Economic Impact of Minnesota's Ethanol Industry

CHAPTER 2

At current capacity, the ethanol industry in Minnesota has annual revenues of about $150 million from sales of ethanol and its animal feed coproducts. Ethanol producers spend most of this money locally, purchasing corn, labor, and other inputs to the production process. In addition, plant construction adds a one-time economic boost to each locality.

This chapter discusses the local and statewide economic impacts of fuel ethanol production. In particular, we address the following questions:

- **What is the local and statewide economic impact of the fuel ethanol industry?**
- **What are the projected economic impacts of further ethanol development?**
- **How do these impacts compare with those of alternative economic development projects?**
- **What effect does ethanol production have on the price of corn?**
- **What are the implications of ethanol development for our dependence on imported oil?**

The first part of this chapter addresses the local effects. We interviewed plant managers at all of the major operating plants. We also interviewed local economic development officials in communities with ethanol production facilities. The second section focuses on economic impacts at the state level. We calculated estimates of statewide economic impacts and reviewed estimates published by the Minnesota Department of Agriculture. Finally, we discuss other statewide and national impacts, such as the strategic importance of ethanol as an alternative to imported oil.

We found that the ethanol industry has a significant impact in the state's economy, and important benefits for the small towns where plants are located. However, we also found that the programs designed to support the ethanol industry have a substantial cost. Overall, we find that the net impact on the state's economy is positive, but there are transfers of income from taxpayers and consumers of gasoline to the ethanol industry that also merit consideration.

LOCAL ECONOMIC IMPACT

Minnesota's ethanol plants are located in communities with populations ranging from 530 in Claremont to over 12,000 in Marshall.[1] Most of the cities and counties in which plants are located are struggling to grow economically. Ethanol plants promise increased employment and tax revenues for small cities, as well as benefits to farmers through cooperative ownership and potentially higher prices for the corn crop. This section considers these issues in turn.

Jobs, Tax Revenue, and Other Growth

Ethanol plants of 5 to 15 million gallons per year capacity can change the face of small cities such as Winthrop, Winnebago, Claremont, and others. A number of indicators show that:

- **Ethanol plants are an economic boon to the communities in which they are located.**

Ethanol plants have created jobs in rural Minnesota.

As Table 2.1 shows, Minnesota ethanol plants typically have become one of the larger employers in the cities where they have been built. Moreover, the plants offer relatively high-paying jobs. The plants we visited employ about 27 people on average and operate around the clock. Most plants have four shifts, with two or three process operators per shift, one boiler operator per shift, four or five maintenance people, plus office staff, and equipment operators. The hourly wages for these jobs range from about $9 to $14.[2] The jobs also provide health insurance and other benefits and are considered good jobs in the community.

Table 2.1 also shows unemployment statistics for the cities and counties where major plants are located. Unemployment in these predominantly rural areas ranged from 3.4 percent to 5.4 percent in 1995.[3] For comparison, unemployment in the metro area in 1995 averaged 2.8 percent. We learned in our interviews, however, that skilled labor markets in these small rural towns are very tight. Often, plants have to bring people in from other communities or even other states. This fact tends to limit local employment effects of ethanol plants, but small towns still benefit from increased population and activity. Table 2.1 also shows that the small cities and rural counties where the plants are located have experienced declining populations in recent years.

In addition to jobs and tax revenue, small cities may receive other benefits from ethanol plants. Most cities improved their roads or utility infrastructure as a result of ethanol plant development. The city of Winthrop updated its water main system for the ethanol plant, and the expanded service may make the area more attractive for other development in the future. In Winnebago, prior to the plant's construction, the city had built a wastewater treatment facility with excess

1 Minnesota Department of Trade and Economic Development, *Community Profiles* (1993).

2 Wage estimates are approximate, but representative. We did not collect detailed payroll data.

3 Minnesota Department of Economic Security, *Local Area Unemployment Statistics Files* (1996).

Table 2.1: Population and Employment Data for Cities and Counties with Ethanol Plants

		1990 Census Population		Population Change 1980-90		1995 County	1995 Average	Largest Employer-City		Ethanol Plant	
Plant Location	County	City	County	City	County	Employment	Unemployment	Employer	Number of Employees	Number of Employees	Rank in City
Claremont	Dodge	530	15,731	-9.56%	6.48%	6,588	5.40%	Ethanol Plant	30	30	1
Winnebago	Faribault	1,565	16,937	-16.27	-14.09	8,008	5.00	Nursing Home	110	45	5
Winthrop	Sibley	1,279	14,337	-7.06	-7.53	6,489	5.20	Assembly & Packaging	230	30	6
Benson	Swift	3,235	10,724	-11.52	-17.00	4,982	4.60	Fertilizer Applicator Equipment	215	28	6
Morris	Stevens	5,613	10,634	4.58	-8.08	5,166	3.40	Univ. of MN-Morris	365	28	*
Marshall	Lyon	12,023	24,789	7.72	-1.68	14,114	3.40	Food Products	872	178	7
Melrose	Stearns	2,561	118,791	8.31	8.83	69,824	4.10	Turkey Processing	300	n.a.	n.a.

Source: Minnesota Department of Economic Security; Department of Trade and Economic Development Community Profiles.

*Not in top 13 in the city.

capacity. City officials believe that the facility now runs more cost effectively. These communities and others feel that plant development has increased their potential for further industrial development and thereby conveys benefits that are hard to quantify.

