Economic Impacts of the Ethanol Industry

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The ethanol industry has transformed Iowa over the past four decades. Starting with some entrepreneurs in the 1970s and 1980s, ethanol's growth has been tied to the Iowa countryside and, more directly, to Iowa's corn production. With the waves of development with wet mills in the 1980s and dry mills more recently, the industry has continued to expand and explore new production and marketing opportunities. This report outlines the growth and current state of the ethanol industry, specifically for Iowa, and details the various economic and financial impacts the industry has had within the state, including to the local economy, corn prices, land prices, and distributional ownership patterns.

The oil crisis of the early 1970s spurred development of alternative energy sources. That crisis set up the first wave for the ethanol industry. By 1978, Iowa ethanol facilities could produce up to 10 million gallons per year. The development of wet mills in corn processing in the late 1970s and early 1980s greatly expanded ethanol capacity. With ADM in Cedar Rapids and Clinton and Cargill's investment in Eddyville, Iowa's ethanol production rose to over 200 million gallons by 1990. In the 1990s, the ethanol industry also benefitted from interest from corn producer groups and rural investors that wanted to create smaller, regional-level energy opportunities. That movement became the force behind the tremendous expansion of dry mill ethanol plants that dominate the ethanol industry today. By 2000, Iowa's ethanol industry had grown to 440 million gallons, with the vast majority of production in wet mill plants. But by 2010, dry mills had become the major production plan and the industry had roughly 3.5 billion gallons of capacity.

State-level Comparison

As of early 2012, Iowa's ethanol industry has 3.852 billion gallons of production capacity. Iowa was not the only state to participate in the ethanol boom. Many other states have seen a similar expansion in biofuel production. Currently, there are over 230 ethanol facilities in the United States with a productive capacity of approximately 15 billion gallons. The vast majority of these facilities utilize corn as the feedstock for ethanol conversion, but there are plants that use sorghum, sugar cane, cheese whey, wood, potato, beer waste, and other vegetative materials to produce ethanol. Figure 1 shows the state-level distribution of ethanol production capacity, lists the millions of gallons of capacity, and outlines the percentage of the national total in each state. Iowa is the top producing ethanol state in the country, holding one-quarter of the nation's ethanol capacity. In fact, Iowa's ethanol industry is larger than the combined size of the other two states in the top 3. Nebraska is second with just over 2 billion gallons of ethanol capacity. A sizable portion of that capacity is located near the Iowa-Nebraska border. Illinois is 3rd with 10% of the nation's ethanol capacity. All of the top 10 ethanol states are in the upper Midwest, but there are ethanol plants from coast to coast, from Florida and New York to Oregon and California. And the push to develop biofuels has opened up research and development of alternative biofuel systems in various parts of the country, exploring crop residues, perennial grasses, and municipal waste streams.

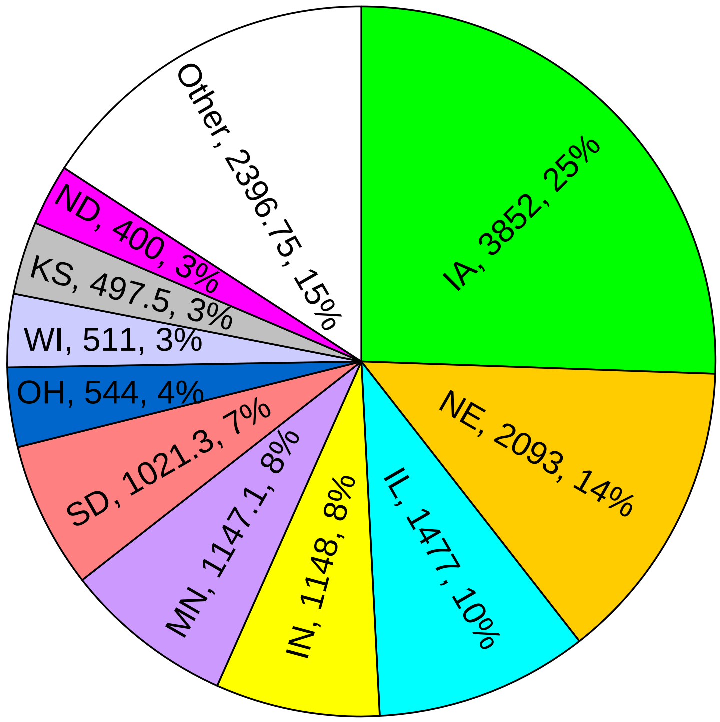

Figure 1. State-level Ethanol Capacity
Sources: Renewable Fuels Association, Iowa Renewable Fuels Association, Ethanol Producer magazine, and various industry websites

Iowa's Ethanol Industry

Table 1 details the 45 ethanol facilities within Iowa. Of those 45 facilities, 3 are under construction and 2 non-corn ethanol plants are not in production. The Iowa ethanol industry is a microcosm of the U.S. ethanol industry. While there are a few large companies in the industry (ADM, Flint Hills, Poet, and Valero), there are also many individual, locally-owned ethanol plants.

Table 1. Iowa's Ethanol Facilities

Plant Name	City	Feedstock	Producing	Not Producing (million gallons)	Under Construction
Absolute Energy	St. Ansgar	Corn	115		
Amaizing Energy	Denison	Corn	55		
ADM	Cedar Rapids	Corn	420		
ADM	Cedar Rapids	Corn	275		
ADM	Clinton	Corn	237		

Plant Name	City	Feedstock	Producing	Not Producing (million gallons)	Under Construction
Big River Res.	West Burlington	Corn	100		
Big River U. Energy	Dyersville	Corn	110		
Cargill Inc.	Eddyville	Corn	35		
Cargill Inc.	Fort Dodge	Corn			110
Corn	Goldfield	Corn	60		
Golden Grain Energy	Mason City	Corn	115		
Grain Processing	Muscatine	Corn	20		
Green Plains	Lakota	Corn	100		
Green Plains	Shenandoah	Corn	55		
Green Plains	Superior	Corn	60		
Flint Hills	Fairbank	Corn	115		
Flint Hills	Iowa Falls	Corn	105		
Flint Hills	Menlo	Corn	110		
Flint Hills	Shell Rock	Corn	110		
Homeland Energy Solutions	Lawler	Corn	100		
Lincolnway Energy	Nevada	Corn	55		
Little Sioux Corn Pro.	Marcus	Corn	92		
Louis Dreyfus	Grand Junction	Corn	100		
Penford Products	Cedar Rapids	Corn	45		
Pine Lake Corn Pro.	Steamboat Rock	Corn	31		
Platinum Ethanol	Arthur	Corn	110		
Plymouth Energy	Merrill	Corn	50		
Poet	Ashton	Corn	56		
Poet	Coon Rapids	Corn	54		
Poet	Corning	Corn	65		
Poet	Emmetsburg	Corn	55		
Poet	Gowrie	Corn	69		
Poet	Hanlontown	Corn	56		
Poet	Jewell	Corn	69		
Quad Co. Corn Pro.	Galva	Corn	30		
Siouxland Energy & Livestock	Sioux Center	Corn	60		
SW Iowa Renew. Energy	Council Bluffs	Corn	110		
Valero	Albert City	Corn	110		
Valero	Charles City	Corn	110		
Valero	Fort Dodge	Corn	110		
Valero	Hartley	Corn	110		
Dupont	Nevada	Corn Residue			27.5
Poet	Emmetsburg	Corn Residue			25
Fiberight	Blairstown	MSW		5	
Permeate Refining	Hopkinton	Sugars & Starches		3	

Figure 2 shows the physical location of these plants and relates that to corn production in the state. The vast majority of the plants are located in the prime corn production area for Iowa or are located on major transportation routes used to ship corn across and out of the state. The three largest plants are the ADM facilities in Cedar Rapids (two) and Clinton. The state's wet mill production is concentrated in the east-central and southeast regions, while dry mill production dominates the rest.

