An Analysis of Ethanol Production in Texas Using Three Ethanol Facility Sizes and Their Relative Optimal Subsidy Levels

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Abstract:

Ethanol production in 15, 30, and 80 million gallon per year production plants are analyzed at various subsidy levels. The results indicate that removing per plant subsidy limits allows reduced total state subsidy expenditures. This action takes advantage of the economies of scale inherent in larger ethanol plants.

INTRODUCTION

State politicians, rural development commissions, and farmers have recently intensified research on the feasibility of ethanol production. Reasons for the recent resurgence of interest in ethanol production can be attributed to many different factors. Some of those may include depressed commodity prices, the rising volatility of gasoline prices, shifts in environmental policy that have threatened the ban of methyl butyl ethylene (MTBE), and lastly, the national focus of fuel self-sufficiency given the events following September 11, 2002.

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The majority of states that have ethanol production facilities subsidize production in some capacity. Tax incentives and producer grants are the most common forms of these subsidies. The Texas State Legislature is developing an ethanol production producer grant program to entice prospective investors to construct and operate ethanol plants in Texas. Texas State Legislature H.B. 788 proposes a $0.20/gal subsidy on the first annual 30,000,000 gallons of production per registered facility. Production volumes that exceed 30 million gallons per year (MMGPY) are still included in the program, however, excess production is unsubsidized.

As facility size increases, it would be expected that economies of scale advantages would apply and it could be cheaper to offer lower subsidies to higher producing plants. The objective of this study is to estimate the total costs of subsidizing ethanol production, with a constant vs. a variable per gallon subsidy level. It is hypothesized that larger facilities would require a sufficiently smaller subsidy per gallon to have a 100 percent chance of economic success thus, lowering the producer grant costs paid by the State of Texas to produce a targeted amount of ethanol.

REVIEW OF LITERATURE

Bryan and Bryan International (BBI) completed the Dumas Texas Area Ethanol Feasibility Study by preparing an analysis of a 30 MMGPY facility in Texas. Similar to production based businesses, ethanol producers face risks of both input and output prices. All past ethanol studies, included BBI, have failed to include a “true” estimate of the risks associated with ethanol production. Those risks include high corn, electricity, and natural gas prices, and low ethanol and dry distillers grain prices. In their analysis, BBI falsely represented the stochastic component of their variable input prices, by simply inflating corn, ethanol and DDGS prices, when ethanol and DDGS prices have a significant downward trend. The reason for the misrepresentation of the stochastic component their variable inputs are mysterious. However, logical reasoning would lead one to conclude that the analysis provided by BBI would need to provide a positive outlook in order to entice prospective investors to provide capital.

In their study, BBI provided the operational and construction costs for three sizes of ethanol facilities: 15, 30, and 80 MMGPY, and the values stated by BBI are consistent with others in the literature. The analysis provided in this study is therefore based on BBI's estimation of operational and construction costs.

METHODOLDOGY

This study describes and applies stochastic simulation to a financial model of an ethanol production facility in Texas using standard economic pro-forma financial statements. Stochastic simulation is defined as a "tool for addressing 'what if . . .' questions about a real economic system in a non-destructive manner" (Richardson 2002).

As most businesses use Microsoft based products as the basis for their analysis, this study is completed in Excel©. To construct a stochastic simulation model in Excel©, it is necessary to use a simulation engine that runs in Excel©. Such a simulation engine or package, must have the ability to do the following: generate pseudo random numbers, collect the output from simulations, and facilitate the analysis of simulation results by presenting the information in alternative forms that aid in the analysis and ranking of the scenarios. SIMETAR© is a simulation package that does all the above and more.

SIMETAR© was developed by Richardson, Schumann, and Feldman in the Department of Agricultural Economics, Texas A&M University. It is an Add-In to

Microsoft Excel© that was developed in Visual Basic for Applications. It consists of both Menu Driven and User Defined Functions in Microsoft Excel©.

The framework of the stochastic simulation model for the evaluation of the optimal level of subsidy provided by the proposed Texas State Producer Grant is provided in this section. The model simulates the economic activity of a 15 million gallon per year facility (MMGPY), yet with assumption changes of input and output coefficients, it can be used to analyze a 30 and 80 MMGPY facilities.