Local Ownership and Co-op Structure

All but one of the major ethanol plants have been organized as farmer-owned cooperatives.[4] Ethanol cooperatives differ from other corporations (and from some other agricultural cooperatives) in that shareholders are required to deliver a bushel of corn for each share of stock owned. Typically, farmers must purchase a minimum of 5,000 shares to become a member, and unlike other corporations, each member holds one vote, no matter how many shares are held.

About half of the financing for the typical Minnesota ethanol cooperative has been raised through sale of shares. Shares initially cost between $2.00 and $2.50 each with a minimum purchase of 5,000 shares, for a minimum investment of $10,000 to $12,500. Most cooperatives have over 500 members, and most of those members live within 40 miles of the plant.

Most Minnesota ethanol plants are organized as cooperatives.

Generally, the plants try to pay 80 percent of the market price for corn at the time of delivery, although the specific language in delivery agreements allows for less to be paid in some cases. Members that fail to perform on delivery agreements forfeit their shares, which can then be sold by the company to recoup the cost of corn. The market price difference at time of delivery is to be paid at the end of the quarter, although this payment may be retained by the plants under some conditions. In addition, the plants are expected to return a value-added dividend to the members whenever possible. In understanding Minnesota's ethanol industry, it is useful to keep in mind:

- **All but one of Minnesota's major ethanol plants are organized as cooperatives, bearing several profit- and risk-sharing benefits.**

The benefits of cooperative structure are essentially two-fold. First, any profits from ethanol production are distributed among the farmer-owners. This allows producers to participate in the profits of processing the raw commodities they produce. Second, as shown in Chapter 4, cooperatives may be better able to withstand periods of high corn prices, making them more stable forces within the community. The delivery agreements allow cooperatives to pay less than the market price for corn at the time of delivery, giving them a competitive advantage over plants that must buy grain on the open market in times of high corn prices. The summer of 1996 saw corn prices reach record highs, yet two new cooperative plants opened and development activities on other projects continued. This record is in contrast to a number of plants across the country, which curtailed or stopped fuel ethanol production.

4 Some of the cooperatives allow non-farmers to buy shares, but each share still requires annua delivery of a bushel of corn.

Corn Prices

Corn is a uniform commodity traded actively on the world market. The prices in effect at rural elevators reflect events taking place in the world's major grain exchanges, including those in Minneapolis and Chicago. We examined price data over a period of weeks for rural elevators near and remote from ethanol production facilities. Many people in the plants and communities that we interviewed believe that corn prices are a few cents higher in the immediate vicinity of ethanol plants. However, we found that:

- **At current production levels, ethanol plants have little discernible effect on the local price of corn.**

There is no consistent evidence that would indicate a permanent price "bubble" in the immediate vicinity of ethanol plants, with the possible exception of the wet milling facility at Marshall. The reason appears to be that, again with the exception of the Marshall plant, the mills grind a small fraction of the region's corn.

Ethanol producers process about 5 percent of Minnesota's corn crop.

Table 2.2 shows that existing plants have the capacity to convert about 5 percent of Minnesota's corn crop to ethanol. We obtained production statistics by county and estimated each plant's grinding capacity as a percentage of the corn grown in surrounding ring of counties. These estimates were in the 4 to 7 percent range, with the exception of the Marshall plant, which grinds, on average, about 12 per-

Table 2.2: Corn Production and Use in Ethanol Plants

	Bushels (in Millions)	Percent
MCP feedstock requirement	12.80	12%
Production: Lyon County and 6 surrounding counties	103.08	
Heartland feedstock requirement	3.85	5
Production: Sibley County and 6 surounding counties	82.97	
Corn Plus feedstock requirement	5.77	5
Production: Faribault County and 5 surrounding counties	115.69	
Al-Corn feedstock requirement	3.85	4
Production: Dodge County and 6 surrounding counties	101.84	
CVEC feedstock requirement	5.77	7
Production: Swift County and 6 surrounding counties	78.15	
Morris feedstock requirement	3.00	5
Production: Stevens County and 6 surrounding counties	59.23	
Minnesota Total feedstock requirement	35.03	5
Production: Minnesota Total	686.15	
US Total Feedstock Requirement	600.00	7
Production: US Total	8,153.00	

Notes: Feedstock Requirements are based on current capacity. Corn production data are 1991 -1995 averages.

Source: Minnesota Agricultural Statistics, Renewable Fuels Association.

cent of the region's corn for ethanol production. Nationwide, about 7 percent of average annual corn production is converted to ethanol.

Although a 5 percent change in supply might be sufficient to put upward pressure on prices, the change would be unobservable under actual market conditions. For comparison, the 1995 corn crop was 20 percent smaller than the 1994 crop, due primarily to weather patterns. Other recent year-to-year changes are even larger and such changes overshadow the impact of small changes in current demands from ethanol production. We conclude that the effect of ethanol production on corn prices at current production levels is too small to be observed. Therefore, we assume that food prices are not affected, and the benefits to corn growers do not extend outside of the membership of the cooperatives.

At current capacity, ethanol has a small effect on the price of corn.

Producing 200 million gallons per year, however, would require about 80 million bushels per year, assuming an efficiency of 2.5 gallons per bushel.[5] This could represent over 11 percent of the state's average corn crop. At this level of ethanol production, corn prices in rural areas, especially areas serving one or more ethanol plants, might be pushed upwards. This would benefit corn growers, but Minnesota livestock producers will not profit from higher corn prices.

