Title: Economic Impacts of Ethanol Production in Georgia

Authors:

Archie Flanders, Economist
313-A Conner Hall
Center for Agribusiness and Economic Development
University of Georgia
Athens, GA 30602
706-542-0751
archief@.uga.edu

Audrey Luke-Morgan, Agribusiness Economist
Tifton Campus, RDC
P.O. Box 1209
Center for Agribusiness and Economic Development
University of Georgia
Tifton, GA 31793
229-391-6877
audreylm@uga.edu

George Shumaker, Economist
Landrum Box 8112
Center for Agribusiness and Economic Development
University of Georgia
Statesboro, GA 30460
912-681-5653
shumaker@uga.edu

John McKissick, Center Coordinator
201 Conner Hall
Center for Agribusiness and Economic Development
University of Georgia
Athens, GA 30602
706-542-4131
jmckissick@agecon.uga.edu

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Economic Impacts of Ethanol Production in Georgia

Abstract

Capital costs to construct a conventional ethanol plant producing 100 million gallons per year are $170.593 million. Average annual net returns average $59.216 million with a 1% chance of annual net returns less than $0. Ethanol production stimulates total economic output of $314.221 million in the Georgia economy. Wages and benefits total $20.181 million for 408 jobs in Georgia. State and local governments derive a total of $4.572 million in tax revenues from ethanol production.

Key Words: economic development, economic impact, ethanol production, stochastic simulation, truncated multivariate normal distribution

JEL Classifications: **R15**

Economic Impacts of Ethanol Production in Georgia

Changing market conditions for petroleum products create potential markets for alternative energy sources. Interest in renewable sources of energy have created potential for agricultural production as alternative fuel supplies. Ethanol production has historically been produced close to corn production which is used as a feedstock. There is much interest among potential investors for the feasibility of ethanol production in Georgia. Public policy concerns of new energy sources are related to reducing consumption of petroleum and stimulating economic development through production of substitutes for traditional fuels. Investors seek other venture capital for financing, but also seek government financial support for prospective ethanol plants. Governments are interested in allocating public resources for economic development that may be stimulated by operation of an ethanol plant.

Atlanta is included as an area that does not meet federal standards for air quality. Federal requirements for such areas mandate that gasoline sold for consumption must contain a minimum of 2% oxygen by weight. Ethanol is a primary oxygenate for gasoline, and environmental regulations create potential for increased demand in the Atlanta area (Shumaker, Luke-Morgan, and McKissick).

The objective of this research is to investigate the financial feasibility of an ethanol plant in Georgia. Operating costs for the plant used to determine feasibility provide data for an input-output model to investigate the economic impacts of ethanol production. Potential financial success of ethanol plant inform investors who seek a profit, while economic impacts inform government officials of the public benefits of supporting ethanol ventures.

Model and Simulation Methodology

A comprehensive review of literature related to ethanol production is given by Richardson et al. Ethanol was first utilized as a U.S. fuel additive in the 1920's as a gasoline blend with 25% ethanol. Interest in ethanol production increased in the early 2000's with rising gasoline costs and uncertain supplies. Feasibility of ethanol production in Texas by Richardson et al applies a stochastic simulation analysis over a 10-year period. This research estimates the variability of net cash income for a plant producing 50 million gallons per year. Results indicate average net cash income of $38 million for 2007.

This analysis investigates a conventional dry grind type ethanol plant in Georgia producing 100 million gallons per year. A fractionation plant is a newer technology than the conventional plant. Much greater initial capital costs of the fractionation plant make a conventional plant more likely for construction in Georgia. Georgia is presently a deficit corn state with most consumption for its large poultry industry imported from Midwestern corn producers. An assumption of this analysis is that corn for ethanol production is shipped in from Midwestern states.

Input requirements for 100 million gallons of ethanol are included in a previous Georgia feasibility analysis by Shumaker, Luke-Morgan, and McKissick. Capital costs for construction of the conventional plant are $170.593 million. A stochastic analysis expands this previous research with only deterministic variables by accounting for variable feasibility outcomes. Risk in ethanol production is associated with changing prices for products sold, as well as uncertain prices for inputs. A conventional ethanol plant produces dried distillers grains and solubles (DDGS), as well as carbon dioxide as co-products with ethanol. DDGS is widely used as cattle feed, and can be utilized by the Georgia poultry industry in feed rations. Revenue form carbon dioxide is only possible if an ethanol plant has a user of this co-product willing to locate near ethanol production. While carbon dioxide could become a co-product that produces revenue, the current analysis assumes it is vented into the atmosphere and returns no revenue.