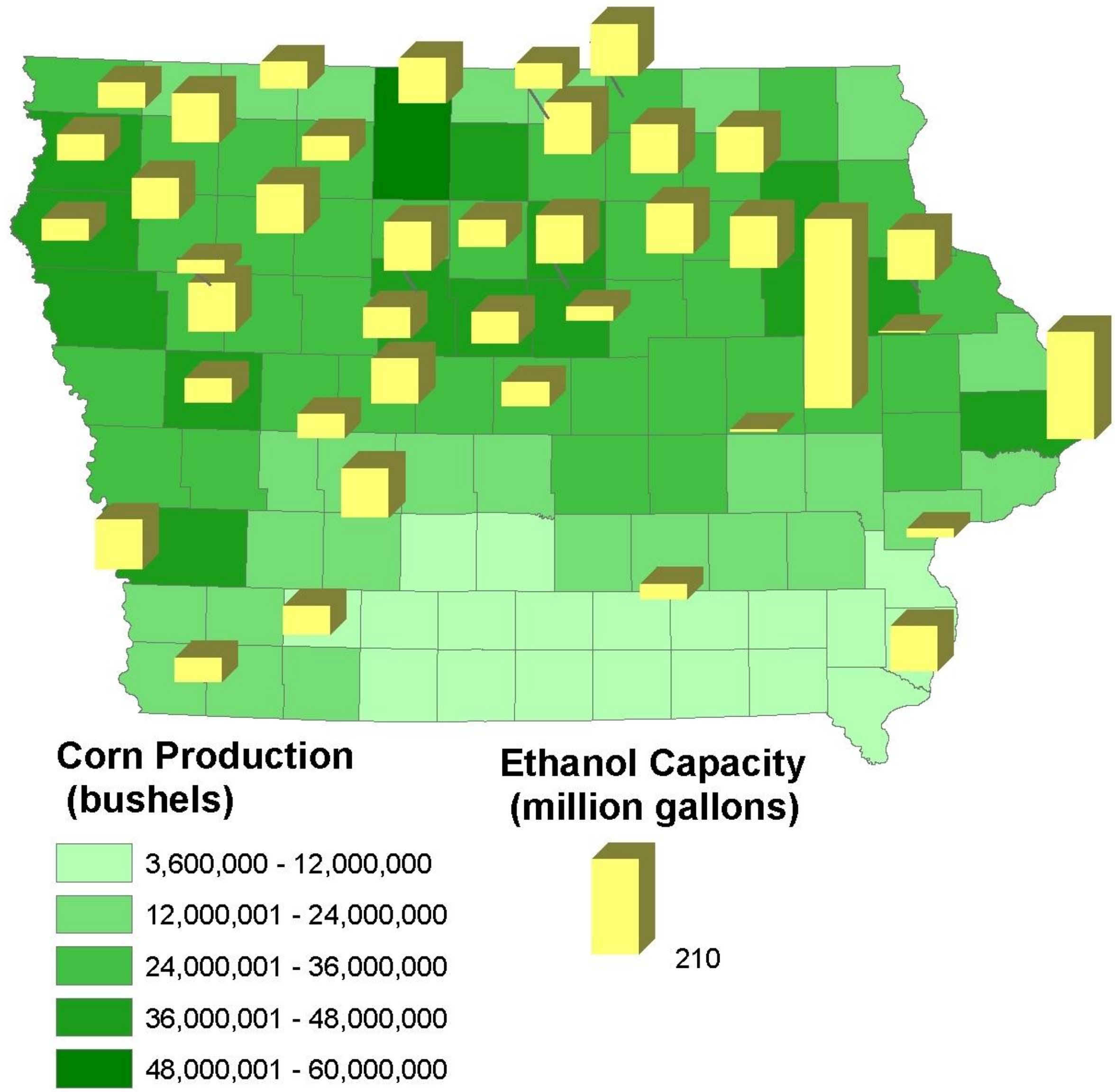

Figure 2. 2011 Corn Production and Ethanol Capacity
Sources: USDA-NASS, Renewable Fuels Association, Iowa Renewable Fuels Association, Ethanol Producer magazine, and various industry websites

For most of this report, we will examine the shifts and impacts from the ethanol industry since 2000. As Table 2 shows, there have been significant shifts in ethanol and corn production during the past 12 years. In the first six years of this millennium, Iowa's ethanol production grew by

1.06 billion gallons. In the following six years, it grew by 2.2 billion. This shift in ethanol production resulted in nearly a 8.5-fold increase in corn demand via ethanol. In order to fulfill that growing demand, Iowa's corn producers have increased production over the past decade. In 2012, Iowa corn producers plan to plant 14.6 million acres. That would be a record amount of corn planting for the state of Iowa and a 19% increase over corn acreage planted in 2000. During the past 5 years, Iowa has had 4 of its 5 largest corn crops (the 2010 crop was only the 7th largest).

Table 2. Iowa's Ethanol Production and Corn Statistics

	Ethanol Production (million gallons)	Corn Use (million bushels)	Corn Production (million bushels)
2000	440	160	1,728
2001	440	160	1,664
2002	440	160	1,932
2003	598	217	1,868
2004	859	312	2,244
2005	1,100	400	2,163
2006	1,500	545	2,050
2007	1,900	691	2,377
2008	2,750	1,000	2,189
2009	3,200	1,164	2,421
2010	3,500	1,273	2,153
2011	3,700	1,345	2,356

Sources: Iowa Renewable Fuels Association and USDA-NASS
Note: Corn Use computed at 2.75 gallons of ethanol per bushel of corn.

Ethanol and Corn Values

Normally, the tremendous increases in ethanol and corn production would have led to lower ethanol and corn prices, but demand for both products was strong enough to maintain and actually raise prices during the expansions. The average price for ethanol from 2000 to 2005 was $1.47 per gallon. From 2006 to 2011, that average was $2.29 per gallon, a 56% increase. The average price for corn from 2000 to 2005 was $2.03 per bushel. From 2006 to 2011, the average was $4.40 per bushel, a 117% increase.

Table 3. Ethanol and Corn Prices

Year	Ethanol ($ per gallon)	Corn ($ per bushel)	Year	Ethanol ($ per gallon)	Corn ($ per bushel)
2000	1.35	1.75	2006	2.58	3.03
2001	1.48	1.90	2007	2.24	4.29
2002	1.12	2.22	2008	2.47	4.10
2003	1.35	2.37	2009	1.79	3.59
2004	1.69	1.99	2010	1.93	5.23
2005	1.80	1.94	2011	2.70	6.15

Sources: Nebraska Energy Office and USDA-NASS

There are many factors that influenced the corn and ethanol markets (weather, geopolitical issues, government policy, etc.), but the largest factor affecting these markets was the global demand for liquid fuels, which created the demand pull for both commodities. Oil prices reached record highs in the summer of 2008, quickly retreated with the recession, but then recovered to hover in the $100 per barrel range recently. With oil and gasoline at historically high values, ethanol and corn have enjoyed similar record breaking values. Table 4 charts the rapid increase in Iowa's ethanol production value and the cost of the corn used in the process. While ethanol production has increased 740% since 2000, ethanol production value has increased 1,582% and the value of the corn used in ethanol production has increased 2,855%. In 2011, Iowa's ethanol industry produced nearly $10 billion worth of ethanol and that is not counting the value of co-products that are also produced. Over $8 billion worth of corn was processed by Iowa's ethanol plants in 2011.

Table 4. Ethanol Values and Corn Costs

	Ethanol ($ million)	Corn ($ million)
2000	594	280
2001	651	304
2002	493	355
2003	807	515
2004	1,452	622
2005	1,980	776
2006	3,870	1,653
2007	4,256	2,964
2008	6,793	4,100
2009	5,728	4,177
2010	6,755	6,656
2011	9,990	8,275

The rise in corn values was not limited to Iowa. As Figure 3 shows, corn futures prices, which serve as a proxy for national and global prices, experienced very similar increases. In fact, the global corn market has basically doubled in value over the past six years. While the ethanol boom was a high profile factor shaping the corn market, other factors contributed to the rise in corn values. Several studies have been conducted over the past few years to examine ethanol's impact on corn prices. Within those studies (for examples, see Lazear 2008, Glauber 2008, and Babcock and Fabiosa 2011), the estimated impacts range from 20 to 36% of the corn price increase. USDA listed a national average corn price of $2.10 per bushel from 2000 to 2005 and $4.37 per bushel from 2006 to 2011. That represents a $2.37 increase. Using the ethanol impact range from the economic studies, ethanol contributed between $0.47 and $0.85 per bushel to the corn price increase. Given that Iowa's corn producers have averaged 2.3 billion bushels of corn over the past 5 years, ethanol's rise has translated into an additional $1-2 billion of corn revenue. Nationwide, given the 5 year average production of 12.6 billion bushels, ethanol has led to a $6-10.75 billion increase in corn values.

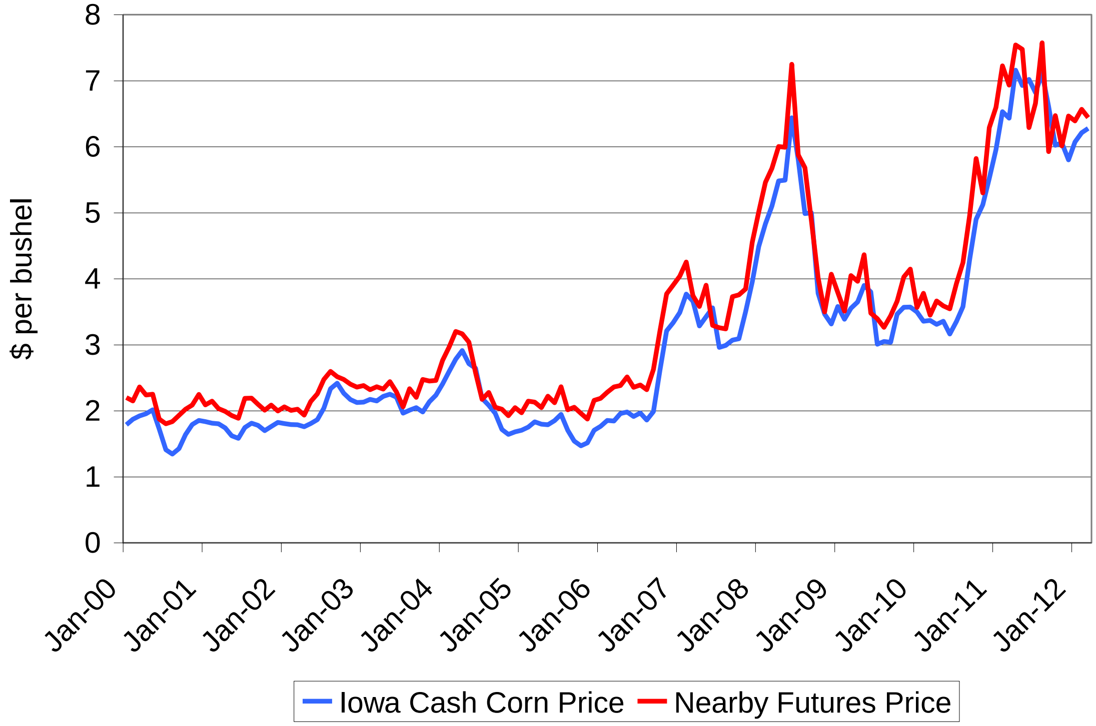

Figure 3. Iowa Cash and Nearby Futures Corn Prices
Sources: Iowa Department of Agriculture and Land Stewardship and CME Group