The following sections describes the development of stochastic variables used in the model, capital and operating loan and interest rate assumptions, production assumptions, financial sheet calculations and the Texas State Producer Grant assumptions.

Stochastic Variables

The stochastic variables used in the ethanol model are annual corn, ethanol, dry distillers gain (DDGS), electricity, and natural gas prices. These are the major exogenous input and output variables in the model. Ethanol and DDGS prices affect the cash receipts while the other stochastic variables affect costs of production. A description of the method used to develop parameters for simulating the stochastic variables is provided in this section.

The lack of publicly collected ethanol price, constrained the amount of monthly historical ethanol prices that could be found for the use in this study. For this reason, monthly prices for other variables were used to match and averaged to develop average annual ethanol prices. The average prices used in this analysis are based on the calendar year, January through December, instead of commodity marketing years. This is true for all exogenous variables described in the following section.

Monthly ethanol prices were provided by ICIS-LOR, from February 1994 to May 2002. The data collected for ISCI-LOR is a simple average of high and low ethanol prices for each month. Monthly dry distillers grain (DDGS) prices were also taken from the United States Department of Agriculture, Economic Research Service, Feed Grains Data Delivery Service as a web query preformed on June 20, 2002, for a period from January 1982 to December 2000. Historical monthly commercial electricity and natural gas prices were taken from the United States Department of Energy, from January 1983 to December 2003 (May to December 2003 are forecasted prices). Annual soybean meal (SBM) prices were collected from the United States Department of Agriculture, Economic Research Service, Feed Grains Data Delivery Service as a web query preformed on June 20, 2002. Historical monthly corn prices were taken from the United States Department of Agriculture though a web query, for a period of January 1993 to April 2002. The data was queried by geographical location and then averaged to generate a monthly U.S. average. A Texas basis was added to localize national corn prices to Texas.

Once historical monthly prices of corn, ethanol, DDGS, electricity, natural gas, and soybean meal were collected, the data was sorted, matched and cropped from February 1994 to December 2000. An annual model is used in this study so the monthly data were averaged to generate annual averages for corn, ethanol, DDGS, electricity and natural gas prices. A correlation matrix of annual prices for corn, ethanol, electricity, natural gas and SBM was estimated in preparation for simulating these variables. There was significant correlation between corn prices and DDGS prices, resulting in a correlation coefficient of 0.92, with a t-statistic of 5.17, and significant correlation between SBM prices and corn prices, resulting in a correlation coefficient of 0.87, with a t-statistic of 3.94; using 7 observations of annual data between 1994 and 2000.

Simple trend regressions were run on corn prices, ethanol prices, natural gas prices, electricity prices, and soybean meal prices to collect the respective residuals to quantify the variation of each variable around its respective trend to develop stochastic deviates for an empirical probability distribution. The trend regressions for ethanol and electricity prices were used to forecast mean values for 2003 to 2015, then the forecast was flat lined from 2016 to 2022. The alpha and beta coefficients as well as their respective t-statistics are summarized in Table 1. The significant correlation between DDGS and corn prices, and DDGS and soybean meal prices, prompted a multiple regression was run with DDGS being a function of corn and soybean meal prices. The respective alpha and beta coefficients as well as their respective t-statistics, R^2 and F-test values are included in Table 1.

The residuals from the regression models contributed the risk component for the stochastic variables in the model in a multivariate empirical (MVE) distribution using the correlation matrix for the residuals from trend and the sorted residuals. The MVE probability distribution was simulated with SIMETAR© generating stochastic deviates that were then applied to project the means for 2003 to 2022.

Forecasted means for 2003-2010 corn and soybean meal prices (SBM) were taken from the Food and Agriculture Policy Research Institute (FAPRI) July 2002 Baseline Projections. After 2010, the FAPRI forecast was flat lined and used as the forecasted corn and SBM prices for 2011 to 2022. DDGS forecasted mean prices were calculated from the multivariate regression of DDGS as a function of FAPRI's projected corn and soybean meal prices. Mean ethanol prices for 2003 to 2022 were forecasted for the period of 2003 to 2015 using the simple trend regression model. After 2015, the forecast was flat lined and fixed at $0.97 per gallon in nominal terms. Forecasted mean prices of corn, ethanol, DDGS, electricity and natural gas prices for 2003 to 2022 were combined with annual stochastic deviates from the MVE distribution to simulate stochastic prices for each year of the twenty-year planning horizon.

