accounts. Closest among the 509 sectors within IMPLAN, the modeling system commonly used in studies like this one, is wet corn milling, but modern dry mill plants use different technology than the older wet mill plants. Therefore, the scenario building step includes detailed assumptions about ethanol production to create an ethanol industry inside the IMPLAN model. We lean heavily on the work of David Swenson (2007) at Iowa State University and chapter 4.

IMPLAN, and input-output models more generally, describe production technologies in terms of dollars of each input per dollar of output. A good strategy to describe the dry mill ethanol industry in this way is to adjust the model's closest sector, wet corn milling. Table 4 shows per dollar amounts for selected inputs in the wet corn milling sector of Illinois and the amounts assumed for the dry mill ethanol industry. Key differences are more corn (part of the grain farming sector), natural gas, chemicals, and less electricity and truck transportation. These numbers assume corn producers pay to truck the corn to the ethanol plant (and in return receive the per bushel premium over market price), and the plant does not pay to transport the ethanol to the buyer.[6] In fact, transportation costs depend on the wide array of ethanol marketing decisions adopted by firms and on how they treat the spent grains.

Table 4. Key Differences between Wet Corn Mill and Dry Mill Ethanol Plants
(Input in Dollars per Dollar Output)

Input from Sector	Wet	Dry
Grain Farming	0.18	0.61
Natural Gas Distribution	0.05	0.14
Rail Transportation	0.06	0.0
Other Basic Organic Chemical Manufacturing	0.01	0.05
Power Generation and Supply	0.04	0.03
Water-sewage and systems	0.0002	0.003
Wholesale Trade	0.15	0.01
Truck Transportation	0.06	0.03
Oilseed Farming	0.004	0.0

The input-output relationships depend on the prices of both the inputs and ethanol. At mid-2007 prices, corn represents well over half the input costs for a typical ethanol plant. A few years ago, it was one third. When the corn price dropped to $2 per bushel in 2005, ethanol became profitable, not just economically feasible, and the low corn prices drove increased ethanol production (Doering 2006). Recent corn prices are far higher (Figure 11).

[6] The price a producer would receive for ethanol if the buyer paid transportation costs from the place of production is the FOB price or freight on board price.

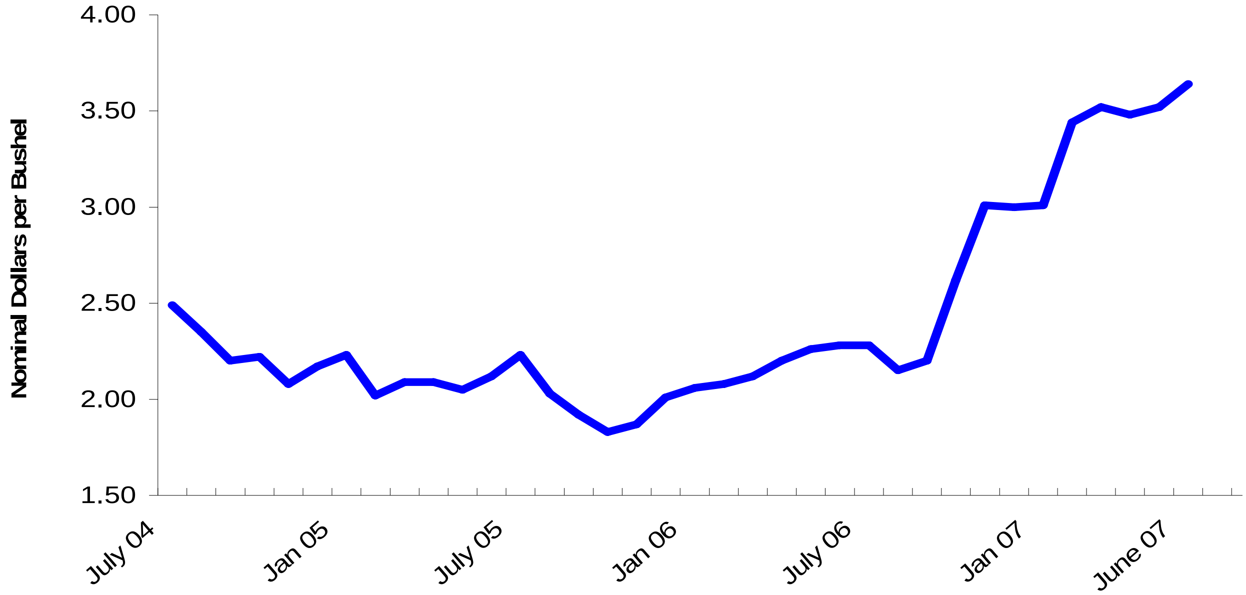

Figure 11. Monthly Average Corn Price Received in Illinois and Futures Price
Data Source: FarmDoc, University of Illinois

The balance among corn prices, ethanol prices, and operating profits is very delicate in today's markets. The ethanol price received by producers varies substantially based upon plant location, marketing contract, and transportation/marketing costs. No industry standard practice exists for transportation or marketing costs. The closest location to the Illinois plants for which the Agricultural Marketing Service provides freight on board (FOB) prices is Des Moines, Iowa. At the October 10, 2007, price of $1.43 a gallon (USDA-AMS 2007), a plant with the costs in our scenario would have operating losses. Therefore, we use the lowest FOB ethanol price that would allow the plant to break-even, $1.80. Ethanol operating profits are sensitive to energy prices on the input cost side, too (Table 6). Natural gas and electricity cost 14 cents per dollar of ethanol at mid-2007 prices (Table 4).