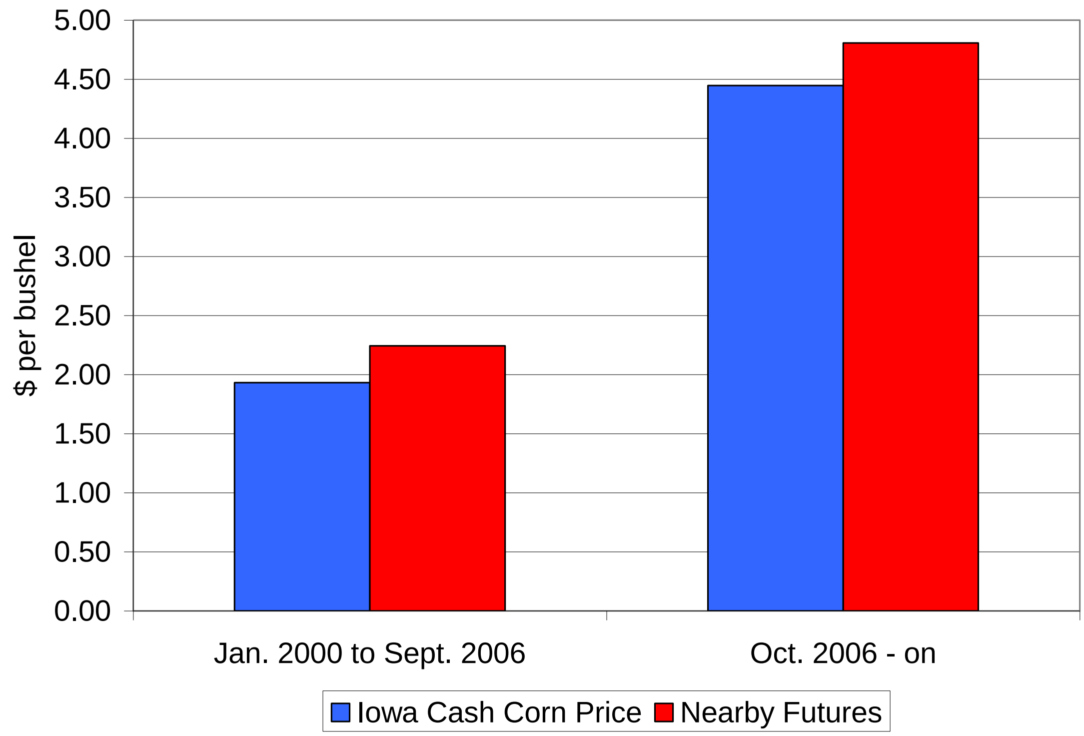

Figure 4. Average Prices Before and During the Ethanol Expansion
Sources: Iowa Department of Agriculture and Land Stewardship and CME Group

The concentration of the ethanol industry in Iowa has also reshaped the relative price relationship between national and Iowa corn prices. Historically, Iowa corn prices have been below the national average. The strong buildup in ethanol production has pushed Iowa corn prices above the national average in 4 of the last 5 years. This shift in relative prices has added another dime to Iowa corn producers' returns, providing an additional $230 million of value to the average Iowa corn crop.

Table 5. National and Iowa Corn Prices

	U.S.	Iowa	Difference
	($ per bushel)		
2000	1.85	1.75	0.10
2001	1.97	1.90	0.07
2002	2.32	2.22	0.10
2003	2.42	2.37	0.05
2004	2.06	1.99	0.07
2005	2.00	1.94	0.06
2006	3.04	3.03	0.01
2007	4.20	4.29	-0.09
2008	4.06	4.10	-0.04
2009	3.55	3.59	-0.04
2010	5.18	5.23	-0.05
2011	6.20	6.15	0.05
2000-05 Average	2.10	2.03	0.08
2006-11 Average	4.37	4.40	-0.03

Source: USDA-NASS

Ethanol Co-Products

While the discussion up to this point has concentrated on ethanol and corn, they are not the only products affected by the ethanol expansion. Both the wet milling and dry milling ethanol processes produce co-products. These co-products are typically targeted at the livestock feed market. For dry milling, the major co-product is distillers grains. For wet milling, the co-products are gluten feed, gluten meal, and corn oil. As wet milling was the dominant ethanol process until the mid-2000s, the gluten products and corn oil were the most plentiful co-products. The rapid buildup of dry mill ethanol plants, really starting in 2003, has meant distillers grains have become the major ethanol co-product today. Table 6 outlines the growth in co-product production since 2000. Gluten feed, gluten meal, and corn oil production via wet mills have increased 86%. Distillers grains production, on the other hand, has increased 6,634% since 2000.

The introduction of these co-products back into the livestock feed market has partially offset the increased cost of corn for livestock producers. The higher corn prices, while benefitting corn producers, represent higher production costs for the livestock industry. The availability of distillers grains and the gluten products offset some corn feed demand, often at less expensive feed prices. Table 7 displays the co-product prices over the past 12 years. Table 8 contains guidelines for the incorporation of distillers grains into livestock feed rations.

Table 6. Estimated Production of Ethanol Co-Products

	Distillers Grains (million pounds)	Gluten Feed (million pounds)	Gluten Meal (million pounds)	Corn Oil (million pounds)
2000	272	1,800	360	230
2001	272	1,800	360	230
2002	272	1,800	360	230
2003	1,051	1,945	389	249
2004	2,337	2,186	437	280
2005	3,524	2,409	482	308
2006	5,496	2,777	555	355
2007	7,468	3,145	629	403
2008	12,444	3,350	670	429
2009	15,226	3,350	670	429
2010	17,080	3,350	670	429
2011	18,317	3,350	670	429

Note: For each bushel of corn used in a dry mill ethanol plant, we calculate 17 pounds of distillers grains production. For each bushel of corn used in a wet mill ethanol plant, we calculated 12.5 pounds of gluten feed, 2.5 pounds of gluten meal, and 1.6 pounds of corn oil.

Table 7. Prices for Ethanol Co-Products

	Distillers Grains ($ per ton)	Gluten Feed ($ per ton)	Gluten Meal ($ per ton)	Corn Oil ($ per hundredweight)
2000	69.40	39.62	208.63	14.92
2001	84.81	45.06	226.07	15.82
2002	77.44	46.43	221.52	20.74
2003	88.23	57.10	235.23	28.50
2004	90.01	62.64	297.27	27.58
2005	60.29	54.56	271.19	28.44
2006	85.64	64.52	265.10	25.05
2007	114.43	83.86	396.66	39.20
2008	156.48	103.21	506.16	63.23
2009	111.11	76.71	532.16	34.76
2010	116.68	85.22	499.84	42.48
2011	196.44	153.18	533.52	61.20

As of the end of 2010, Iowa had approximately 3 million head of beef cattle, 340,000 dairy cattle, 40 million head of hogs, 350,000 sheep and lambs, 66 million chickens, and 9 million turkeys. Given standard feed rations that do not use ethanol co-products, Iowa's livestock would require 682 million bushels of corn for the rations. With the co-products, the corn needed for the rations is reduced to 620 million bushels. Based on typical livestock rations, as outlined by Iowa State University Extension Livestock Enterprise Budgets (Ellis et al. 2010), 3.4 billion pounds of distillers grains are being utilized by Iowa livestock feeders. As distillers grains are typically priced at roughly 90% of the corn price, the incorporation of 3.4 billion pounds of distillers grains in Iowa livestock rations has reduced feed costs by $39 million in 2011 (assuming a ton of distillers grains offsets a ton of corn in the ration).

Table 8. Distillers Grains Inclusion in Livestock Rations

Livestock	Distillers grains inclusion
Grain fed cattle	40% of ration dry matter
Milk cows and heifers	20% of ration dry matter
Market pigs	20% of diet
Layers	15% of diet
Turkeys	10% of diet

Note: Based on peer reviewed experiments, field studies, and extension recommendations as summarized by the U.S. Grains Council (2007).

The 3.4 billion pounds of distillers grains only represents 18% of Iowa's total distillers grains production. Just as Iowa was and continues to be a state that exports excess corn, Iowa's ethanol plants have met Iowa's distillers grains demand and have ample supplies for export to other states and countries. Table 9 shows the overall value of the Iowa's ethanol co-product markets. Combined, the co-products provide an additional $2 billion of value to the state.

Table 9. Values for Ethanol Co-Products

	Distillers Grains ($ million)	Gluten Feed ($ million)	Gluten Meal ($ million)	Corn Oil ($ million)
2000	9	36	38	34
2001	12	41	41	36
2002	11	42	40	48
2003	46	56	46	71
2004	105	68	65	77
2005	106	66	65	88
2006	235	90	74	89
2007	427	132	125	158
2008	974	173	170	271
2009	846	128	178	149
2010	996	143	167	182
2011	1,799	257	179	262

Land Values

Farmland values have also risen with the ethanol expansion. Figure 5 displays Iowa land values from the Iowa State University Extension Farmland Value Survey. The land is categorized into high, medium, and low quality land. For each class, land values have increased with ethanol production and corn prices. This relationship is to be expected. As Dr. Michael Duffy, the Iowa State economist who conducts the survey, stated, "Farmland values are highly correlated with gross farm income. As gross farm income increases, so will land values." (Duffy 2011).