The MVE simulation procedure insured that the future prices are correlated the same way they were correlated in the past and the relative risk of simulated prices equal their historical relative risks. The stochastic annual prices were linked into the financial statements to calculate costs and receipts.

Capital, Operating Loan, and Interest Rate Assumptions

Interest rates for the 15-year loan on the proposed ethanol facilities use a fixed interest rate of 8.27 percent based on the 2002 prime rate of 5.77 percent plus a localized wedge of 2.5 percent. Revolving or operating loan interest rates were fixed at eight percent for the 20-year period between 2003 and 2022.

The capital loan values for the three size facilities were calculated using the capital breakdown requirements provided by BBI (2001a). Each of the three facilities, installation costs per gallon, provided by BBI (2001a) were used to calculate the total loan amounts. Total capital loan values are: $31,141,869, $60,553,633, and $138,408,304, respectively, for the 15, 30, 80 MMGPY facilities. A ratio of borrowed to owned equity is an industry standard taken from BBI (2001b). It was assumed that 50 percent of the capital requirements are borrowed funds. The remaining half of the total capital requirements is contributed capital from prospective investors (grower-members).

The analysis of this study assumed that land values would not appreciate as normal land values would, as upon termination of the facility's use, the property would have significant clean up costs that would offset the appreciated portion value of the land. Lastly, startup costs including working capital, start-up inventory, spare parts, organizational costs, and independent engineering costs are capitalized and depreciated in the balance sheet.

Production Assumptions

Ethanol yields, DDGS yields, variable costs including denaturant, enzymes, chemicals, natural gas, maintenance materials, labor, administrative and miscellaneous costs were taken from BBI (2001a) for each of the three size facilities. Variable costs for 2003 including mean electricity and natural gas prices are inflated at 1.5 percent per year to adjust for inflation across the 20-year analysis period. Variable electrical and natural gas costs per gallon were stochastically simulated and included in the income statement. The respective costs and assumptions for each of the three size facilities being analyzed are incorporated into the individual models for the analysis.

There are economies of size as evidenced by cost saving for large plants (Table 2). Denaturant costs, enzyme and chemical costs decrease between the 30 MMGPY and the 80 MMGPY facilities. In addition, there is a savings in electricity costs per gallon when a facility is increased from 15 MMGPY to 30 MMGPY.

Savings on maintenance materials, labor, and administrative costs were seen as facility size increased (Table 2). Decreased electrical and natural gas costs due to economies of size are taken into consideration when the conversion rates were simulated for each of the three size facilities. Excluding electricity, natural gas and corn prices, variables costs decrease by \$0.05/gal from the 15 MMGPY to the 30 MMGPY facilities. In addition, variable costs, excluding the above mentioned variables additionally decrease by \$0.10 when the facility size increases from the 30 MMGPY to 80 MMGPY.

A start-up and learning curve for all ethanol facilities, this report assumes that each of the three size facilities would be operated at 85 percent capacity in 2003, 95 percent in 2004 and 100 percent for the remaining 18 years.

Financial Sheet Calculations

Common financial statements were developed and used for each of the three facilities bing analyzed. The necessary changes in terms of total capital loan amounts, differentiation in operating costs, and state grants were made as the model was applied to the three different size facilities. This section describes the generic model, and when appropriate, indicates changes in the variables for the different size plants.

Income Statement

Total annual receipts were calculated by summing ethanol, dry distillers grains (DDGS) receipts and interest earned on ending cash balances. Annual ethanol receipts were derived by multiplying the annual stochastic ethanol price by the volume of ethanol produced (which was adjusted for start-up and included a five percent denaturant) for each of the 20 years being analyzed. The ethanol production curve included start-up reductions at a rate of 85 percent, 95 percent, for 2003 and 2004, respectively, and 100 percent of engineered capacity (plus five percent denaturant) for the remaining 18 years. Annual DDGS receipts were calculated in a similar fashion by first calculating the annual quantity of corn demanded for the level of production in each year, then the assumed DDGS yield coefficient was incorporated to calculate the total volume of DDGS production per year. DDGS production was multiplied by the annual stochastic DDGS price for each of the 20 years. Interest earned on ending cash balances is simply calculated by multiplying ending cash balances from the previous year (if positive) by the interest rate for cash balances.