STATEWIDE ECONOMIC IMPACT

Ethanol production has an overall economic impact that is greater than the value of plant revenues. Firms that supply goods and services to the plant, such as corn growers and trucking companies, receive benefits and local shopkeepers profit from increased economic activity. The total economic impact is not directly measurable, but it can be estimated. This section summarizes our estimates of the impact of the ethanol industry in Minnesota and compares our estimates to those of the Minnesota Department of Agriculture.

New businesses hire workers, purchase raw materials and other inputs, pay taxes, and generate profits. These are termed "direct" impacts. What we think of as "ripple effects," caused by increased demand for everything from office products to haircuts, are divided into "indirect" and "induced" categories.

- "Direct" effects are equal to the value of sales.
- "Indirect" economic impacts are defined as those that come about through better opportunities for suppliers at all levels, in this case primarily corn growers.
- "Induced" effects are those brought about through increased disposable income of new employees, for example, the purchases of ethanol plant workers.

5 National average over dry and wet milling processes.

The total economic impact is the sum of the direct, indirect, and induced effects, and is almost always greater than the direct effect alone, but measurement can be complicated.

Input-Output Analysis

We analyzed direct and "ripple" effects in the economy.

Indirect and induced effects can be calculated through survey research, but the costs of such surveys are high and errors are magnified by the level of detailed information required. An alternative to the survey method is to conduct an "input-output" analysis, using data from sources published regularly by the federal government and other sources to estimate direct, indirect, and induced effects. This method is appealing because it is less costly and can be used to evaluate potential projects as well as completed ones. Input-output analysis was pioneered in the 1930s by Wassily Leontief, who received the Nobel Prize for his contribution to economics.

It is widely understood that the effects of plant closings and openings have repercussions throughout the economy. Input-output analysis provides a way to estimate these effects.

Within this framework, the ability of an industry to create significant economic impacts is summarized in the concept of a "multiplier." Multipliers show how estimated statewide economic output will change with a given change in industry output. According to economists, multipliers typically range in value from just above one (for a project with few indirect or induced effects) to about 2.5. Multipliers for a sampling of Minnesota industry sectors are listed in Table 2.3, which shows that the multiplier for the ethanol industry, excluding corn impacts, is 1.44. Thus, for a $1 increase in ethanol production, statewide economic output goes up $1.44.

In general, the statewide economic impacts are greater in industries with higher multipliers. It is not possible, however, to rank industries based on their multipliers alone. Industries must "fit into" a region in ways that are too varied to summarize here before meaningful comparisons can be made. As shown in Table 2.3, the multiplier associated with ethanol production is not as high as some alternatives, but may be as high or higher than most economic opportunities with wide-spread applicability for rural areas.

Advantages and Limitations

Input-output analysis is a convenient way of estimating the direct and ripple effects through a region's economy. The structure of the accounts provides a framework for investigating questions that are inherently complex. Input-output analysis can be used to investigate alternative future development proposals. Furthermore, the analysis results in a numerical estimate that is easily understood and can be readily compared.

Table 2.3: Selected Minnesota Industrial Sectors and Their Multipliers

Sector	Multiplier
Dairy Farm Products	1.54
Poultry and Eggs	1.45
Ranch Fed Cattle	1.55
Hogs, Pigs, and Swine	1.83
Feed Grains (including corn) [a]	1.53
New Industrial and Commercial Buildings	1.83
Ethanol (dry milling, not including corn impacts) [a]	1.44
Wet Corn Milling	1.73
Commercial Printing	1.69
Boiler Shops	1.80
Sheet Metal Work	1.66
Pipe, Valves, and Pipe Fittings	1.72
Machine Tools, Cutting Metal Types	1.81
General Industrial Machinery	1.59
Electronic Computers	1.67
Surgical and Medical Instruments	1.75
Wholesale Trade	1.73
Miscellaneous Retail	1.81
Security and Commodity Brokers	1.90
Elementary and Secondary Schools	2.24
State and Local Government - Non Education	1.98
Middle Income Household Spending [a]	1.18
Ethanol Plant Construction [a,b]	1.76

Note: Data is from 1993.

Source: Minnesota IMPLAN Group.

[a]Used in the impact analysis.

[b]Multiplier for a combined project including the following sectors: new industrial and co mmercial build - ings; boiler shops; pipe, valves, and pipe fittings; general industrial machinery; and comput ers.

On the other hand, there are several known sources of bias "built in" to the way impacts are estimated in input-output analysis. The careful analyst can assess the severity and compensate for many of them on a case-by-case basis.

Economic impacts need to be interpreted cautiously.

For example, in the case of a specific industrial development project, the input-output results would be calculated under the assumption that all new employees represent net additions to the labor force, and all inputs to the production process must be created from raw materials. Sometimes, this is an accurate assessment of expected outcomes. For the case at hand, it presents a problem; ethanol was intially proposed as an alternative use for surplus corn. We do not anticipate ethanol production at proposed levels to have an expansionary effect the number of acres planted to corn. Our analysis, therefore, omitted this expansionary effect..

It is important to recognize that analyzing economic impacts is difficult and sometimes controversial. Credible results depend heavily on careful specification of events. Even with reasonable assumptions, it is difficult to judge the accuracy of the results.

FISCAL YEAR 1997 ESTIMATES

At current capacity, ethanol programs produce net benefits.

Estimates of the net economic impacts of current ethanol industry development and public support measures are presented in Table 2.4. Our analysis indicates that current levels of industrial development generate $269 million in economic activity, not including the impacts arising from profits or losses of corn producers. Impacts from corn profits range from a possible loss of $58 million to a gain of the same amount. However, we estimate that the producer payment, the blender's credit, higher fuel costs, and lower fuel economy cost the state between $67 and $102 million annually in foregone household spending. Overall, we estimate the net annual impact to be between $109 and $260 million. This section details our assumptions, beginning with benefits.