Stochastic prices for ethanol revenue and unleaded gasoline for an expense as a denaturant are determined by Omaha, NE rack prices (Nebraska Ethanol Board). Price variability of DDGS sold as a co-product is represented by prices in Lawrenceburg, IN. Feedstock expense variability is derived by No. 2 yellow corn prices in Central Illinois (USDA, ERS). Corn prices for shipments into Georgia from the Midwest are estimated with a $0.40/bu. differential added to Central Illinois prices.

Correlations between all stochastic prices are estimated with monthly data for 2005-2006. Corn prices are not correlated with any of the other prices, but prices for ethanol, DDGS, and gasoline have statically significant positive correlations. Table 1 shows the covariance matrix for generating 500 iterations of monthly 2005-2006 prices for ethanol, DDGS, and gasoline with the multivariate normal function of Simetar (Richardson, Schumann, and Feldman). Corn prices are simulated for the same period with a univariate normal distribution in Simetar. Simulation with normal distributions can result in simulated random variables that are outside of historical bounds (Richardson, Klose, and Gray). Iterations are truncated at levels determined by reasonable expectations for annual prices. Table 2 includes historical average monthly prices for 2005-2006, minimums and maximums for truncation, and the resulting average after truncating the iterations. Gasoline used as a denaturant is a lower grade than typical consumer grades and the average price in Table 2 is correspondingly lower. Imposing truncation slightly increases all prices except for denaturant.

Revenue from 100 million gallons of ethanol and 320,225 tons of DDGS leads to annual revenue of $245.630 million. Total costs consisting of processing costs and fixed costs are $186.414 million in Table 3. Subtracting costs from revenue results in net returns to land and management of $59.216 million. Figure 1 indicates the probability that annual NR is less than $0 is only 1%. There is a 52% probability that NR is greater than $0 and less than $50 million. The probability that NR is greater than $50 million is 42%. Thus, average NR is $59.216 million with little risk that annual NR is negative.

Economic Impacts of Ethanol Production

Results for NR indicate that ethanol production is an attractive investment for investors. Economic impact analysis investigates public benefits due to adding an ethanol to the state economy. Economic impacts can be estimated with input-output models that separate the economy into various industrial sectors such as agriculture, construction, manufacturing, trade, and services. The input-output model then calculates how a change in one industry changes output, income, and employment in other industries. These changes, or impacts, are expressed in terms of direct and indirect effects. Impacts are interpreted as the contribution of the enterprise to the total economy. Direct effects represent the initial impact on the economy of either construction or operations of an enterprise. Indirect effects are changes in other industries caused by direct effects of an enterprise and include changes in household spending due to changes in economic activity generated by direct effects. Thus, the total economic impact is the sum of direct and indirect effects. Input-output analysis can interpret the effects of an enterprise in a number of ways including output (sales), labor income (employee compensation and proprietary income), employment (jobs), and tax revenue (MIG).

Economic impacts result from a multiplier effect that begins with expenditures of an enterprise stimulating business to business spending, personal income, employment, and tax revenue. Impact analysis involves quantification of spending levels and proper allocation to impacted sectors. Output impacts are a measure of economic activity that results from enterprise expenditures in a specific industrial sector. Output is equivalent to sales, and this multiplier indicates how initial economic activity in one sector leads to sales in other sectors. Labor income impacts measure purchasing power that is created due to the output impacts. This impact provides the best measure of how standards of living are affected for residents in the impact area.

An enterprise involves a specified number of employees that is determined by the technology utilized Employment multipliers indicate the effect on employment resulting from the enterprise initiating economic activity. IMPLAN (MIG) indirect employment includes both full-time and part-time jobs without any distinction. Jobs calculated within an IMPLAN industrial sector are not limited to whole numbers and fractional amounts represent additional hours worked without an additional employee. With no measure of hours involved in employment impacts, IMPLAN summations for industrial sectors which include fractional employment represent both jobs and job equivalents. Since employment may result from some employees working additional hours in existing jobs, instead of terming indirect employment impacts as “creating” jobs, a more accurate term is “involving” jobs or job equivalents.

Table 4 shows the direct output impact of production is equal to the average total revenue of the plant. Direct labor income impact is the annual wages and benefits paid to the 46 employees of the plant. Indirect output is $68.591 million for a total output impact of $314.221 million to the state economy. Indirect labor income to Georgia is $18.340 million for 362 jobs for a total impact of $20.181 million in wages and benefits for 408 jobs. This averages $49,463 per job that includes full-time and part-time jobs. Operation of an ethanol plant generates $2.401 million in state tax revenues and $2.171 million in taxes for local governments in Georgia for total taxes of $4.572 million per year. The allocation of impacts in the major industrial sectors of the Georgia economy is in Table 5. Ethanol production is a manufacturing process, and this sector has the greatest impacts for output. State impacts for labor income and employment are greatest in the service sector.