Table 6. Selected Costs and Revenue (millions of dollars)

	60 MGY Plant	100 MGY Plant
Cost of Corn, $3.50 per bushel	79	131
Cost of Energy	22	36
Cost of Water and Sewer*	0.3	0.6
Cost of Chemicals, Enzymes, Yeasts	7	14
Cost of Rail Transportation**	0	0
Cost of Labor	2	2
Revenue from Ethanol, $1.80 per gallon	108	180
Revenue from Distillers' Grains	21	35
Total Costs	126	209

* Water costs are on the low-end here; these costs vary greatly by plant.

**Rail Transportation costs vary greatly by plant and are assumed to be zero because we assume FOB ethanol price.

Local Corn and Cattle Production Assumptions

Having estimated that a typical 100 MGY plant will utilize 37.4 million bushels of corn per year, at a value of $131 million when corn is $3.50 per bushel, the next question is the source of that corn. Local corn production can be expected to increase when a premium-paying ethanol plant locates within the area. Depending on local conditions, including the size of the premium relative to the transportation costs it defrays, the premium can lead to conversion of other lands into cropland, substitution away from other crops into corn, neither, or both. For areas with prime farmland, like Kankakee and Coles, most productive agricultural land is already in crops. There a reasonable assumption is that cropland acres will remain unchanged in the short term, and any corn increase must be offset by a decrease in production of other crops. The usual practice of rotating corn with soybeans to prevent pest problems may be postponed, with corn planted in consecutive years.[7] Conservation Reserve Program land is not a significant short-term option to increase cropland because it is under contract with withdrawal penalties. Thus far, attempts to change the rules to waive the penalty have not succeeded. For areas with less productive farmland, land in forage crops and other uses, including recreation, and vacant land, might be drawn into corn production.

The proposed plants in Coles and Kankakee will be able to draw most of their corn locally, but the one in Hamilton will not, which is why it plans to use grain shipped by rail to the adjacent 1.5 million bushel grain elevator. Table 7 shows the number of bushels needed to operate each plant at full capacity and the bushels of corn harvested in its county in 2006. Coles and Kankakee counties probably will source all of their corn from within the county, because 90 percent of the quantity needed is already produced within the county and the corn premium should result in it being sold to the plant. Furthermore, farmers can substitute away from soybeans and grow corn following corn. On productive farmland, the added returns to corn will cover the costs of additional inputs and decreased yield that makes up for the failure to rotate (Roe and Jolly 2006).

Table 7. Corn Harvest in Home County, Three Case Study Plants

	Bushels Harvested for Grain (millions), 2006	Bushels Used by Plant (millions)	Percent Already Locally Produced
Coles 60 MGY	19.2	21.4	90%
Hamilton 100 MGY	8.2	35.7	23%
Kankakee 100 MGY	32.2	35.7	90%

Data Source: NASS Illinois Ag Stats, 2006, and appendix.

Teasing out an ethanol plant's effect on substitution among crops is difficult. Substitution depends on relative prices, and relative prices depend on the extent of substitution. Modeling the substitution effect requires determining how many acres will be converted and how many dollars would result from the output gained in corn and lost in soybeans. Doing that means forecasting producer behavior well and trusting the IMPLAN model to reflect accurately what happens in the local economy as farmers switch from soybeans to corn.[8]

[7] One Piatt County producer farms 3000 acres, 98% corn, and claims some of it is fifth year corn!

[8] Input-output models like IMPLAN assume constant returns to scale. They are ill suited to modeling changes at the margin that involve substitution in industries with scale economies like corn and soybean production.

The substitution of corn for soybeans being observed in 2007 stems primarily from the relative changes in corn and soybean prices at the national level. The price changes are being driven by overall supply and demand conditions, including the growth in the number of ethanol plants, not by any one local ethanol plant. Most of the extra corn will be produced regardless of whether a new ethanol plant offering a modest premium is located within the county.

Nevertheless, for illustrative purposes, we shall estimate the effects of certain amounts of corn-soybean substitution as if it were caused entirely by the plant. To best assess the net effect of substituting corn for soybean production, we calculate the number of acres of corn needed above the 2006 production levels to meet the proposed plant's entire demand. We assume farmers will grow corn rather than soybeans to satisfy that demand and calculate the dollar output decrease in soybeans and dollar increase in corn from converting the necessary acreage. We assume realistically that there are no employment changes on the farm from the crop change.