Economic Impact of Ethanol Production

In fiscal year 1997, the Minnesota Department of Agriculture projects that the ethanol industry will manufacture 99 million gallons of ethanol. Using the 1989-96 average price for ethanol of $1.30, this represents about $129 million in revenue. We estimate an additional $41 million in revenue will come from sales of animal feed byproducts, again assuming 1989-96 average prices. The department projects producer payments will total $17 million. Thus, industry revenues for fiscal year 1997 are expected to sum to $187 million. Table 2.3 shows the multiplier for ethanol (excluding corn impacts) to be 1.44, so the total annual output impact is estimated to be $269 million, as shown in Table 2.4.

Table 2.4: Net Economic Impact of Ethanol Programs, Current Capacity

		Value	Output Impact (Millions)	Employment Impact (Jobs)	Personal Income Impact (Millions)
ANNUAL BENEFITS AND COSTS [a]					
99 Million Gallons Ethanol Production		$187	$269	1,375	$44
Corn Profits [b]	+$1.00 to -$1.00 per bushel	38 - (38)	58 - (58)	243 - (243)	7 - (7)
Producer Payment		17	(20)	(314)	(8)
Blender's Credit		6	(7)	(102)	(3)
Metro Area Summertime Use:					
Higher Fuel Cost	2 to 5 cents per gallon	13 - 33	(16) - (39)	(246) - (633)	(6) - (15)
Lower Fuel Economy	2.3 to 3.5 percent decrease	20 - 30	(24) - (36)	(373) - (575)	(9) - (14)
Total Annual Benefits and Costs			$109 - 260	(492) - 583	$(3) - 25
ONE-TIME NET BENEFITS:					
Construction Impacts	1/2 Local Content	99	174	1,146	38
	2/3 Local Content	132	232	1,537	50
	3/4 Local Content	149	261	1,733	57

Source:

[a] All benefits and costs are based on fiscal year 1997 projections, except as noted.

[b] Corn profits from ethanol production is the value added per bushel over the market price for th e raw commodity.

Economic Impact of Corn Profits

Corn growers profit if the price paid by ethanol plants exceeds the overall market price for corn. Corn prices and ethanol plant profits are highly variable, so we present a range of potential values. The projected 99 million gallons of ethanol output will require about 38 million bushels of corn. If the growers receive $1.00 per bushel in value added through ethanol production, then the total value is $38 million. Table 2.3 shows the multiplier for the feed grains sector to be 1.53, so the total output impact associated with a $1 per bushel dividend is $58 million.

Alternatively, if the growers receive just 50 cents per bushel, then the impact is likewise reduced by half. Similarly, if the farmers lose money, we estimate a negative statewide economic impact. Impacts for $1 per-bushel profits are shown in Table 2.4, together with impacts for losses of $1 per bushel. Overall, we estimate statewide economic impacts from corn profits may range from $58 million to a loss of the same amount.

Economic Impact of the Producer Payment

Minnesota's Department of Agriculture projects producer payments to total $17 million in fiscal year 1997 (see Table 1.2 in Chapter 1). We estimate the cost of this public expenditure by calculating the impact of an equivalent increase in middle income household spending. The multiplier for household spending, listed in Table 2.3, is 1.18.[6] If the producer payments were not made, and instead taxes on middle income households were reduced by an equivalent amount, the impact would be a $20 million increase in statewide economic output, as shown in Table 2.4.

Economic Impact of the Blender's Credit

Until it is completely phased out in October of 1997, the blender's credit reduces revenues accruing to Minnesota's Trunk Highway Fund. As with the producer payment, we estimated the costs of the blender's credit by calculating the impact of an equivalent increase in middle income household expenditures. The Department of Revenue projects the value of credits for fiscal year 1997 to be $6 million. If middle income households spent this money, using the multiplier of 1.18, we estimate the total economic impact to be $7 million, as shown in Table 2.4.

Economic Impact of Metro Area Summertime Ethanol Use

Consumers also incur costs as a result of the year-round oxygenated fuel requirement in the Twin Cities area. We assume that about 2 billion gallons of gasoline

6 Household spending multipliers for the state are small relative to those for producing sectors because a small proportion of consumer goods are made in Minnesota. The expenditures of middle income households are used as representative of all households, but this does not affect the results appreciably. Because the household spending multiplier is relatively small, our estimate of the cost impacts may be considered conservative.

are used in the state, and about one-half of that total is used in the Twin Cities area. Federal law requires use of an oxygenate in four winter months in the Twin Cities, so only two-thirds of the annual costs associated with use are attributable to state policy. Thus, about 667 million gallons are to be affected in fiscal year 1997. The costs of the oxygenated fuel requirement can be measured in higher fuel prices and lower fuel economy.

In Chapter 1, we estimated that oxygenated fuel costs consumers 2 to 3 cents more per gallon than conventional gasoline. Table 2.4 shows the impact of raising the price of 667 million gallons of gasoline by 2 cents per gallon and alternatively, by 5 cents per gallon. Assuming a 2 cents per gallon premium, year-round ethanol use costs Twin Cities area residents over $13 million, and at the higher premium of 5 cents per gallon, the total is over $33 million annually. Were these amounts not spent on gasoline, other expenditures would generate between $16 and $39 million in economic activity. In other words, year-round ethanol use in the Twin Cities costs the state between $16 and $39 million, annually.