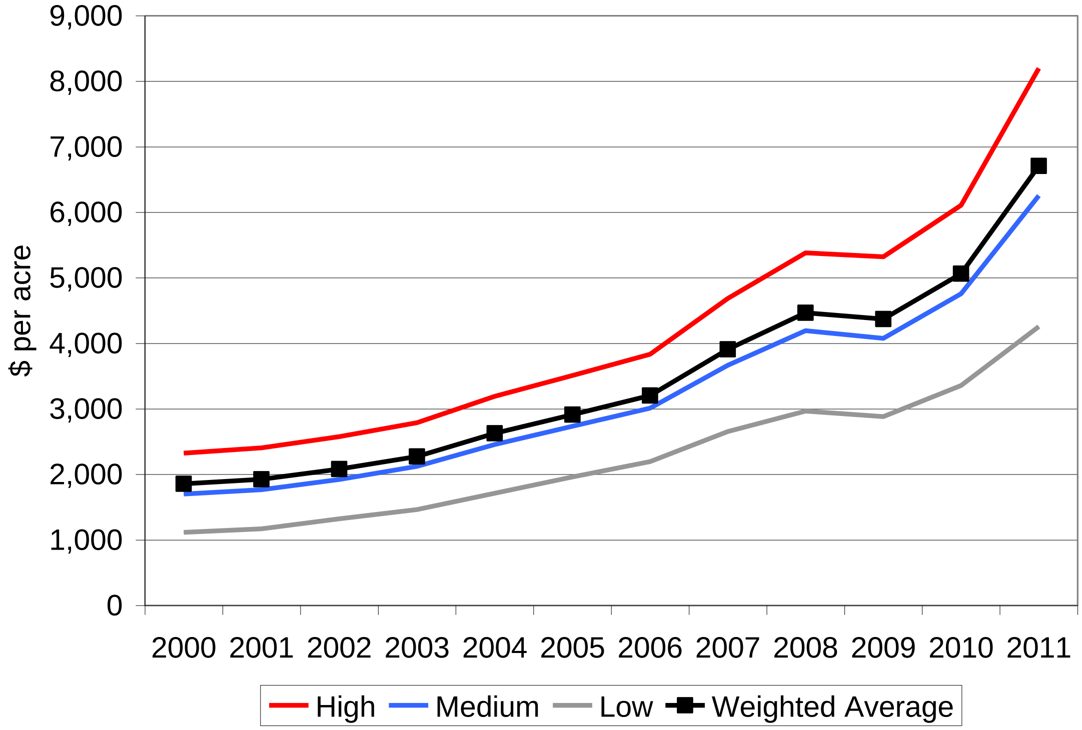

Figure 5. Iowa Land Values
Source: Farmland Values Survey, Iowa State University Extension

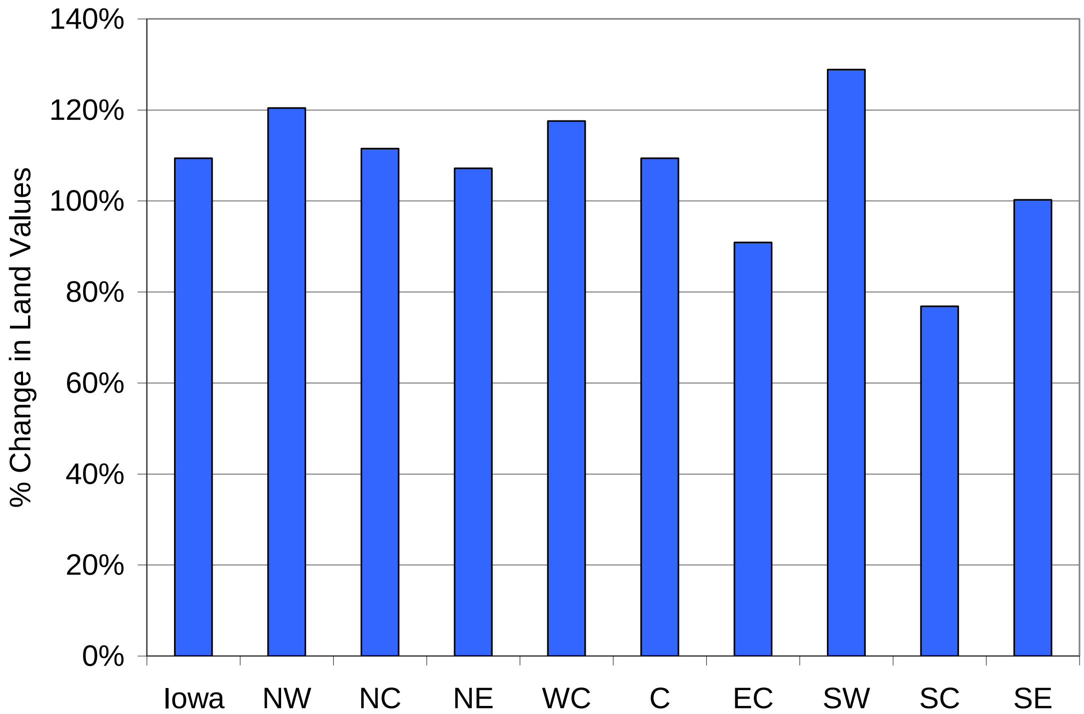

Figure 6. Percentage Change in Farmland Values, 2006 to 2011
Source: Farmland Values Survey, Iowa State University Extension

Figure 6 shows the percentage change in farmland values from 2006 to 2011. Every region in Iowa has seen land values jump by nearly 80% since 2006. Given the linkages of ethanol to corn and corn to land values, a rough approximation of the impact of Iowa's ethanol expansion on Iowa's land values is based on the percentage impact ethanol has on corn prices. Earlier in this report, we cited literature indicating 20-36% of the increase in corn prices is due to ethanol. Using those same percentages here would indicate that 22-39% of the increase in Iowa farmland values is related to ethanol. With the weighted average of Iowa farmland values at $6,708 per acre and the increase in value from 2006 being $3,504 per acre, that would equate to $700-1,260 per acre of additional value based on Iowa's ethanol production.

Grain Storage

With ethanol's year-round demand for corn, grain storage has taken on added importance in Iowa. Currently, there are nearly 3.5 billion bushels of grain storage capacity in Iowa. Commercial storage accounts for 1.38 billion bushels, while the rest (over 2 billion bushels) is on-farm storage. Since 2000, commercial storage capacity has increased 35% and on-farm storage has grown by 24%. This additional storage has been needed given Iowa's recent run of large crops. The storage has also provided additional opportunities for farmers to store grain deeper into the marketing year. Given typical price seasonality in corn, prices reach their peak in late spring and early summer. More on-farm storage translates into more opportunities to catch that peak. As the earlier discussion on corn prices showed, Iowa farmers have been able to capture better prices recently.

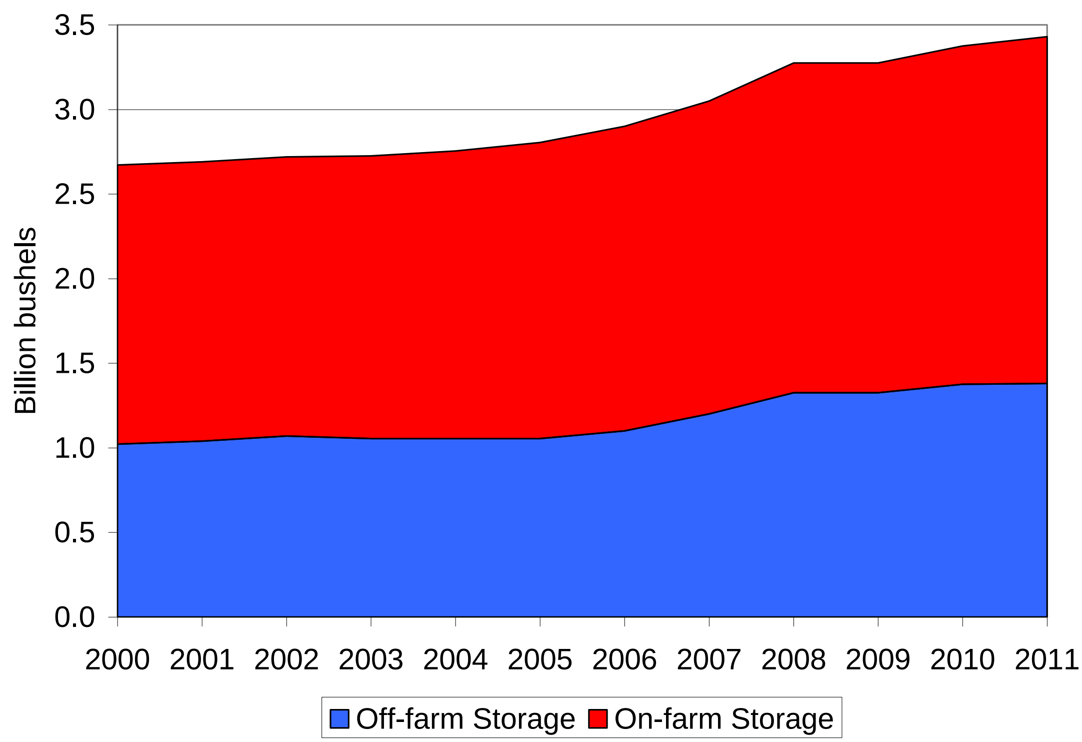

Figure 7. Iowa Grain Storage Capacity
Source: USDA-NASS

The linkage between on-farm storage and ethanol production seems to be fairly strong. As Figure 8 shows, the pace of Iowa's on-farm storage growth has almost exactly matched the growth of ethanol production in Iowa. The expansion of both on-farm and commercial storage provided another financial boost to the Iowa economy. At a rough cost of $2 for each bushel of storage capacity, the expansion in grain storage since 2000 created an additional $1.5 billion of economic activity.