Variable production costs (per gallon) for 2003 were taken from Table 13 (except for electricity and natural gas costs), inflated at 1.5 percent per year, multiplied by the volume of anhydrous ethanol produced to compute the total variable costs for each year. It is crucial not to overstate variable expenses by applying the variable costs against the volume of denaturized ethanol produced. The cost of the denaturant is included in the variable costs per gallon. Each of the three size facilities has its own variable production costs; therefore each cost array was applied to their respective models. Because electricity and natural gas prices are stochastic variables, the values provided in Table 2 were not used in the analysis. Rather, the stochastic prices were substituted. The means used for stochastic electricity and natural gas prices were inflated at 1.5 percent per year, as well.

Loan interest costs included in the income statement were calculated using a loan calculator that uses original loan life and interest rate as an input. The loan calculator determined the total payment values, the interest and principal portions of the payment, and the ending balance for each year in the 15-year repayment period.

Total annual costs were computed by summing annual variable costs, loan interest costs, and depreciation expense for each of the 20 years. Net income (losses) was calculated by subtracting total annual costs from total annual receipts.

Statement of Cash Flows

Beginning cash balances equal the ending cash balances from the previous year. In 2003 (year 1) beginning cash balance is zero for the plant. A depreciation adjustment is included in the statement of cash flows, as depreciation is not a cash flow expense. The summation of annual beginning cash balance, net cash income (losses), and the depreciation adjustment equals total annual cash inflow.

Total annual cash outflows are calculated by summing the principal portion of the capital loan annual payment (taken from the loan payment calculator), capital replacement costs ($100,000, $200,000, and $533,000 per year for the 15, 30, and 80 MMGPY facilities[1]), and repayments of cash flow deficits. Repayment of cash flow deficits is calculated based on the amount borrowed to cover cash flow losses in the previous year. For 2003 (year 1), there are no cash flow deficits.

Based on the ethanol literature, the majority of ethanol producing firms are structured as cooperatives. However, regardless of their business structure, the firm's owner, draw upon the company for their personal income needs. Cooperatives pay these personal income needs as dividends or value-added returns above the price their grower/members received for their crops. Proprietors draw on their respective capital accounts for their living expenses as well, and at the end of the year, they hope there are earnings equal to or greater than the sum of their draws. Regardless of the organizational

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[1] These figures were based on BBI (2001a) capital replacement schedule for a 15 MMGPY facility. The values for the 30 and 80 MMGPY facilities was calculated using the same ratio of capital dollars per annual gallon of production.

structure, management and labor are company expenses. For the purposes of this study, 30 percent of positive net income is paid as a dividend. Most cooperatives disperse 30 percent of earnings as dividends to their members (Smith).

Total cash inflows minus annual total outflows and dividends paid equals ending cash balance before borrowing. If the ending cash balance is negative, then the firms must borrow enough to make ending cash balance zero.

Balance Sheet

Annual total assets are computed using ending cash balances, land value[2], and book value for property, plant, and equipment (PP&E) adjusted for the MARCS Depreciation Table for a 15-year recovery period (Smith, et al. p. 191). Annual net property plant and equipment value was calculated by subtracting each year's depreciation from the value of the PP&E, and capitalized startup costs January 1st each year.

Current and long-term liabilities are calculated as follows: current liabilities are simply equal to the cash flow deficits from the current year, and long-term liabilities equal to the ending balance of the original loan. Total annual liabilities are computed by summing both current and long-term liabilities.

Ending owners equity is calculated by adding retained earnings (losses) and subtracting dividends from beginning owners equity (BOE). The report presents ending owners equity in two forms: one) nominal or current terms, and two) real (2002) dollars, for which the nominal values have been discounted using an annual compounded discount rate of 7.5 percent.

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[2] Land values were not appreciated as clean up costs at the end of the plants useful life may offset any appreciation gained over the 20-year period.

As defined by Richardson and Mapp, the probability of economic success requires calculation of net present value (NVP) which is shown in the following formula.

$$\text{NPV}= -\text{BOE} + \sum_{t=1}^{20}\left(\frac{\text{Dividends}}{(1+i)^{t}}\right) + \left(\frac{\text{EndingNetWorth}}{(1+i)^{20}}\right)$$

If the NPV is positive, the firm has a rate of return greater than the discount rate or is an economic success. The NPV variable is used to calculate the probability of economic success and as such, is used to determine the optimal level of the producer grant that would generate a 100 percent chance of economic success.