Finally, the local ethanol plants might lead to increased numbers of cattle on feed. Indeed, the Renewable Fuels Association (2007) has noted an increase in livestock production near ethanol plants, likely due to availability of the relatively inexpensive feed that is a by-product. Given the productivity of cropland in Kankakee and Coles, additional cattle are unlikely because the rich cropland is more profitable in corn production than in cattle. However, Hamilton County, with a below Illinois average corn yield of 140 bushels per acres in 2006, has the possibility of increased cattle production. To get a sense of the magnitude of local economic effects, we model a 200 percent increase in cattle. A full blown study of an integrated ethanol plant and large-scale feedlot would require the same kind of attention to detail and research on that new cattle-feeding technology as was done here for ethanol. Instead, we simply use the current technology in IMPLAN to make a rough estimate.

Farmland Value and Rent Assumptions

The locally caused substitution effect of an ethanol plant, as opposed to those caused by ethanol plants collectively, results from the corn price premium. It generates income over and above what producers would have received at their local grain elevators, and it becomes capitalized into land values. Producers will produce more corn, but land prices and rents will rise. Producers who own their farmland profit by keeping the corn premium, and producers who rent farmland face higher rents (ISPFMRA 2007). In short, with land as the fixed factor in corn production, the corn price premium from proximity to ethanol plants accrues to farmland owners in the forms of higher rents. The local premium is pocketed by the producer in the initial period but affects rents and land value, for instance, when the next year's cash rent is negotiated. In the long run, benefits will accrue mostly to the land owner rather than the producer.

Fragmentary empirical evidence exists on the increases in farmland values and cash rents after an ethanol plant locates locally. The Illinois Society of Professional Farm Managers and Rural Appraisers (2007) found a $250 to $500 per acre premium on land values close to ethanol plants in northwest Illinois, which translates into a 5 to 10 cent premium per bushel.[9] Ethanol Producer Magazine reports a 5 to 10 cent per bushel premium paid on the 2007 corn crop (Schill 2007). Apparently no rigorous studies have yet separated the ethanol plant proximity effect from the many

[9] Assuming a 3.5 percent rental return rate and 180 bushels per acre

other factors increasing farmland values. Generally increases in farmland value caused cash rents to rise 10 percent between the 2006 and 2007 growing seasons, and they are projected to increase approximately 10 to 20 percent for 2008 (ISPFMRA 2007). The Federal Reserve Bank of Chicago (Oppendahl 2007) found that the value of good Illinois farmland increased by 6 percent in 2006 and varied regionally, for instance, 17 percent near Chicago and 4 percent in east central Illinois. A reasonable baseline estimate is that a new ethanol plant will cause local farmland prices to rise by the premium paid to producers. We use 5 cents per bushel, a 1.4 percent increase but also consider an alternative high-end scenario with a 10 percent or 35 cents per bushel increase.

The annual additional income to all farmland owners from the premium paid by a local ethanol plant can be imputed as the additional rental income if all farmland were cash rented to producers. The annual rate of return or cash rents for farmland is 3.5 percent, based on historical rates of return (ISPFMRA 2007), so the cash rent premium from proximity to an ethanol plant is 3.5 percent of the higher land value.

Local Ownership Assumptions

Only a portion of the imputed additional income of farmland owners affects the local economy; income of absentee landlords leaves the local community. Again, information is fragmentary and incomplete, leaving a wide band of uncertainty (Table 8). ISPFMRA (2007) finds 55 percent of farmland not owned by the operator. A 2002 Iowa State University survey found that 45 percent of Iowa farmland owners do not live on the land and 19 percent of Iowa farmland is owned by those living out-of-state (Duffy 2004). These estimates suggest that local ownership is greater than 45 percent and less than 81 percent. The analysis that follows uses both extremes.

Table 8. Evidence on Percent Local Land Ownership

Source	Finding	Implication
ISPFMRA 2006	55% IL farmland not owner operated	Local ownership > 45%
Duffy 2004	19% IA farmland owned out-of-state	Local ownership <81%

The added income of local farmland owners is calculated in a few steps, illustrated here with a 1.4 percent land value increase, 3.5 percent of land value as rent, and 45 percent local ownership (Table 9). The average land values for each county's average type of farmland (ISPFMRA 2007) multiplied by the acres of cropland forms the starting point. The added income to local landowners ranges from $75,700 in Hamilton, where cropland values are lowest per acre, to $331,000 in Kankakee, where cropland values per acre and the number of cropland acres are highest.