Summary

Capital costs to construct a conventional ethanol plant producing 100 million gallons per year are $170.593 million. Annual revenues average $245.630 million with average operating costs of $186.414 million. Average annual net returns average $59.216 million with a 1% chance of annual net returns less than $0. Ethanol production stimulates total economic output of $314.221 million in the Georgia economy. Wages and benefits total $20.181 million for 408 jobs in Georgia. State and local governments derive a total of $4.572 million in tax revenues from ethanol production.

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Table 1. Covariance Matrix for Correlated Monthly Prices, 2005-2006

Variable	Ethanol	Denaturant	DDGS
Ethanol	0.3799	0.0834	3.033
Denaturant		0.0284	0.7431
DDGS			53.00

Table 2. Historical Average, Truncated Minimum and Maximum, Simulated Average for Stochastic Variables

Variable	Historical	Truncated Minimum	Truncated Maximum	Simulated
Ethanol ($/gal.)	2.17	1.70	2.80	2.20
Denaturant ($/gal.)	1.00	0.80	1.25	1.00
DDGS ($/ton)	80.94	70.00	100.00	81.14
Corn ($/bu.)	2.50	2.30	2.79	2.54

Table 3. Costs of Ethanol Production (100 MG)

	Dollars
Feedstock Cost	102,391,160
Enzymes	5,280,000
Yeast & Chemicals	1,810,000
Denaturant- Unleaded Gas	5,017,904
Natural Gas	27,200,000
Electricity	5,000,000
Water/Sewer	800,000
Labor plus Benefits	1,841,423
Repairs & Maintenance	2,000,000
Supplies/Office/Laboratory	400,000
Insurance	800,000
Other/Sales/Gen./Admin	5,780,000
Marketing - Ethanol	1,000,000
Freight - Ethanol	6,000,000
Management/Consulting	2,000,000
Interest on ST Debt	494,916
Processing Costs	**167,815,402**
Depreciation	10,742,193
Interest on LT Debt	7,856,570
Fixed Costs	**18,598,763**
Total Costs	**186,414,165**

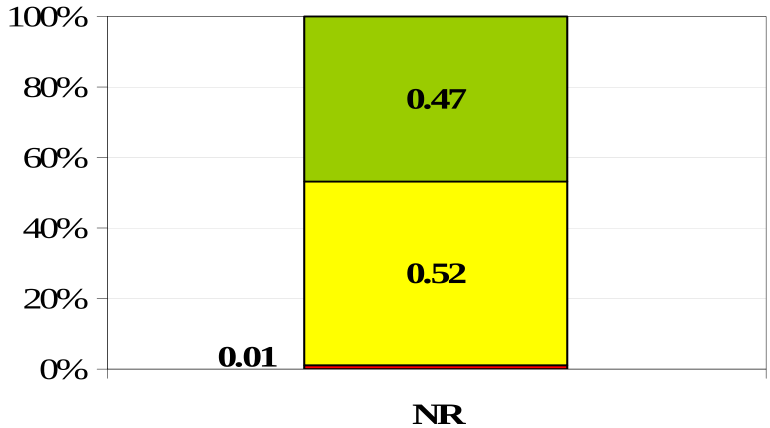

Figure 1. Probabilities NR Less Than $0 and Greater Than $50 Million

Table 4. Ethanol Production Impacts to Georgia

	Direct Impact	Indirect Impact	Total Impact
Output ($)	245,630,012	68,590,745	314,220,757
Labor Income ($)	1,841,423	18,339,726	20,181,149
Employment	46	362	408
State Taxes ($)			2,401,071
Local Taxes ($)			2,171,327
Sum of Taxes ($)			4,572,398

Table 5. Ethanol Production Impacts to Major Sectors, Georgia

Sector	Output ($)	Labor Income ($)	Employment
Agriculture	168,107	51,276	2
Construction & Mining	719,489	232,707	4
Utilities	27,061,630	4,897,926	35
Manufacturing	250,818,176	2,477,896	55
Transportation, Warehousing	8,723,535	3,006,280	72
Trade	3,586,806	1,390,323	40
Finance, Insurance, & Real Estate	4,418,911	1,226,651	24
Services	16,505,361	6,804,259	174
Government and non-NAICS	2,218,744	93,832	2
Total	314,220,757	20,181,149	408