Key Output Variables of Interest

To analyze the optimal Texas State Producer Grant value for the three sizes of facilities, the value was calculated such that each of the facilities would have a 100 percent chance of economic success as defined by Richardson and Mapp. Table 3 compares the optimal subsidy level to a base subsidy value of zero. From the optimal subsidy level, resulting key output variables KOVs are analyzed. Those KOVs are average present value annual net worth (2003-2022), average annual cash income (2003-2022), average annual dividends (2003-2022), present value of ending net worth in 2022, probability of dividend payment, and probability of increasing real net worth. The following section provides the results of each KOVs in order of the facility size.

Key Output Variables Calculations

The probability of economic success as defined by Richardson and Mapp, is the chance that a firm will generate a rate of return greater than or equal to the assumed discount rate. For the purposes of this study, the discount rate was assumed to be 7.5 percent.

Average present value of annual net worth was calculated by averaging ending net worth from each year analyzed (2003-2022). Average annual cash income was calculated in a similar fashion by taking the average of annual net cash income from 2003 to 2022. Present value of ending net worth in 2022 was simply calculated by taking the nominal value in 2022 and discounting it 7.5 percent over the 20 year period. Lastly, the probability of dividend payment was generated by using the simulation results of 500 iterations and developing a probability distribution to count those values greater than zero.

RESULTS

The results for the 15, 30, and 80 MMGPY facilities are presented in the following section. The values for the KOV's and simple statistics are located in Table 3.

15 MMGPY Facility Results

Under a subsidy value of zero, the 15 MMGPY facility has a zero percent chance of economic success, while a $0.455/gal subsidy would generate a 100 percent chance of economic success. The base scenario generates negative average present value of annual net worth and the simple statistics show that it has no chance of generating positive numbers. Compared to the optimal subsidy level, the 15 MMGPY facility has an average present value of ending annual net worth of $15,922,033 and zero chance of seeing negative values. Average annual net cash income under the base scenarios would generate a 100 percent chance of negative net cash income, in comparison to the optimal subsidy level of $0.415/gal, which would average net cash income of $3,534,093 and zero percent chance of negative cash income. When comparing the average annual dividends from the base scenario to the optimal value, the mean annual dividend and the probability of dividend payment increased from $2,839 and 31 percent to $1,114,629 and 100 percent, respectively. Furthermore, present value of ending net worth in 2022 increases from an average of $(15,547,887) with zero percent chance of becoming positive, to $15,057,076 with a 100 percent chance that it will never be negative. Lastly, the 15 MMGPY facility has a zero percent chance of growing owners equity under the base scenario compared to the optimal scenario which generates a 42 percent chance of increasing owners equity.

30 MMGPY Facility

The results from the 30 MMGPY facility are that a subsidy value of $0.375/gal would generate a 100 percent chance of economic success. Under the base scenario value, the facility has an average annual present value of ending net worth of $(7,292,737) and under the optimal subsidy value, the facility has an average annual present value of ending net worth of $31,415,854. Average annual net cash income values increase dramatically when an optimal subsidy value is applied. Under the base scenario, the 30 MMGPY firm has an average annual net cash income of $(5,866,499) with a zero percent chance of positive annual cash income. The optimal subsidy level returns an average annual net cash income value of $6,979,585 with a 100 percent chance of positive annual net cash income. The value of average annual dividends increases dramatically for the 30 MMGPY facility from $33,300 to $2,189,206 with a 76.6 percent and 100 percent chance of dividend payments, respectively. The present value of ending net worth in 2022 increases from negative $(20,650,240) to $29,681,926 when an optimal subsidy value of $0.375/gal is applied. Under the base scenario, the facility has a zero percent chance of growing owners equity and under the optimal subsidy value, the facility has a 46.7 percent chance of increasing owners equity.