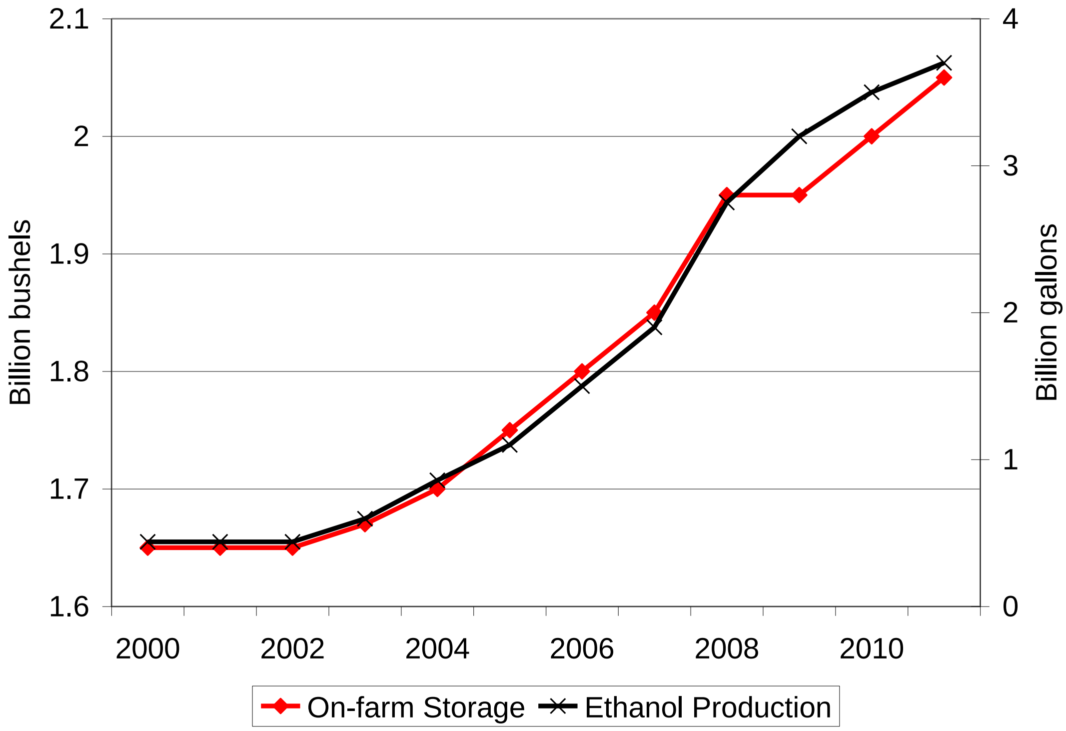

Figure 8. On-Farm Storage and Ethanol Production
Sources: USDA-NASS and Iowa Renewable Fuels Association

Economic Contribution of the Iowa Ethanol Industry

Iowa's 3.8 billion gallons per year of ethanol production capacity represents 25% of the total US capacity. The concentration of this capacity in Iowa is no accident as Iowa is also the leading corn producing state in the US. This section investigates the economic contribution, direct and secondary, that the ethanol industry makes to the state of Iowa.

An economic impact analysis is conducted to estimate the overall direct and secondary impacts of this production activity to the regional economy. While overall economic impacts include returns to investors and retail sales in communities, this study includes information on residential location of plant investors to illustrate local distributional patterns of ownership and investment earnings.

Economic impacts of the ethanol industry in Iowa were estimated utilizing the IMPLAN input-output (I-O) economic modeling software customized to capture the economic impact for the state of Iowa. IMPLAN uses historical data to estimate linkages between industries in the regional economy and determine how changes in one industry affect other industries within Iowa's economy. Input-output models are used to estimate three types of effects:

- Direct effects are economic impacts that are generated "directly" by the ethanol or "target" industry.
- Indirect effects are economic impacts generated by purchases of products and services by the target industry from other sectors (e.g., grain merchandising and logistics, energy, restaurants, or hospitals).
- Induced effects measure the impact of spending by employees on goods and services that typically fall outside of the target industry.

As other researchers have pointed out, the uncritical use of input-output models applied to the ethanol industry can cause measurement issues (Swenson 2006, Low and Isserman 2009). Probably the most important shortcoming of some modeling efforts is that the backward linkages of the IMPLAN system will attribute a large number of new jobs to producing corn (or other grains) to supply the ethanol industry when the same corn production would have found an alternate use independent of ethanol production. Additionally, agricultural production (i.e., all major crops combined) is unlikely to change significantly. Overtime, the expansion of ethanol production has put pressure to transfer acreage from pasture land or out of the Conservation Reserve Program. However, these effects, outside the processing facilities, are incorporated into our I-O analysis.

Modeling Assumptions

Creating the models to measure the effects of the ethanol processing scenarios on the local economy is straight forward with the commercially available IMPLAN software and database (www.implan.com), but with some modifications. First, because the IMPLAN model has no modern dry mill ethanol industry, the existing wet mill technology sector was modified to reflect Iowa prices and availability of inputs. The primary inputs used in ethanol processing, based on a 100 million gallon per year (MGY) facility, are listed in Table 10. This structure of inputs is used to model the ethanol processing activities and to analyze the impacts of both a single local plant and the statewide ethanol industry. The production function framework of the input-output model in calculating the economic effects of a new ethanol plant wants 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.

Modeling Results

The prototypical 100 MGY ethanol plant itself generates over $300 million in sales and employs 42 full-time equivalent workers, creating $4.2 million in wages and salary. The construction costs and the quantity and costs of the primary inputs used in the ethanol processing facility are listed in Appendix 1. Our economic impact modeling is based upon adapting the wet corn milling sector of our IMPLAN model to reflect this structure of inputs.

These inputs 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 234 jobs and $12 million of labor income in our representative rural Iowa county (Table 11). The economic impacts would be larger in more populous counties with typically more complex economies because more multiplier effects happen locally when more goods and services are available locally. The different multipliers reflect the characteristics of the ethanol industry.

The potential for capturing impacts increases when we consider statewide impacts of the ethanol industry in Iowa. In 2011 Iowa's ethanol facilities generated 3.7 billion gallons of ethanol, 25% of total US production. They also produced 9.16 million tons of DDG. At current prices, this sums to $12 billion of aggregate statewide sales of ethanol products from Iowa facilities. Using the efficiency of the 100 million gallon ethanol processing facility as a standard for the statewide totals of 3.7 billion gallons implies 1,554 jobs statewide in this industry (Appendix 1). This estimate is consistent with the 1,650 jobs employed in ethanol processing (NAICS 325193 – Ethyl Alcohol Manufacturing) as reported by Iowa Employment Services in 2010.

Table 10. Statistics for Representative 100 and 50 Million Gallon Ethanol Facilities

Ethanol	(gallons)	100,000,000	50,000,000
DDGS	(tons)	33,929	16,965
Corn	(bushels)	39,285,714	19,642,857
Natural Gas	(100 cubic feet)	3,300,000	1,650,000
Electricity	(kilowatt hours)	77,000,000	38,500,000
Water	(gallons)	385,000,000	192,500,000
Chemical Costs	(dollars)	11,660,000	5,830,000
Other Costs	(dollars)	12,746,151	6,373,076
Jobs		42	32
Jobs per Million Gallons		0.420	0.639

Table 11. County-Level Economic Summary of a 100 Million Gallon Ethanol Facility

Impact Type	Jobs	Labor Income (dollars)	Total Value Added (dollars)	Output (dollars)
Agriculture	4.5	344,271	470,723	942,670
Mining	1.1	8,090	16,156	299,759
Construction	5	218,313	257,949	536,192
Manufacturing	51.1	4,061,194	47,671,455	310,102,895
TIPU	25.1	1,484,944	2,786,822	6,333,174
Trade	20.6	731,539	1,215,159	1,513,957
Service	117.7	4,556,844	7,681,225	13,608,734
Government	9.3	631,878	647,669	2,386,591
Total	234.3	12,037,073	60,747,159	335,723,971

Source: IMPLAN model for Iowa.

Table 12. Statewide Economic Contribution of Ethanol Facilities in Iowa

Impact Type	Jobs	Labor Income (dollars)	Total Value Added (dollars)	Output (dollars)
Agriculture	167	12,772,462	17,463,816	34,973,038
Mining	41	300,120	599,388	11,121,066
Construction	186	8,099,423	9,569,908	19,892,712
Manufacturing	1,896	150,670,309	1,768,610,984	12,249,064,353
TIPU	931	55,091,411	103,391,111	234,960,737
Trade	764	27,140,093	45,082,410	56,167,790
Service	4,367	169,058,927	284,973,444	504,884,039
Government	345	23,442,678	24,028,535	88,542,541
Total	8,693	446,575,423	2,253,719,588	13,199,606,276

Source: IMPLAN model for Iowa.

Impacts to the US Economy

The economic contribution of the ethanol industry to the US economy can be estimated using the IMPLAN model for the US and similar information on the technology and productivity of resources used in the industry. By including a larger region of the national economy to capture indirect and induced effects, we expect the total multiplier impacts to be larger than in a statewide region Total US ethanol production in 2011 of 13.9 billion gallons, with associated co-products, is used as the direct effects for the I-O analysis. Using the worker productivity rates and an full time equivalency basis to estimate economic effects, we estimate impacts of 44,000 jobs and $3 billion of income.

Table 13. Impact Summary of 13.9 Billion Gallons of Ethanol Production in US

Impact Type	Jobs	Labor Income (dollars)	Total Value Added (dollars)	Output (dollars)
Agriculture	1,159	40,315,640	56,376,557	118,845,948
Mining	825	83,689,904	169,402,274	334,607,338
Construction	534	27,231,013	32,516,339	64,186,552
Manufacturing	9,930	1,182,103,381	6,251,296,280	45,022,377,615
TIPU	3,767	307,766,634	744,745,345	1,535,969,982
Trade	4,952	221,936,672	370,771,169	462,572,798
Service	21,774	1,207,870,204	2,048,264,319	3,356,812,303
Government	1,055	85,567,566	83,471,415	290,641,055
Total	43,995	3,156,481,019	9,756,843,699	51,186,013,586

Source: IMPLAN model for US.