Table 9. Calculation of Premium to Land Owners Due to Corn Price Premium

	Coles	Kankakee	Hamilton
Average Land Value per acre(ISPFMRA)	$2,908	$4,500	$1,669
Acres of Cropland(USDA)	238,586	333,821	205,784
Value of Cropland	$693,808,088	$1,502,194,500	$343,453,496
Increase in Land Value (1.4%)	$9,713,313	$21,039,723	$4,808,348
Land Value Increase to Local Owners (45% local ownership)	$4,370,990	$9,463,825	$2,163,757
Rental Income Increase from Land Value Increase (rent = 3.5% of value)	$152,984	$331,233	$75,731

Modeling Assumptions

All the scenario deliberations reduce to four ways a new ethanol plant can affect the local economy: (1) producing ethanol, which entails purchasing labor and other inputs locally, (2) paying a premium for corn, which provides added income for farmland owners, (3) drawing additional land into corn production, and (4) increasing cattle production. In IMPLAN modeling language, the event being modeled is an increase in ethanol output within the county, an increase in land owners' income, an increase in corn acres, and a decrease in soybean acres to accommodate the substitution into corn. Creating the models to measure the effects of the scenarios on the local economy is straight forward with the commercially available IMPLAN software and database (www.implan.com), but four aspects of corn-based ethanol add some complexity.

First, as noted, the IMPLAN model has no modern dry mill ethanol industry, so we added one by modifying the wet mill technology. A gasoline blender is not added to the models because we assume all ethanol will be sold to a non-local gasoline blender. We also assume the ethanol plant is not locally owned because most of the newest plants are not (Swenson and Eathington 2006).

Second, input-output models are demand-driven; they assume that when demand exists, supply will be forthcoming. At the extreme, the models imply that local producers will respond to the demand from the new ethanol plant and, hence, produce another 37.4 million bushels of corn. A common mistake when calculating the economic effects of a new ethanol plant is to treat all the local corn used by the plant as new output; corn that would have been produced locally anyway is not part of the local economic impact of the plant. To avoid this problem, we set the regional purchase coefficient for corn in the model to zero, thus, preventing the ethanol plant's corn demand being transformed into new corn production within the county.[10]

Third, cornbelt counties are already close to their short term capacities for corn and soybean production, and corn will be grown regardless of whether the purchaser will be a grain elevator or a new local ethanol plant. The ethanol plant should not be credited for the employment and income resulting from existing corn output in the county or from switches between corn and soybeans that are driven by general market prices. The relevant change is any resulting from the local corn price premium offered by the plant to attract the corn away from other uses.

Given interest in the effect of corn-soybean substitution and ignoring this fundamental issue of untangling general and local price causality, we estimate the local economic effects of corn-soybean substitution. To illustrate, we calculate the number of acres that must be planted in corn using 2006 average yield per acre, so that total production in the county equals all the corn needed by its new plant. Average prices permit estimating the value of the decrease in soybean output and the increase in corn output. Per worker output values are manipulated within the model, so that the net employment effect of switching from soybeans to corn production on the farm is close to zero.[11]

[10] The regional purchase coefficient measures the proportion of demand that can be satisfied by the local economy.

[11] Input-output models like IMPLAN assume constant returns to scale. They are ill suited to modeling changes at the margin that involve substitution in industries with scale economies like corn and soybean production. Thus we have to modify the constant returns assumptions for the model to represent real employment decisions as a result of the corn/soybean substation.

Hamilton County does not have enough acres to produce the corn needed for its proposed plant due to relatively low yields and a terrain less suitable for row crops; there we put all tillable land into corn production, leaving the remaining corn to be imported.

Table 10. Estimated County Change in Corn Output and Soybean Output

	Hamilton	Kankakee	Coles
2006 Corn Acres Harvested	58,700	73,400	114,000
Additional Corn Acres Needed and Feasible	90,000*	43,500	20,000
Value of Additional Corn Output ($ millions)	43.9	25.5	11.7
Value of Decrease in Soybeans ($ millions)	18.4	33.1	9.1

Data Source: 2006 Illinois Ag Stats, NASS, USDA

*Over 209,000 acres are needed, more than Hamilton County can provide. Analysis is limited to a feasible number of additional corn acres.

Fourth, we model the local effects of the corn premium as income to land owners, or proprietor's income in IMPLAN modeling language. It could be modeled as additional household income, but proprietor's income seems better because farmland owners are more likely to reinvest the income in their farms than treat it as additional household income (Swenson 2007).

A few more decisions merit brief mention. The geographic area for each model is the county of the proposed plant, not the full drawing area of the plant's labor force and other inputs. Using larger areas would lead to larger economic effects because more inputs could be sourced within the larger area. Construction period effects of the plant are not considered, in part because they are short lived and most ethanol plant construction is performed by industry specialists from outside the area. The price of corn does not enter the model explicitly but is an important factor in estimating the return to landowners and the production coefficients of the ethanol industry.