80 MMGPY Facility Results

As expected, the 80 MMGPY facility has a dramatically lower optimal subsidy level. To achieve a 100 percent chance of economic success, the 80 MMGPY facility requires only a $0.225/gal. Under a producer grant value of $0.225/gal, the average annual present value of owners equity in 2022 is $76,544,794 in comparison to a subsidy level of zero, which returns a value of $16,904,102. Average annual net cash income increases from $(4,719,202) to $16,904,102 when the optimal subsidy value is applied compared against the base scenario value. Average annual dividends increase from $666,433 to $5,286,370. Both scenarios generate a 100 percent chance of dividend payments. Present value of ending owners equity in 2022 returns values of $(9,065,890) and $70,990,437, respectively. Although both the values are positive, only the optimal subsidy level returns a probability of increasing equity at 58 percent.

CONCLUSIONS

The stochastic feasibility study provides an unbiased estimate of how risks of input and output prices affect the viability of three size ethanol production facilities in Texas. Doing such, the study provided the basis to calculate an optimal subsidy level for each of the three sizes of facilities, that would generate a 100 percent chance of economic success. As facility size increases, advantages in economies of scale dramatically lower the optimal subsidy level. It would be more beneficial to the Texas State Government to eliminate the 30 MMGPY limit and encourage investors to construct larger facilities, thus lowering the needed subsidy level on a per gallon basis. If the Texas State Government encouraged the construction of smaller facilities, they would only be encouraging the inefficient plant sizes at a cost to the Texas taxpayers and investors alike. From the analysis, it is conclusive that the 80 MMGPY facility requires the lowest subsidy value. Therefore, the Texas State Producer Grant Program should promote the construction of larger facilities, generating a cost savings to them on a per gallon basis.

Table 1. Regression Results and Statisitics

	Intercept (t-stat)	Coeffecient (t-stat)	Coeffecient (t-stat)	F-test	R^2
		trend			
Trend Regression on Corn	335.03	-0.166		2.097	0.296
	(1.46)	(-1.448)			
Trend Regression on Ethanol	24.081	-0.011		0.14	0.027
	(0.393)	(-0.374)			
Trend Regression on Electricty Price	0.639	0.000		2.974	0.373
	(1.857)	(-1.725)			
Trend Regression on Natural Gas Price	-386.65	0.186		0.469	0.469
	(-2.081)	(2.100)			
Trend Regression on Soybean Meal	14728.96	-7.285		0.725	0.127
	0.862	(-0.855)			
		soybean meal	corn		
Multivariate Regression of DDGS* Prices on Corn and Soybean Meal Prices	10.926	-0.172	50.885	12.165	0.859
	(0.462)	(-0.679)	(3.003)		

* Denotes dry distillers grains (DDGS).

Table 2. Production Assumptions and Costs of 15, 30, and 80 MMGPY* Facilities

Assumptions		15 MMGPY	30 MMGPY	80 MMGPY
Anhydrous Ethanol Production	gal	15,000,000	30,000,000	80,000,000
Installed Cost	$/gal	$ 1.80	$ 1.75	$ 1.50
Ethanol Yield	gal/bu	2.65	2.65	2.65
DDGS** Yield	lb/bu	17.30	17.30	17.30
Denaturant Cost	$/gal	$ 0.80	$ 0.80	$ 0.80
Natural Gas Price	$/MCF	$ 4.00	$ 4.00	$ 4.00
Electricity Price	$/kWh	$ 0.04	$ 0.04	$ 0.04
Per Gallon Expenses				
Denaturant	$/gal	$ 0.04	$ 0.04	$ 0.03
Enzymes	$/gal	$ 0.06	$ 0.06	$ 0.05
Chemicals	$/gal	$ 0.03	$ 0.03	$ 0.02
Natural Gas	$/gal	$ 0.16	$ 0.16	$ 0.16
Electricity	$/gal	$ 0.05	$ 0.04	$ 0.04
Maintenance Materials	$/gal	$ 0.04	$ 0.03	$ 0.02
Labor (O&M***, Supervision, Ber	$/gal	$ 0.10	$ 0.07	$ 0.03
Administrative Costs	$/gal	$ 0.05	$ 0.04	$ 0.02
Miscellaneous Costs	$/gal	$ 0.03	$ 0.03	$ 0.03

*Million gallons per year (MMGPY).
**Dry distillers grain prices (DDGS).
***Overhead and maintenance
Source: BBI (2001).