Local Investment Impacts

As the ethanol industry rapidly expanded during the first decade of the 21st century, a frequently asked policy question concerned impacts to the local economy of local versus outside investors. A recently completed report on the Iowa ethanol industry by the Iowa Department of Revenue

(IDR) provides information on residence of investors in limited liability company (LLC) ethanol facilities that started up in the 2005-2008 time period (Jin and Teahan 2009). Based on the information available through July 1st, 2008, sixty-one companies have invested in 71 biofuel production projects that have been awarded state tax credits in Iowa. Eleven projects are owned by eight C-corporations. Fifty-one projects are owned by LLCs.

Administrative IDR data and shareholder information for 28 of the 51 LLCs was collected including some pass-through entities. Only underlying shareholders were included in the analysis after examining every ownership level. The individual income tax dataset was also used to identify investors with farm income. Table 14, originally Table 18 from the Jin and Teahan report, shows summary statistics of the ownership structure in these 28 LLC facilities. The average number of investors is 367. The median number of investors is 167, which implies that a small number of facilities have a large number of investors. The company with the largest number of shareholders has 1,533 underlying owners. The report indicates that most shareholders are Iowans, including individuals and corporations, and Iowans also own the majority of the companies. On average, there are 316 Iowa resident shareholders in every company and they own 89 percent of the company. The median number of Iowan shareholders is 54, much lower than the average number, but the median percentage of the company owned by Iowans is higher, at 99 percent. Most of the investors are individuals. Of the 367 owners per producer on average, 346 are individual investors, and they own 81 percent of the company.

Table 14. Ownership Statistics for Biofuel Producers Organized as a LLC

	Average	Median	Min.	Max.
Number of Owners	367	167	3	1,533
Number of Iowa Owners	316	54	3	1,584
Shares Owned by Iowa Owners	0.89	0.99	0.01	1.0
Number of Individual Owners	346	161	3	1,533
Shares Owned by Individual Owners	0.81	0.91	0.01	1.0
Number of Iowa Farm Owners	168	75	0	745
Shares Owned by Iowa Farmer Owners	0.31	0.38	0	0.62

Source: Iowa Department of Revenue
Note: The data are for 28 LLCs.

Because the biofuel industry is one of the most important markets for corn, farmers' stakes in biofuel producers were also examined. On average, 168 of the 367 owners of a biofuel company have farm income and they have a 31 percent stake in the company. On median terms, 75 of the 167 owners of a biofuel company have farm income and they own 38 percent of the company. Investors in biofuel plants are likely to live within a 100 mile radius of the plant. The geographic distribution of investors with and without farm income is indistinguishable as both types of investors are clustered around the plant. Likewise, the tendency of investors to live near the plant is independent of whether it is an ethanol or biodiesel facility (see Figure 9). Ownership patterns may have been different for plants later in this time period as developers promoted plant investment opportunities more widely to outside investors.

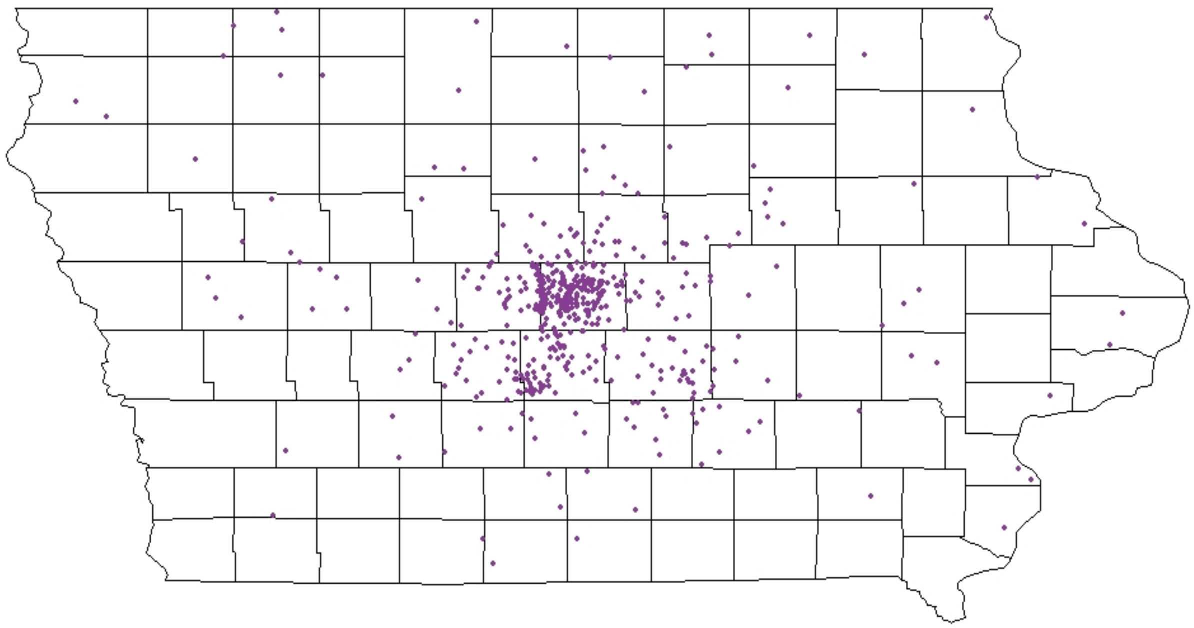

Figure 9. Residential Location of Iowan Investors in Actual Central Iowa Ethanol Plant
Note: Each dot represents one investor.

Information on payouts to investors is available from the 10K reports filed with the Securities and Exchange Commission by LLCs. As the report for Golden Grain Ethanol LLC in Mason City, Iowa indicates these returns for facilities in place by 2006 could be substantial, returning $250-$350 on a $100 investment made on November 1, 2005 (Figure 10). The "Cash Flows from Financing Activities" table of these reports indicates that from 2006 through 2008 Golden Grain Ethanol LLC distributed $43,115,000 to members. Another 100 million gallon ethanol facility, the Little Sioux LLC in Marcus, Iowa, distributed $54,563,509 to its members during the same time period. No distributions were reported for 2009 or 2010 as higher grain prices and tighter margins were incurred.

These representative returns on investments from plants in operation during this period combined with the Iowa Department of Revenue data on residential location for investors can illustrate the economic benefit to local economies from having the preponderance of investment being local. Using the Little Sioux LLC in Marcus as a representative operation from this 3-year era, the $54.6 million of returns paid out to investors has a multiplier impact in the local economy as the investor-owners spend in state. These multiplier impacts can be estimated by using Iowa IMPLAN to model the effects of $54.6 million incremental increase to high-income Iowa households. The result of this scenario is presented in Table 15. The $54.6 million of increased dividend income to ethanol investors results in additional induced effects in the economy of an estimated $14.7 million of new income, 431 jobs, and $46 million of new sales, primarily in retail trade and service categories.

Table 15. Impact of Dividend Payout from 100 Million Gallon Ethanol Facility

Impact Type	Jobs	Labor Income (dollars)	Total Value Added (dollars)	Output (dollars)
Agriculture	1.8	64,545	124,751	407,653
Mining	0.2	1,816	3,746	51,972
Construction	4.3	187,218	228,394	480,591
Manufacturing	8.9	504,024	851,710	3,650,977
TIPU	8.1	457,800	951,398	1,661,560
Trade	126.5	3,871,051	6,375,801	7,656,923
Service	276.9	9,279,916	18,268,349	31,176,696
Government	4.7	334,130	333,269	1,091,479
Total	431.4	14,700,498	27,137,417	46,177,850

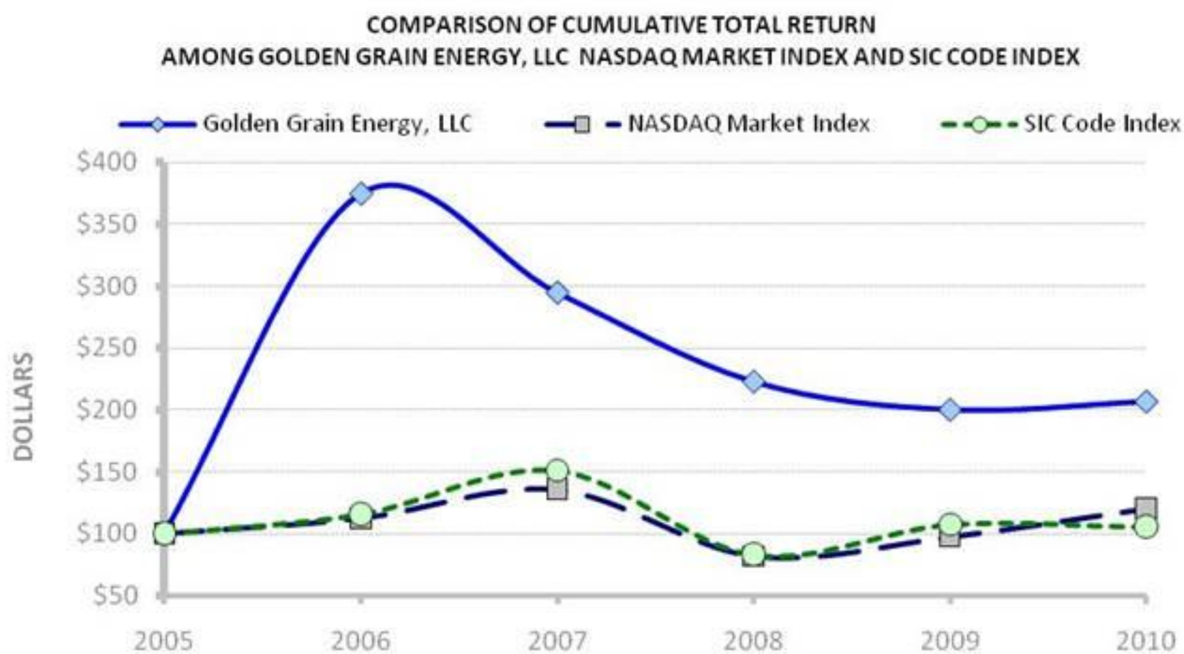

Figure 10. Comparison of Total Returns

Source: http://www.sec.gov/Archives/edgar/data/1206942/000110465910064209/a10-24165_110k.htm

Note: Assumes $100 invested on Nov. 1, 2005 and dividend is reinvested for fiscal year ending Oct. 31, 2010.