Modeling Results

<u>Plant Operations</u>

The prototypical 100 MGY ethanol plant itself generates $203 million in sales and employs 39 full-time equivalent workers, creating $2.4 million in wages (appendix). The smaller, 60 MGY plant generates $121 million in sales and employs 35 full-time equivalent employees. These are the direct local effects of the plants on output and employment. In addition, indirect effects result from the local purchases of goods and services by the plant, as well as the local purchases of goods and services by the local firms that supply the plant. Furthermore, there are induced effects from the consumption expenditures by employees of the plant, its suppliers, and their suppliers.

At full capacity, considering the direct, indirect, and induced effects, the proposed plants would generate 153 jobs in Hamilton County, 152 in Coles, and 248 in Kankakee (Table 11). The largest economic impacts are in Kankakee, which has the most complex economy and a large plant. More generally, job creation is lower the more rural the county, a typical finding in impact studies, because more multiplier effects happen locally when more goods and services are available locally.

Table 11. Economic Effects of Ethanol Plant Operation

	Hamilton, 100MGY Rural		Coles, 60MGY Mixed Rural Micropolitan		Kankakee, 100MGY Mixed Rural Metropolitan	
	Total Output (millions)	Employment	Total Output (millions)	Employment	Total Output (millions)	Employment
Direct	214.6	39	128.8	35	214.6	39
Indirect	14.6	97.1	15.4	82.7	27.2	152.1
Induced	1.6	16.7	3.0	34.6	5.7	59.1
Total	230.8	152.7	147.2	152.2	247.6	250.1

Data Source: IMPLAN regional input-output economic impact estimator, 2006 data

The results for the three study areas illustrate how important local conditions are in determining the indirect and induced effects of an ethanol plant. An identical plant leads to 100 more jobs in Kankakee than in Hamilton, which has a population of only 8,000 and a far smaller local economy. Likewise, the 60 MGY plant in Coles has the same total employment effect than the 100 MGY Hamilton plant because Coles has a more complex economy. In output terms, the Hamilton economy grows more than the Coles economy and almost as much as the Kankakee economy, but solely because plant output is the dominant output changes.

To create a better understanding of how the effects occur within an economy, Table 12 shows the employment effects for the sectors most affected in Kankakee County.

Table 12. Employment Effects of Ethanol Plant Operation, Kankakee

Sector	Direct	Indirect	Induced	Total
Sum of all sectors	39	152	59	250
Truck Transportation	0	57	0	57
Dry mill ethanol	39	0	0	39
Natural Gas Distribution	0	14	0	14
Food Services and Drinking Places	0	5	7	12
Wholesale Trade	0	10	2	12
Other State and Local Gov't	0	7	0	7
Civic-Social-Professional Organization	0	4	1	5
Automotive Repair and Maintenance	0	4	1	5
Monetary Authorities and Depositories	0	3	1	4
Hospital	0	0	4	4
Maintenance and Repair of Nonresidential Buildings	0	4	0	4

<u>Corn Premium</u>

Compared to plant operations or corn production, the land rent changes resulting from the corn premium have relatively small effects. With the 1.4 percent land value increase and 45 percent local land ownership rate, Hamilton's added rental income of $75,700 creates a fifth of a job, Cole's $153,000 yields 1 job, and Kankakee's $331,000 generates 2.2 jobs (Table 13).

Table 13. Economic Effects of Ethanol Plant Corn Price Premium, 1.4% land value increase, 45% local land ownership

	Hamilton 100MGY		Coles 60MGY		Kankakee 100MGY	
	Total Output (thousands)	Employment	Total Output (thousands)	Employment	Total Output (thousands)	Employment
Direct	75.7	0.2	153.0	0.7	331.2	1.6
Indirect	1.5	0	9.3	0.1	25.8	0.2
Induced	1.1	0	10.9	0.1	33.6	0.3
Total	78.3	0.2	173.2	1.0	390.7	2.2

Since the farmland rent and ownership assumptions are based on such fragmentary information, sensitivity analysis is worthwhile. Table 14 shows the imputed rental increases under several assumptions. The highest, a 10 percent rent increase with 80 percent local ownership, generates 12.7 times as much imputed local rental income as the far more likely 1.4%, 45% scenario. Given the proportional nature of input-output models, 12.7 times more income produces 12.7 times more local effect. The 10%, 80% assumptions bring the local economic effects of the corn premium to 28 jobs in Kankakee, 12 in Coles, and 3 in Hamilton (Table 15). The two middle options would produce effects 1.8 and 7.1 times those shown in Table 13.