Table 3. Comparison of Selected Aoutput Vairables for Different Size Ethanol Plants Given Optimal Subsidy Level

	15 MMGPY		**30 MMGPY**		**80 MMGPY**	
	$0.00/gal	**$0.455/gal**	**$0.00/gal**	**$0.375/gal**	**$0.00/gal**	**$0.225/gal**
Probability of Economic Success	**0%**	**100%**	**0%**	**100%**	**0%**	**100%**
Average PV Ending Annual Net Worth	**$ (7,796,265)**	**$ 15,922,033**	**$ (7,292,737)**	**$ 31,415,854**	**$ 16,821,749**	**$ 76,544,794**
Standard Deviation	$ 2,185,491	$ 1,896,093	$ 4,348,216	$ 3,805,777	$ 11,725,794	$ 10,150,789
Coefficient of Variation	$ (28)	$ 12	$ (60)	$ 12	$ 70	$ 13
Minimum	$ (14,668,271)	$ 9,559,713	$ (20,974,920)	$ 18,604,328	$ (19,401,331)	$ 42,389,327
Maximum	$ (1,794,043)	$ 20,749,896	$ 4,669,493	$ 41,100,625	$ 48,329,780	$ 102,740,685
Average Annual Net Cash Income	**$ (4,077,963)**	**$ 3,534,093**	**$ (5,866,499)**	**$ 6,979,585**	**$ (4,719,202)**	**$ 16,904,102**
Standard Deviation	473324.5063	584536.6426	$ 951,008	$ 1,170,672	$ 2,817,090	$ 3,125,905
Coefficient of Variation	-11.60688495	16.53993429	$ (16)	$ 17	$ (60)	$ 18
Minimum	-5465756.072	1919331.069	$ (8,638,844)	$ 3,739,883	$ (12,457,706)	$ 8,159,767
Maximum	-2738546.852	5108960.809	$ (3,191,727)	$ 10,133,231	$ 3,609,340	$ 25,338,940
Average Annual Dividends	**$ 2,839**	**$ 1,114,629**	**$ 33,300**	**$ 2,189,206**	**$ 666,433**	**$ 5,286,370**
Standard Deviation	6061.151784	156997.2511	$ 34,602	$ 312,942	$ 317,821	$ 816,133
Coefficient of Variation	213.5004246	14.08516004	$ 104	$ 14	$ 48	$ 15
Minimum	0	657982.173	$ -	$ 1,287,809	$ 73,692	$ 3,009,521
Maximum	54801.2873	1567833.561	$ 143,111	$ 3,093,611	$ 1,990,899	$ 7,652,368
PV Ending Net Worth 2022	**$ (15,547,887)**	**$ 15,057,076**	**$ (20,650,240)**	**$ 29,681,926**	**$ (9,065,890)**	**$ 70,990,437**
Standard Deviation	$ 2,221,823	$ 2,029,226	$ 4,406,879	$ 4,072,006	**$ 12,215,669**	**$ 10,972,318**
Coefficient of Variation	$ (14)	$ 13	$ (21)	$ 14	**$ (135)**	**$ 15**
Minimum	$ (22,068,614)	$ 9,539,303	$ (33,648,239)	$ 18,594,863	$ (44,305,678)	$ 40,539,807
Maximum	$ (9,253,994)	$ 20,338,161	$ (8,407,440)	$ 40,271,945	$ 25,557,119	$ 99,564,128
Probability of Dividend Payment	**31%**	**100%**	**76.6%**	**100%**	**100%**	**100%**
Probability of Increasing Real Net Worth	**0%**	**42%**	**0%**	**46.7%**	**0%**	**58%**