Local Communities: Impact on Retail Sales

Another perceived local benefit of ethanol plants is an increase in general economic activity in the surrounding communities. This indirect benefit should be quantifiable by measuring retail sales. Retail sales data is available from the Iowa Department of Revenue sales tax database at the county and town level. For this purpose, the data are limited to businesses in the retail trade category, which includes furniture, clothing, grocery stores, and specialty retailers, and the accommodations and food service category, which includes hotels, motels, bars, and restaurants. Sales for stores within the retail trade category should increase if general economic activity increases. It is hypothesized that sales for businesses within the accommodations and food service category might increase during the construction phase since specialized construction workers travel around the country building ethanol plants.

A map showing the percentage change in retail sales from 2003 to 2007 does not indicate a very strong correlation between counties that had an ethanol plant constructed between 2003 and 2007 and growth in retail sales (see Figure 11). Two counties had changes in retail sales between -5 and -14%, four counties had between a -4 and +5% change, two counties had between a 6 to 15% increase and one county's real retail sales increased by more than fifteen percent. One possible explanation for this finding is that ethanol plants are often located on the border of two counties thus the local benefits transcend county lines. Also, local benefits may be limited to communities located in close proximity to the plant hence not benefiting the county as a whole.

A separate regression analysis comparing retail sales performance for cities with an ethanol facility compared to comparable Iowa communities without an ethanol facility did not find a significant difference in the performance of the two groups of cities. During the period of ethanol expansion, nonmetropolitan communities as a group lost retail to larger trade center communities. While the presence of an ethanol facility and its associated economic activity certainly provides a spending boost to rural economies, these results suggest that other structural changes and consolidation may be offsetting and diminishing the net benefits.

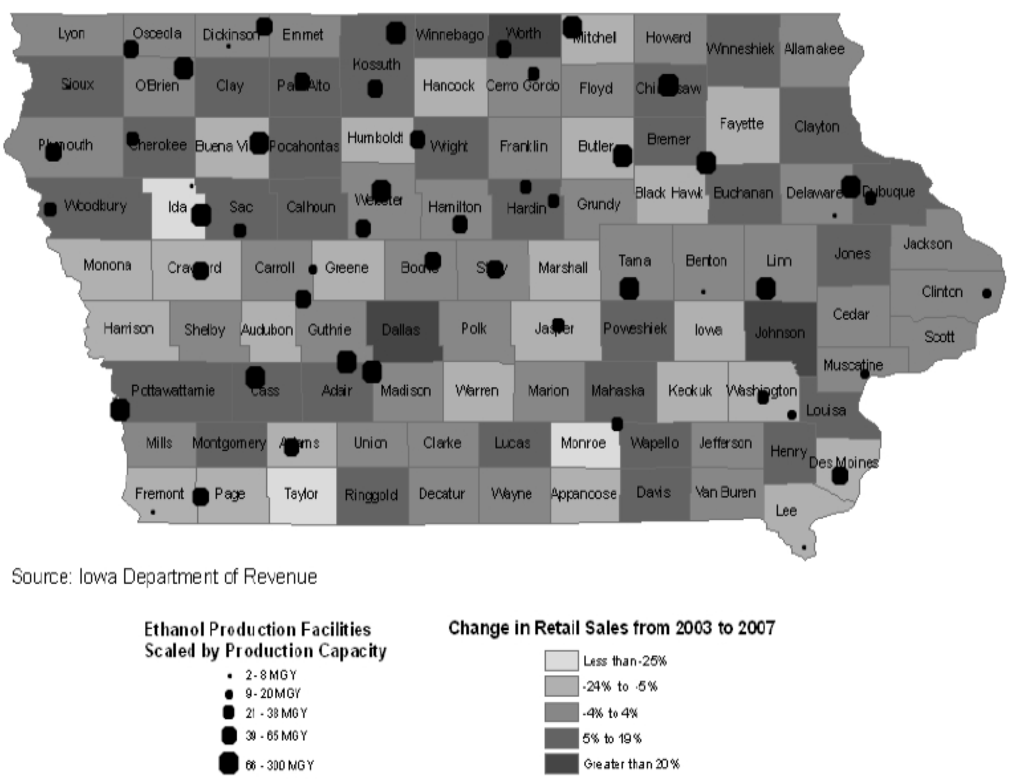

Figure 11. Map of Change in Retail Sales in Iowa Counties, 2003-2007

Discussion of Next Generation Biofuels and Alternative Projections

The biofuel industry has grown quickly, mainly through corn-based ethanol and a mixture of feedstocks for biodiesel. Much of the policy discussion of the past decade for biofuels has concentrated on "next generation" biofuels, moving to additional alternative (mostly non-food) feedstocks and seeking alternative fuel types (such as butanol and "green" gasoline). The Energy Act of 2007 outlined an aggressive roadmap for development of next generation biofuels, with a distinct concentration on cellulosic biofuels. That outline is known as the Renewable Fuels Standard (RFS). Back in 2007, Congress built a target of 500 million gallons of fuel from cellulosic sources in 2012 in the RFS. The Environmental Protection Agency, the agency that enforces the RFS, analyzed the cellulosic fuel production potential for 2012 and concluded that 8.65 million gallons of fuel production is possible. While there has been and continues to be substantial research and development of alternative biofuel pathways, those research efforts have not yet created commercially viable fuel platforms. As they currently stand, next generation biofuels have had little to no impact on the fuel market. Even if the next generation biofuel production were to double tomorrow, the impact would be minimal.

But longer-term, it is an interesting question how the possible development of next generation fuels might affect fuel markets and, specifically, the corn-ethanol market. To that end, the Food and Agricultural Policy Research Institute (FAPRI) staff at the University of Missouri recently published their biofuel baseline, looking out over the decade. Their analysis reached several conclusions:

1) The RFS will continue to drive biofuel production, but the rate of growth will be lower in the future.
2) The slower growth in biofuels will affect other markets, specifically corn.
3) Without breakthroughs in blending technology or substantial increases in fuel demand, the RFS may set the market for biofuels in the longer run.
4) Without breakthroughs in blending technology or substantial increases in fuel demand, usage of E-85 will need to expand quickly.
5) Corn-based ethanol prices will likely fall in the short term.
6) Biodiesel will increasingly be sought to fill part of the RFS.
7) Ethanol trade will likely return to its previous pattern where the U.S. is a net importer from Brazil (although two-way trade is still likely to occur).
8) Cellulosic biofuels will continue to grow slowly, but the pace should pick up substantially by mid-decade.

In their analysis, cellulosic biofuels expand from under 10 million gallons today to 3.6 billion gallons by 2022. This expansion is well below the targets of the RFS, but still represents tremendous growth in that sector. Over the same period of time, corn-based ethanol is projected to increase from 14 billion gallons this year to nearly 16 billion gallons in 2022. And corn-based ethanol is projected to still be the largest biofuel we have in 2022. Due to the differing requirements in the RFS, the FAPRI-Missouri staff project that differential pricing will develop for the various types of biofuels, with cellulosic and other advanced biofuels carrying a higher price than corn-based ethanol.

Figure 12 shows the difference in fuel pricing. The projection shows cellulosic biofuels reaching the commercial market sometime in 2013/14. And that the prices for cellulosic biofuels will trend upward for the decade. Meanwhile, corn-based ethanol will maintain lower and steadier pricing. In fact, the projections show ethanol maintaining an energy-equivalent pricing relationship with gasoline for the next 10 years, as ethanol retail prices are projected to be between 65 and 67% of gasoline retail prices. So in essence, the projected pricing pattern is very similar to the current situation in the fuel market.

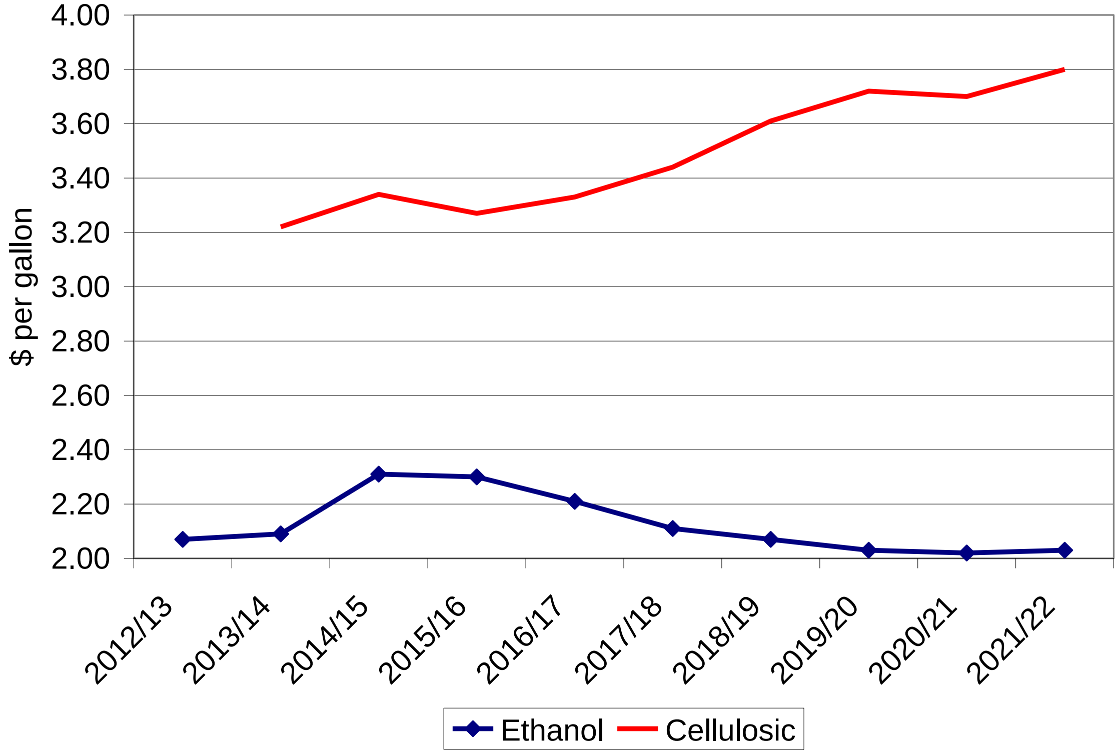

Figure 12. Projected Ethanol and Cellulosic Biofuel Prices
Source: FAPRI-Missouri