Furthermore, fuel efficiency in terms of miles per gallon is reduced with oxygenated fuel as compared with conventional gasoline. As explained further in Chapter 3, this results in 2.3 to 3.5 percent more gasoline being consumed, and (assuming a price of $1.30 per gallon) an annual increase in fuel costs of about $20 to $30 million for Twin Cities residents. This corresponds to a loss of $24 to $36 million in statewide economic impacts, as shown in Table 2.4.

Economic Impact of Ethanol Plant Construction

Plant construction brings one-time benefits.

Construction of an industrial facility such as an ethanol plant has a large, but short-lived, impact on the state's economy. The impact on the state's economy of constructing ethanol facilites is presented in Table 2.4. This impact differs from others in Table 2.4 in that it represents a one-time boost to the state's economy.

The size of the impact depends on what percent of construction costs are paid to Minnesota firms. In most plant construction projects, some equipment was purchased secondhand and engineering services were contracted to out-of-state firms. Out-of-state purchases must be subtracted before estimating the construction impact.

Plant records indicate that construction of a dry milling ethanol production facility costs roughly $2 per gallon of installed capacity. Using this figure, the cost to build the state's projected 99 million gallons of capacity is $198 million. Our interviews with plant managers suggested that about two-thirds of construction costs went to Minnesota firms. Using this assumption, the total value is $132 million. The multiplier of an ethanol plant construction project was shown in Table 2.3 as 1.76. Thus, the total one-time output impact from facilities construction is $232 million. Table 2.4 also show estimates derived under the assumptions of one-half and three-fourths local content of $174 million and $261 million, respectively.

Net Benefits

Summing the benefits and costs discussed above, Table 2.4 shows that:

- **The ethanol industry generates a net annual impact of between $109 and $260 million, statewide. In addition there is a one-time benefit of $174 to $261 million from plant construction.**

Statewide job impact of current plant capacity is unclear.

Employment and Personal Income Impacts

The previous section focused on impacts measured in changes to the value of the state's economic output. The input-output model we used also calculates impacts in terms of employment and personal income. As shown in Table 2.4, we estimate that on an annual basis, employment impacts range from a loss of 492 jobs to a gain of 583 jobs. The reason that employment impacts may be negative is because of differences in labor patterns between the sectors where job gains and losses occur.

The sectors that gain employment directly from increased ethanol production are mostly manufacturing sectors. In general, these sectors are highly mechanized and levels of output per worker are high. Hence, a given change in output supports a relatively small number of jobs. In contrast, decreases in household spending affect workers mainly in the retail sectors, where output per worker is lower. Thus, for a given transfer of income from households to the ethanol industry, more retail jobs are lost than there are opportunities created in manufacturing. Our analysis indicates that:

- **Statewide employment gains are less significant than increases in the value of economic output, and reduced household spending due to the cost of ethanol programs may result in a net loss of jobs.**

As shown in Table 2.4, we estimate that 1,375 jobs are supported annually by an ethanol industry with 99 million gallons of production capacity. Changes in farm profits potentially affect a number of jobs in the wider economy ranging from a loss of 243 jobs to a gain of the same amount.[7] However, our analysis shows that the producer payment, blender's credit, and year-round oxygenated fuel requirements in the Twin Cities raise costs to taxpayers and consumers of motor fuel. Reduced household expenditures in other areas decrease state employment by between 1,035 and 1,624 jobs.

In terms of total personal income in the state, our analysis again shows less significant impacts than for the value of total state economic output. Unlike the employment results, however, the range of personal income impacts stays largely above zero. As shown in Table 2.4,

7 Although the model predicts that changes in corn grower's profits will directly lead to similar changes in farm employment, we believe that this is unlikely. Our estimates, therefore, do not include the employment changes directly affecting the corn growing sector, although indirect and induced effects on the wider economy are included.

- **The ethanol industry has a net positive impact on total state personal income under all but the most unfavorable combination of assumptions.**

We estimate that statewide personal income increases by about $44 million due to the direct, indirect, and induced effects of ethanol production. To the extent that corn growers earn profits or losses, personal income impacts may be adjusted up or down by up to $7 million. However, the costs of the producer payment, blender's credit, and oxygenated fuel requirements for the Twin Cities reduce statewide personal income by $22 to $35 million.[8] The net personal income gain is between negative $3 million and positive $25 million.

FUTURE ETHANOL DEVELOPMENTS

Table 2.5 shows estimated economic impacts associated with projected future industry growth, as well as those resulting from extending the oxygenated fuel requirement statewide.

Table 2.5: Net Economic Impact of Ethanol Programs, Fiscal Year 2001

		Value	Output Impact (Millions)	Employment Impact (Jobs)	Personal Income Impact (Millions)
ANNUAL BENEFITS AND COSTS [a]					
178 Million Gallons Ethanol Production		$329	$472	2,426	$78
Corn Profits [b]	+$1.00 to -$1.00 per bushel	68 - (68)	104 - (104)	444 - (444)	12 - (12)
Producer Payment		(23)	(27)	(436)	(11)
Subtotal: 178 million gallons of production			$341-549	1,546-2,434	$55-79
Statewide Year-Round Use:					
Higher Fuel Cost	2 to 5 cents per gallon	(33) - (83)	(39) - (99)	(633) - (1,608)	(15) - (38)
Lower Fuel Economy	2.3 to 3.5 percent decrease	(50) - (76)	(59) - (89)	(954) - (1,118)	(23) - (26)
Subtotal: Statewide Year-Round Use			$(188) - (98)	(2,726) - (1,587)	$(64) - (38)
Total Annual Benefits and Costs			$153 - 451	(1,180) - 847	$(9) - 41
ONE-TIME NET BENEFITS					
Constuction Impacts	1/2 Local Content	178	313	2,078	68
	2/3 Local Content	237	417	2,781	90
	3/4 Local Content	267	470	3,134	102

Source:

[a] All benefits and costs are based on fiscal year 2001 projections, except as noted.