Table 14. Rental Income Increases, Alternative Assumptions

Assumptions	Hamilton	Coles	Kankakee
1.4% land value increase, 45% local land ownership	$75,731	$152,985	$331,234
1.4% land value increase, 80% local land ownership	$134,634	$271,973	$588,860
10% land value increase, 45% local land ownership	$540,939	$1,092,748	$2,365,956
10% land value increase, 80% local land ownership	$961,670	$1,942,663	$4,206,145

Table 15. Economic Effects of Ethanol Plant Corn Price Premium, 10% land value increase, 80% local land ownership

	Hamilton, 100MGY Rural		Coles, 60MGY Mixed Rural Micropolitan		Kankakee, 100MGY Mixed Rural Metropolitan	
	Total Output (millions)	Employment	Total Output (millions)	Employment	Total Output (millions)	Employment
Direct	1.0	2.4	1.9	9.2	4.2	20.1
Indirect	0.02	0.2	0.1	1.4	0.3	3.1
Induced	0.01	0.2	0.1	1.6	0.4	4.4
Total	1.0	2.7	2.2	12.2	5.0	27.6

The decision to treat these rents as proprietor income rather than household income makes a small difference. Modeling the extreme case as additional income to households with incomes of $75,000 to $100,000 yields a total output of $5.1 million with 36 jobs in Kankakee, instead of the $5.0 million and 28 jobs when modeling it as proprietor income.

Corn-Soybean Substitution

Conversion of 43,500 acres to corn in Kankakee, 20,000 in Coles, and 90,000 in Hamilton (Table 10) results in a net increase in farming output because corn has a higher value than soybeans. Table 16 shows the estimated change in output and the economic impact of substituting what would normally be acres of soybeans for acres of corn.

Table 16. Estimated Economic Impact of Switching Soybean Acres to Corn Acres to Meet Plant Demand

	Hamilton 100MGY		Coles 60MGY		Kankakee 100MGY	
	Total Output	Employment	Total Output	Employment	Total Output	Employment
Direct	10.8	0.1	4.0	0.1	5.6	0.7
Indirect	1.4	13.2	0.7	10.1	3	22.6
Induced	0.03	0.3	0.3	3.2	0.5	4.7
Total	12.3	13.6	3.0	13.2	9	28.0

The effects vary among the counties because of differences in acreage, yields, and the local economies. Kankakee again has the largest indirect and induced effects because its local economy is able to provide more goods and services. Hamilton has the largest direct output effect largely because the most acreage is converted there. The negligible direct employment effects reflect the assumption built into the analysis that there would be no labor change on the farm from converting acreage.

Feeder Cattle

We assumed Hamilton County's cattle industry would triple in size from 3,000 to 9,000 head, a small amount compared to the 100,000 cattle that the plant's by-products could feed at any one time. Since no integrated feedlot is planned, and it takes time to breed cattle and create the infrastructure to raise, process, and transport extra cattle, this tripling of production is reasonable for the first few years and serves to illustrate a cattle scenario. Recall that modeling a large, integrated feedlot should involve changing the cattle production coefficients in the model. Using the existing sector, the scenario implies an extra $5.4 million in cattle sector output and an extra 37.8 jobs in the cattle sector. Eighteen indirect jobs result, including 8.5 in cattle production, including raising calves, 3 in forage production, 2 in real estate, and 1 in veterinarian services. In all, tripling the cattle industry creates a total of 59.4 jobs and $8.3 million in additional output.

Summary

The dominant effect on the local economy in terms of job creation is from the operation of the ethanol plant. In the four case studies, there are 35 to 39 jobs at the plant and 99 to 250 after all the indirect and induced effects in the county are included. Increases in cattle operations, where feasible, could have large effects, but the effects depend on the technology to be used, its integration with the local economy, and its labor intensiveness. The effects of the corn price premium are small, whether through rent increases, land values, or crop substitution.

Comparing results to other studies is a useful check of any impact study, but the opportunities for comparison are limited here. Most reports are vague about their assumptions and utilize the wrong industry sector, treating ethanol plants as wet corn milling instead of creating a dry mill industry (e.g., Petersan, 2002 and Pierce et al., 2006). In a report for the Renewable Fuels Association, Urbanchuk (2008) estimates a 100 MGY ethanol plant will lead to 1,137 jobs in the local economy and 1,790 jobs statewide. That local impact is four times the 250 jobs found here for Kankakee and eight times the 153 jobs for Hamilton (table 7). Noting that the size of the impact will depend on the "the amount of inputs that will be sourced locally," Urbanchuk makes some simplifying assumptions, e.g., half of the corn will procured from farmers within 100 miles, and his results are not for any particular area or state. The choice of areas does not explain the big difference between his numbers, which are widely distributed by the Renewable Fuels Association, and the numbers here. Modeling the statewide effect of a 100 MGY plant in Illinois in the same way as for the four counties, again without the corn premium and cattle effects, yields 581 jobs, far fewer than the 1,790 reported by Urbanchuk. Since Illinois ought to have larger impacts, not smaller impacts, than a prototypical state because of the size and complexity of the Illinois economy, the differences in the studies are not caused by the choice of places.