While the pricing relationship between gasoline and ethanol is projected to maintain current structure, returns to ethanol are projected to increase mid-decade. That is based on slightly ethanol prices and the movement of corn prices down into the $4.80 per bushel range. As corn represents the largest cost component of ethanol production, the drop in the price of corn reduces costs at a time when ethanol revenues are projected to increase. Toward the end of the decade, both ethanol and corn prices are expected to moderate. Projected prices for 2021/22 are $2.03 per gallon for ethanol and $4.56 per bushel for corn.

Based on these projections, corn-based ethanol will continue to be the leading biofuel for the next decade. And while other types of biofuels will come online over the next 10 years, ethanol will maintain a cost advantage that will continue to incentivize its usage as a liquid fuel. The ethanol industry is now a mature industry, but one that continues to evolve. As margins have tightened, industry participants are exploring new techniques and pathways to capture more value from each bushel of corn that passes through their operations. From fractionation and the production of high-protein distillers grains to possible conversion of corn to other types of fuels, such as butanol, the corn-based ethanol industry continues to evolve and compete in both the agricultural and energy markets.

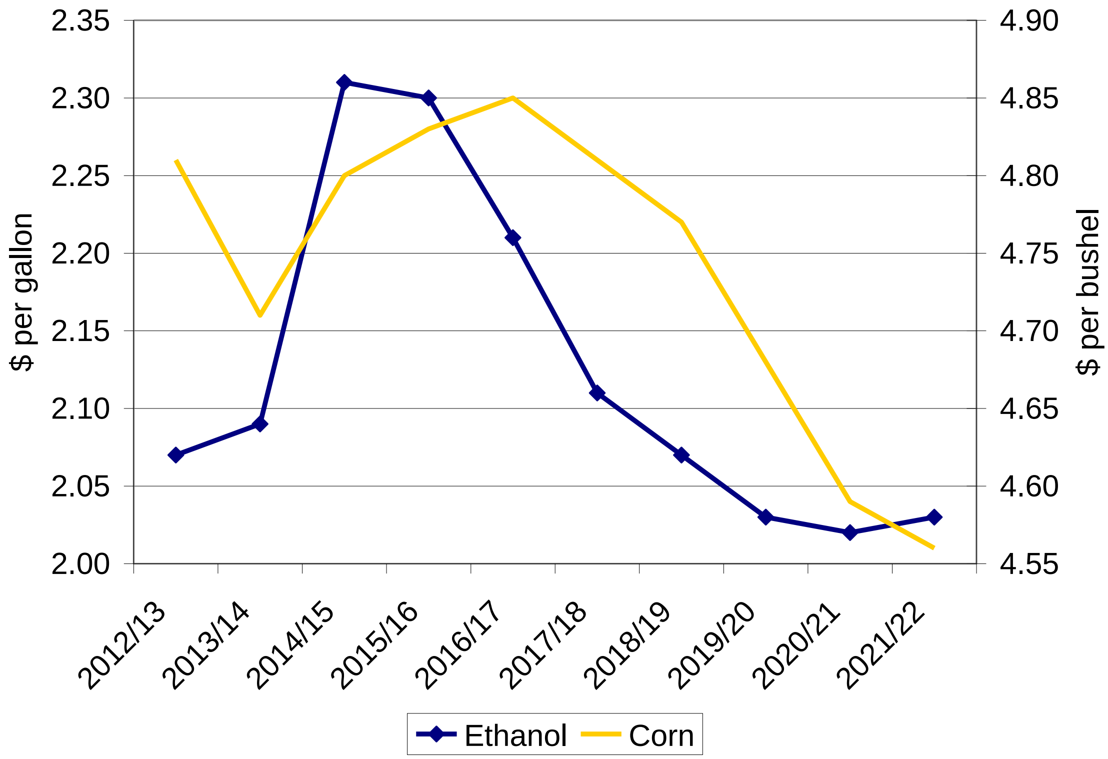

Figure 13. Projected Ethanol and Corn Prices
Source: FAPRI-Missouri

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Appendix 1. Production, Resources, and Costs

	Quantity	Units	Costs	Share of Costs
Construction Costs				
Equity			$126,748,200	
Debt			$84,498,800	24.5%
Depreciation			$12,083,133	3.5%
Production				
Nameplate Capacity	100,000,000	Gallons		
Operating Capacity	110,000,000	Gallons		
DDG Production	333,929	Tons		
Corn Usage	39,285,714	Bushels	$196,428,570	56.9%
Natural Gas Usage	3,300,000	1000 ft^3	$18,150,000	5.3%
Electricity Usage	77,000,000	Kilowatt-hrs	$4,235,000	1.2%
Water Usage	385,000,000	Gallons	$1,347,500	0.4%
Labor and Management	42	Employees	$4,184,000	1.2%
Interest Costs			$6,971,151	2.0%
Enzyme Costs			$3,850,000	1.1%
Yeast Costs			$2,200,000	0.6%
Chemical Costs			$1,650,000	0.5%
Denaturant Costs			$3,960,000	1.1%
Repairs and Maintenance			$2,750,000	0.8%
Transport Costs			$825,000	0.2%
Other Costs			$2,200,000	0.6%

Appendix 2. IMPLAN Software and Database

The IMPLAN Software. IMPLAN is a computer software package that consists of procedures for estimating local input-output models and associated databases. The acronym is for *Impact Analyses and Planning*. IMPLAN was originally developed by the U.S. Forest Service in cooperation with the Federal Emergency Management Agency and the U.S. Department of the Interior's Bureau of Land Management to assist in land and resource management planning. Since 1993, the IMPLAN system has been developed under exclusive rights by the Minnesota Implan Group, Inc. (Stillwater, Minnesota) which licenses and distributes the software to users. Currently, there are hundreds of licensed users in the United States including universities, government agencies, and private companies.

The IMPLAN Database. The economic data for IMPLAN comes from the system of national accounts for the United States based on data collected by the U. S. Department of Commerce, the U.S. Bureau of Labor Statistics, and other federal and state government agencies. Data are collected for 528 distinct producing industry sectors of the national economy corresponding to the Standard Industrial Categories (SICs). Industry sectors are classified on the basis of the primary commodity or service produced. Corresponding data sets are also produced for each county in the United States, allowing analyses at the county level and for geographic aggregations such as clusters of contiguous counties, individual states, or groups of states.

Data provided for each industry sector include outputs and inputs from other sectors, value added, employment, wages and business taxes paid, imports and exports, final demand by households and government, capital investment, business inventories, marketing margins, and inflation factors (deflators). These data are provided both for the 528 producing sectors at the national level and for the corresponding sectors at the county level. Data on the technological mix of inputs and levels of transactions between producing sectors are taken from detailed input-output tables of the national economy. National and county level data are the basis for IMPLAN calculations of input-output tables and multipliers for local areas.

IMPLAN Multipliers. The IMPLAN software package allows the estimation of the multiplier effects of changes in final demand for one industry on all other industries within a local economic area. Multipliers may be estimated for a single county, for groups of contiguous counties, or for an entire state; they measure total changes in output, income, employment, or value added. Definitions are provided below. More detail on the derivations of multipliers is available in the IMPLAN Users Guide.

For a particular producing industry, multipliers estimate three components of total change within the local area:

- *Direct effects* represent the initial change in the industry in question.
- *Indirect effects* are changes in inter-industry transactions as supplying industries respond to increased demands from the directly affected industries.
- *Induced effects* reflect changes in local spending that result from income changes in the directly and indirectly affected industry sectors.

IMPLAN allows the analyst to choose from multipliers that capture only direct and indirect effects (Type I), multipliers that capture all three effects noted above (Type II), and multipliers that capture the three effects noted above and further account for commuting, social security and income taxes, and savings by households (Type SAM). Total effects multipliers usually range in size from 1.5 to 2.5 and are interpreted as indicated below:

- *Output multipliers* relate the changes in sales to final demand by one industry to total changes in output (gross sales) by all industries within the local area. An industry output multiplier of 1.65 would indicate that a change in sales to final demand of $1.00 by the industry in question would result in a total change in local output of $1.65.
- *Income and employment multipliers* relate the change in direct income to changes in total income within the local economy. For example, an income multiplier for a direct industry change of 1.75 indicates that a $1.00 change in income in the direct industry will produce a total income change of $1.75 in the local economy. Similarly, an employment multiplier of 1.75 indicates that the creation of one new direct job will result in a total of 1.75 jobs in the local economy.
- *Value added multipliers* are interpreted the same as income and employment multipliers. They relate changes in value added in the industry experiencing the direct effect to total changes in value added for the local economy.