[b] Corn profits from ethanol production is the value added per bushel over the market price for the raw commodity.

8 These impacts were estimated by calculating the change in employment and income associated with changes in household spending.

Economic Impact of Ethanol Industry Expansion

In fiscal year 2001, the Minnesota Department of Agriculture projects that the ethanol industry in Minnesota will manufacture 178 million gallons of ethanol. Using the same prices for ethanol and feed byproducts as in the estimates above, this represents $231 million in revenue from ethanol and an additional $75 million in revenue from sales of animal feed byproducts. The department projects producer payments will total $23 million in fiscal year 2001. Thus, industry revenues sum to $329 million. Table 2.3 showed the multiplier for ethanol production to be 1.44, so the total annual output impact is estimated to be $472 million in fiscal year 2001, as shown in Table 2.5.

It is important to note that the input-output method assumes that capacity will be added by increasing the number of facilities and keeping the average plant size constant. Increasing ethanol plant capacities would mean more cost-efficient operation and hence, smaller economic impacts. We acknowledge that the estimate for the year 2001 is biased upwards, but the extent of this bias is unknown. We present it as an upper bound to the range of possible true impacts.

Economic Impact of Corn Profits

Manufacturing the projected 178 million gallons of ethanol would require about 68 million bushels of corn. If the corn growers receive $1.00 per bushel in value added through ethanol production, then the total value is $68 million. Table 2.3 shows the multiplier for the feed grains sector to be 1.53, so the total output impact at this increased capacity is $104 million. Table 2.5 shows this estimate, along with those for other potential profit margins. Overall the impacts from corn profits may range from $104 million to a loss of the same amount.

Economic Impacts of the Producer Payment

The Minnesota Department of Agriculture projects producer payments to total $23 million in fiscal year 2001 (see Table 1.2 in Chapter 1). We estimate the cost of this public expenditure by calculating the impact of an equivalent increase in middle income household spending. The multiplier for household spending, listed in Table 2.3, is 1.18. If the producer payments were not made, and instead taxes on middle income households were reduced by an equivalent amount, the impact would be a $27 million increase in statewide economic output.

Summing production benefits and subtracting the costs of the producer payment, we find:

- **The projected level of output in 2001 of 178 million gallons per year will generate an estimated $341 to $549 million in annual statewide economic benefits. Actual impacts will probably be smaller, depending on the actual increases in efficiency.**

Economic Impact of Statewide Year-Round Ethanol Use

Statewide ethanol use adds significant costs for consumers.

Consumers will also incur costs as a result of the year-round oxygenated fuel requirement. We assume that about 2 billion gallons of gasoline are used in the state. Federal law requires use of an oxygenate in four winter months in the Twin Cities metro area only, so about five-sixths of the annual costs associated with use are attributable to the state policy requiring oxygenated fuel statewide and year-round. Thus, about 1.67 billion gallons are affected under statewide oxygentated fuel requirements sceduled to take effect in October, 1997. The costs of oxygenated fuel use are measured in higher fuel costs and lower fuel efficiency.

Table 2.5 shows the impact of raising 1.67 million gallons of gasoline by 2 cents per gallon and, alternatively, by 5 cents per gallon. Assuming a 2 cent per gallon premium, this amounts to over $33 million in extra fuel costs. At the higher estimate of 5 cents per gallon, the costs total over $83 million. Were these amounts not spent on gasoline, other middle income household expenditures would generate between $39 and $99 million in economic activity.

Furthermore, vehicles travel fewer miles per gallon of oxygenated fuel as compared with conventional gasoline. This results in 2.3 percent to 3.5 percent more gasoline consumed, and (assuming a price of $1.30 per gallon) $50 to $76 million is extra fuel costs. In terms of household expenditures, this represents an annual loss of $59 to $89 million in statewide economic impacts.

Totalling these results, we estimate:

- **Statewide, year-round ethanol use will cost consumers $83 to $159 million, with statewide economic impacts of $98 to $188 million annually.**

Economic Impact of Ethanol Plant Construction

Using the cost assumption of $2 per gallon of installed capacity, the total cost to build the state's projected 178 million gallons of capacity is $356 million. Assuming two-thirds of this total supports Minnesota construction firms, the total value is $237 million. The multiplier of an ethanol plant construction project was shown in Table 2.3 as 1.76. Thus, the total one-time output impact from facilities construction is $417 million. Table 2.5 also show estimates derived under the assumptions of one-half and three-fourths local content of $313 million and $470 million, respectively.

Combining the above impacts, we estimate that:

- **The net annual impact of future ethanol developments is estimated between $153 and $451 million in economic output. In addition,**

one-time ethanol plant construction benefits are estimated to grow to a cumulative total of $313 to $470 million.

Employment and Personal Income Impacts

Expansion of current plant capacity will have mixed impacts on jobs and personal income.