The more modest results here are similar to those of Swenson (2008). His 50 MGY plant for regions of Iowa leads to $133.5 million total output and 133 jobs, proportionately comparable to the economic impact of the 60 MGY Coles County plant, $147.2 million output and 152 jobs from the plant operations (without corn premium and cattle effects). Likewise, his 100 MGY plant leads to $254 million output and 170 jobs, more jobs than the same size plant in rural Hamilton but fewer than in metropolitan Kankakee, and output almost the same as in Kankakee (table 7).

The differences among studies stem chiefly from the assumptions made in the scenarios. Any study that considers the corn production and the corn producers an impact of the plant will yield far larger numbers than one that assumes correctly that most of the corn would have been grown anyway. Urbanchuk's method includes the effects of growing corn, which Swenson (2007) estimates accounts for 18, 398 jobs of the 27,205 that Urbanchuk attributes to ethanol in Iowa. The core assumption built into the input-output model, constant returns to scale or everything is proportional, is particularly bad for ethanol. It is a heavy user of water, natural gas, and electricity, utilities that are the textbook example of industries with decreasing, not constant, costs to scale. Based on interviews with industry professionals, Swenson (2007) takes another 1,943 jobs away from Urbanchuk's Iowa total because the utilities do not add jobs proportionately to their output increases. Swenson chips away further: 1,081 jobs stemming from transportation because the corn would have been transported to export without the ethanol plant and 351 jobs from petroleum refining unlikely to occur in Iowa. In the end, changing the assumptions reduced the estimated Iowa job impact from 27,205 to 5,431.

Thus, assumptions matter, a lot. Understanding an industry, and how the various parts of its supply chain respond to demand changes, and understanding the assumptions made in regional input-output modeling are essential when conducting an economic impact analysis. The world is not as simple as the demand-driven, fixed proportions input-output model. With more detail than possible in this paper, the series of reports, Swenson (2006, 2007, 2008) and Swenson and Eathington (2006), illustrates beautifully what must be done to conduct a well-informed industry economic impact analysis.

Conclusions

An ethanol plant offers the same enticing benefits to the local economy as any manufacturing plant that employs 30 to 50 people and pays good wages. Local economic development in many places is aimed at attracting such enterprises because they provide jobs and a local tax base, increase demand for housing and land, and provide customers for local businesses. A common danger is that the manufacturing plants and other establishments that can be attracted to an area often are the very ones that can be re-attracted elsewhere when conditions change to favor another location, for example, because of free trade agreements or lower wages. In contrast to typical "footloose" industries and branch plants, ethanol production is tied to local advantages and resources—the corn, the railroad, the water and energy, and the proximity to markets. Rooted in the local economy in this fashion, ethanol production offers more security than many other industrial employers.

The security of ethanol jobs is undermined for other reasons, however. The industry's long-term, and even mid-term, evolution is uncertain. There are dark storm clouds on the horizon. Various doomsday scenarios are easy to conjure up, each of which would put particular ethanol plants at risk. Corn might be replaced by other feed stocks, which might change the relative advantages of Cornbelt locations.[i] The energy and corn price balance could squeeze profits so that only plants with a particular technology and facing relatively low energy and feedstock prices would survive. The protective policy umbrella might develop some holes. Other cheaper, oxygenates might be created. The scale of the industry might continue to evolve toward larger plants, more efficient technologies, and vertically integrated companies, and the industry could consolidate, driving out many of today's ethanol plants like the local meat processing plants of yore. Plants might change ownership repeatedly, as new owners try to cut costs and become profitable. The good jobs and tax base, the very benefits that made the ethanol plant desirable for local economic development, may erode as the plant provides fewer good jobs and asks for tax credits and other fiscal incentives to remain in business. At the end, which may be only a few years away, a community may be left with only a vacant plant and unpaid bonds for new water, energy, and transportation infrastructure. Ethanol will be the latest on the list of robust heartland industries that have disappeared. Indeed, in the past months the plans for plants in Kankakee and Coles have been dropped, and the Harlan and Hamilton plans are at a standstill. Location factors suggested these were good sites, but the economics of the industry and the currently high corn prices and relatively low ethanol prices make the business too risky right now.

Another, better story of ethanol and local economic development can be told. The storm clouds dissipate. Energy prices and new industrial and agricultural technologies combine to make ethanol a sustainable industry in the Cornbelt (or for whatever crop the belt is known in the ethanol age). In that case, the ethanol plant is a long-term part of the local economy—not a magic change agent that hires hundreds and allows high school graduates to stay in the area, but a contributor of good jobs, a local market for value added agricultural production, a good corporate citizen, and one of the anchors of the local economy.