Table 2.5 also shows the impacts of 178 million gallons of annual production and statewide, year-round ethanol use measured in terms of employment and personal income. For the same reasons explained above, employment impact estimates at this greater level of production and use show a trade off between jobs in the ethanol sector and jobs supported by household spending, which are mainly in retail sectors. The net impact depends on the specific assumptions, but estimates range from a loss of 1,180 jobs to a gain of 847 jobs. The direction of personal income impacts is also dependent on assumptions, but the estimates on Table 2.5 range from a loss of $9 million to a gain of $41 million.

Like any impact analysis, these estimates rely on projections of current economic patterns and little is known about the accuracy of such models. Without careful specification the models can overstate impacts. Our analysis has made every effort to properly account for costs as well as benefits.

The Department of Agriculture's Estimates

The Minnesota Department of Agriculture has published estimates of the impact of ethanol on the Minnesota economy. These estimates include "balance of trade effects," total value of output, total economic impact, job creation, and fiscal impacts. The department's analysis examines three scenarios for ethanol production: 25 percent market share (50 million gallons per year), 50 percent market share (100 million gallons per year) and 100 percent market share (200 million gallons per year). Overall,

- **The Department of Agriculture's estimates of economic impact focus on the benefits of ethanol production while ignoring the costs of state programs.**

The department's balance of trade analysis is based on the value of ethanol as a direct substitute for gasoline, which is "imported" from other states. The department claims that replacing 10 percent of all gasoline sold in Minnesota (200 million gallons, at $0.50 per gallon) with ethanol would improve the balance of payments by $100 million. This analysis greatly oversimplifies the balance of payments effect and overstates the potential benefit by singling out one of the potential benefits of ethanol, and none of the associated costs. A more thorough analysis of the impact on the balance of trade would include the lost "exports" of raw corn or alternative products, and the "import" of people and capital to build and operate the plants.

We also think that the arguments concerning balance of trade effects are largely out of place in an economic impact analysis. Reduced imports mean a loss of jobs and income at some level, if only in the importing sector. More likely, the

changes will have repercussions in many areas of trade. We do not think it is acceptable to count reductions in imports as a category of economic benefits alongside increases in income and output. While we acknowledge the desirability of fuel supply as a national security issue, our analysis examines this issue separately.

To estimate economic impacts, the department uses input-output analysis as we have done in this chapter. The department's estimates are much higher than ours, primarily because they do not consider the economic impacts of public support, higher fuel costs, or reduced fuel economy. For example, the department's estimate of the total impact resulting from 100 million gallons of ethanol production is $301 million.[9] We estimated the net impact of 99 million gallons of ethanol production, excluding corn impacts and all forms of cost, to be $269 million. With corn impacts and costs included, our estimate falls to between $109 and $260 million (see Table 2.4).

Comparing the estimates of the annual economic impact of ethanol production alone, we believe our estimates are essentially similar to those of the department. Our estimates benefited from a more recent data set than that used by the department, and we think our estimates better account for some of the inherent biases of the input-output method. However, the numerical benefit estimates are close; the major difference is the lack of cost impacts in the department's analysis.

The Department of Agriculture's estimates consider benefits but not costs.

The department's analysis of fiscal impacts balances the cost of producer payments against estimates of payroll tax, taxes on cooperative member's dividends, and property taxes. This, too, is oversimplified. As outlined elsewhere, there are many other forms of state assistance, and a more complete analysis would also include the costs to local infrastructure and municipal services.

Furthermore, the department's analysis assumes a property tax rate of 7 to 8 cents per gallon of capacity installed, and therefore forecasts an increase in tax revenues whenever output increases. Our data suggests that the sum total of all taxes amount to less than 2 cents per gallon of capacity for a small plant and much less for larger facilities. Moreover, many of the plants have secured tax increment financing, whereby they can reduce their net property tax exposure.

By the department's own analysis, the ethanol subsidies will create a net drain on government revenues up until the industry reaches a 90 percent market share. The only factor limiting the loss is the $30 million spending cap. We believe, however, that net fiscal impacts are tangential to the question of economic impacts. The ethanol programs were designed to transfer funds to a fledgling industry, and cost containment measures such as the spending cap and the 10 year limit were enacted by a Legislature cognizant of the potential fiscal impacts involved.

9 Su Ye, *Economic Impact of the Ethanol Industry in Minnesota* (St. Paul: Minnesota Department of Agriculture, May, 1996).

STRATEGIC VALUE OF ETHANOL

In addition to the economic benefits described above, Minnesota's ethanol industry may have a strategic value stemming from ethanol's partial substitutability for gasoline. In 1993, the United States imported about 2.5 billion barrels of crude oil, almost 40 percent of our consumption, and imports are increasing in volume and percentage terms. More than half of oil imports come from members of the Organization of Petroleum Exporting Countries, and there is lingering concern about the power of the OPEC cartel. This section summarizes strategic value by looking first at the amount of petroleum used to produce ethanol, followed by strategic values to the nation, and finally, the state of Minnesota.

Net Energy Value

For ethanol to play a role in energy security, it must have a positive net energy value, meaning that it must contain more energy than is used in the ethanol production and distribution process. Although in earlier years this was a valid criticism of ethanol production technology, more recent studies indicate that:

Ethanol production is energy efficient.

- **Ethanol contains more energy than is used to manufacture it.**

The most recent and best study indicates a national average gain in energy value of about 24 percent, including values for coproducts.[10] This study also includes some state level estimates, from which we infer even higher net energy values in Minnesota. Compared to other major corn producing states, Minnesota uses less nitrogen fertilizer and less irrigation, both of which are energy intensive. We therefore consider the national estimates conservative from the state's perspective.

A related measure of energy value considers petroleum fuels only. This ratio balances the energy content of ethanol against only the petroleum used to manufacture ethanol. The USDA reports that ethanol contains 7.24 times the energy in the petroleum used in the production and distribution process. Put another way, producing one Btu of ethanol energy requires 0.14 Btu of petroleum energy.

The Cost of Gasoline and the Strategic Value of Ethanol

There is little doubt that the total costs to society of petroleum use are greater than the prices paid by consumers. A recent study suggested that the "true" cost of gasoline was 32 cents higher than the average retail price.[11] Most of this difference (19.2 cents per gallon) is attributable to military expenditures. Environ-

10 Hoesin Shapouri, James Duffield, and Michael Grabowski,*Estimating the Net Energy Balance of Corn Ethanol* (Washington, D.C.: USDA Economic Research Service, 1995).

11 Jenny Wahl, *Oil Slickers: How Petroleum Benefits at the Taxpayers' Expense* (St. Paul: Institute for Local Self Reliance, 1996).

mental and health costs are also important, adding 11.5 cents. Finally, the tax breaks enjoyed by the oil industry cost 1.45 cents per gallon of gasoline.

We think that this pricing problem is not relevant to an evaluation of the ethanol industry. From a national perspective, ethanol is a minor energy source. In 1994, ethanol fuels accounted for 0.1 percent of total energy consumption, whereas petroleum supplied about 39 percent. Ethanol consumption could triple from these levels and still represent less than half of 1 percent of total energy consumed, and less than 1 percent of the nation's consumption of petroleum energy. Thus:

- **Ethanol replaces a tiny fraction of imported petroleum, and cannot be credited with any national energy security benefits.**

Furthermore, there is no plausible scenario under which ethanol can meet expected increases in petroleum demand. Crude oil imports are projected to grow almost 30 percent by the year 2000 on an energy content basis.[12] This amount translates to over 44,000 times as much ethanol as is currently produced in the US. Expanding ethanol production to meet these increased petroleum demands would require over 2,000 times as much corn as is grown in the US in an average year.

The United States is committed to being a large petroleum importer for the foreseeable future, with or without ethanol production. To this end, military expenditures, human health costs and environmental costs will likely remain at or above current levels. The effect of ethanol on energy security is no more than symbolic, and may be counterproductive if more effective strategies exist to reduce our reliance on imported oil.

Octane and Replacement Value

Ethanol currently replaces a tiny fraction of imported oil.

Even without national security benefits, ethanol can have value to the state as a gasoline additive.

This may come about through simple substitution, with ethanol replacing a quantity of gasoline with equal energy content. Ethanol contains 33 percent less energy than an equal volume of gasoline. Using this factor, the 69 million gallons produced in Minnesota in fiscal year 1996 replaced 46 billion gallons of gasoline. This represents 2.3 percent of statewide gasoline consumption. In terms of its replacement value,

- **A gallon of ethanol replaces 0.67 gallons of gasoline.**

Ethanol may also have a value in use stemming from its high octane content. Cheaper, lower octane gasoline formulations can be used in ethanol blends, since the octane in ethanol will bring the oxygenated fuel up to specification. Of course, to take full advantage of this refiners must expand their systems to include tankage and handling capability for another grade of gasoline.

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12 Statistical Abstract of the United States (Washington, D.C: US Bureau of the Census, 1995).

We spoke with representatives from two major refiners that produce gasoline with an octane rating of about 84. This fuel is not sold as is, but is used exclusively at the refinery to produce oxygenated unleaded regular gasoline with an octane rating of 87. This pre-blended fuel is distributed exclusively in the Twin Cities area, because tankage and handling capacity in the remainder of the state can not accommodate an additional grade of fuel. A third refiner we spoke with said that due to handling and capacity problems, they did not produce any sub-grade gasoline for ethanol blending.

However, even the refiners that take fullest advantage of the octane benfits of ethanol acknowledged that there are cheaper octane enhancers available to them. Without the oxygenate mandate, and the tax benefits associated with ethanol, they said they would use very little ethanol.

SUMMARY

Minnesota's ethanol industry conveys significant net economic benefits for the small cities where the plants are located, and also for the state as a whole. Most of the recent development in ethanol production has been focused on small rural cities, which gain benefits in terms of economic diversification, job growth, and improved economic environments. In addition, ethanol plant development has brought improvements in small cities' infrastructure, which may improve future prospects for additional growth.

The industry generates significant statewide net economic benefits as well. Subtracting the cost impacts from the annual production impacts, we estimate that the present level of development has had a net impact of $109 to $260 million, depending on which assumptions about corn growers profits and fuel costs are used.

The projected level of output in the year 2001 of 178 million gallons per year would generate an estimated $341 to $549 million in statewide economic benefits, net of costs of subsidy, assuming the industry maintains the current level of efficiency. Actual impacts will probably be smaller, however, as planned expansions of the current plants should make them operate more efficiently.

Implementation of the statewide, year-round oxygenated fuel requirement will increase Minnesota's fuel costs by increasing fuel prices and decreasing average fuel economy. We estimate the annual costs to be between $83 and $159 million. Were these costs not imposed, other household spending would generate between $98 and $188 million in annual statewide economic activity.

We found other potential benefits, such as energy security, to be unsubstantiated. Comparatively, ethanol constitutes a tiny fraction of petroleum demand, and arguments based on national energy security or the "true" costs of oil are symbolic at best. There is simply no plausible scenario under which ethanol derived from corn can lessen our dependence on imported petroleum.