Under these long-term conditions, the local economic development concern is not the plant's industrial survival but the nature of the terms under which it locates there. Ethanol production requires large quantities of water and energy and puts a considerable burden on the road system. The water demand alone is controversial in areas where residents worry about depleting aquifers, and any project that generates a lot of truck traffic also brings out local opposition. The fiscal impacts and the plant's balance of costs and revenues merit careful consideration. In the flurry of inter-county competition for ethanol plants and amidst the enthusiasm for adding jobs, stimulating economic activity, and supporting value-added agriculture, local decision makers forgetting to tote up the local benefits and costs is understandable, but could be a serious mistake.

The number of jobs created or other measures of economic activity depend on the size of the plant, complexity of the local economy, what goods and services are available locally, and how much income is generated locally by the corn price premium. The ethanol plant leads to 250 jobs under the most favorable assumptions for job creation in the most complex economy with the highest farmland values. In all, these numbers mean an ethanol plant is a contributor not a panacea for a county, more like a corn chip manufacturer than an automobile plant. Its economic contributions are small enough to merit a careful look at the demands a plant would place on local services, infrastructure, and resources and to recognize the uncertainties that surround the ethanol industry and the viability of a particular plant.

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Appendix. The Hypothetical Ethanol Plant

Table A summarizes the production, input, and revenue assumptions used throughout this study to characterize a modern 100 MGY ethanol plant. Table A is based upon the same data used in Chapter 4 of this volume and is comparable to data collected by David Swenson, Department of Economics, Iowa State University. Swenson's data are based on interviews and information he received from industry and biological science experts. The major difference is the cost of water and water treatment and this may be because water availability and disposal varies plant-to-plant. The numbers represent a typical dry mill ethanol plant. Ethanol input technology and corn, energy, and ethanol prices are highly volatile and vary over time and space, but these data provide a plausible snapshot of such prices and input combinations. We use Swenson's methodology to scale the 100 MGY plant inputs to a 60 MGY plant.

To estimate local economic effects, we assume the plant operates at full capacity with a conversion rate of 2.8 gallons of ethanol per bushel. Some analysts use a higher conversion rate, but the 2.8 rate was reported to Swenson by organic chemists he interviewed in 2006. We assume corn is $3.50 per bushel to be congruent with analysis in other chapters of this larger study. Corn, ethanol, and energy prices are representative of autumn-2007 levels.

Fall 2007 FOB ethanol prices predict a loss for the ethanol plant. This illustrates how volatile corn and energy prices make ethanol a risky business. We have increased the FOB price by close to 50 cents per gallon of ethanol, so that the plant breaks even for our analysis. Should federal subsidies to the ethanol purchaser were reduced from current levels, the ethanol price and plant revenues would likely drop. In short, the short-term profitability or losses of an ethanol plant at any give time are highly dependent upon technology, prices, and public policy that affects both input and ethanol prices.

Table A: Costs and Revenues of a Hypothetical 100 MGY Ethanol Plant

Production Assumptions	**Baseline**	**Ranges**		
Rated capacity (gal per year)	100,000,000	20 to 100 million		
Nameplate factor	100%	90% to 120%		
Denatured Alcohol (gal per bushel)	2.8	2.5 to 2.9		
DDGS yield (lb per bushel)	18	15 to 22		
CO2 yield (lb per bushel)	7.7	15 to 22		
Primary Inputs	**Baseline**	**Input Costs**	**Prices / cost**	**Unit/Basis**
Corn (bu)	37,428,571	131,000,000	3.5	Bushel
KwH Electricity	75,000,000	6,000,000	0.08	KwH
Natural Gas (btu* bu*alc. yield)	3,353,600,000,000	30,182,400	9	Million BTU
Other Inputs				
Enzymes		5,432,832	0.145	Bushel
Yeasts		2,490,048	0.067	Bushel
Chemicals: processing and antibiotics		2,263,680	0.06	Bushel
Chemicals: boiling and cooling		679,104	0.018	Bushel
Denaturants		4,094,835	0.109	Bushel
Water		600,000	0.017	Bushel
Real estate tax, licenses, admin		2,000,000		
Unspecified costs		7,857,143	0.22	Bushel
All interest costs (average of 1st 5 years)		8,875,951	0.089	Bushel
All other unspecified		7,857,143	0.22	Bushel
Labor				
FTE	39			
Average Wage and Benefits	$62,500			
Total labor and management	$2,437,500			
Total Costs		$209,482,601		
		Production Income	**Price Received**	**Unit**
Denatured alcohol (gal)	100,000,000	180,000,000	1.8	Gallon
DDGS (tons)	346,500	34,650,000	100	Ton
CO2 (tons)	145,000	-	0	Ton
Total Revenue		$214,650,000		

[i] Epplin et al. (2007) envision a centrally managed and coordinated, vertically integrated cellulosic feedstock production and delivery system based on a low-cost perennial such as switchgrass. They cite one study positing that 55 million acres of cropland, idle cropland, and cropland pasture could be seeded in a perennial energy crop and another concluding that 100 million acres could be devoted to switchgrass with some economic incentives.