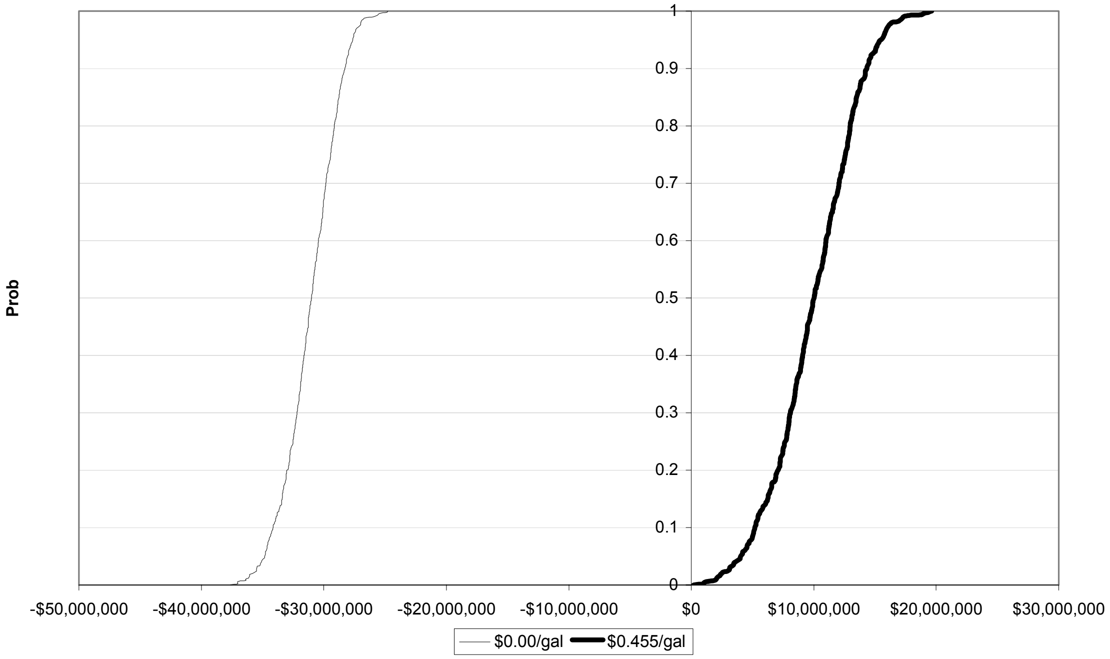

Figure 1. Probability of Economic Success for the 15 MMGPY Ethanol Facility in Texas

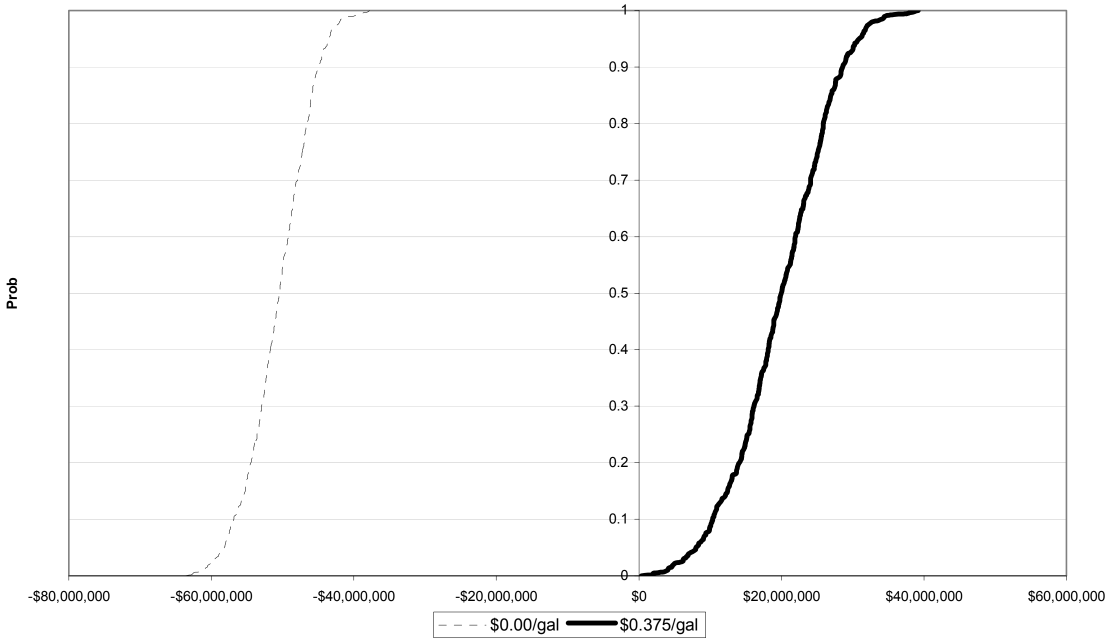

Figure 2. Probability of Economic Success for the 30 MMGPY Ethanol Facility in Texas

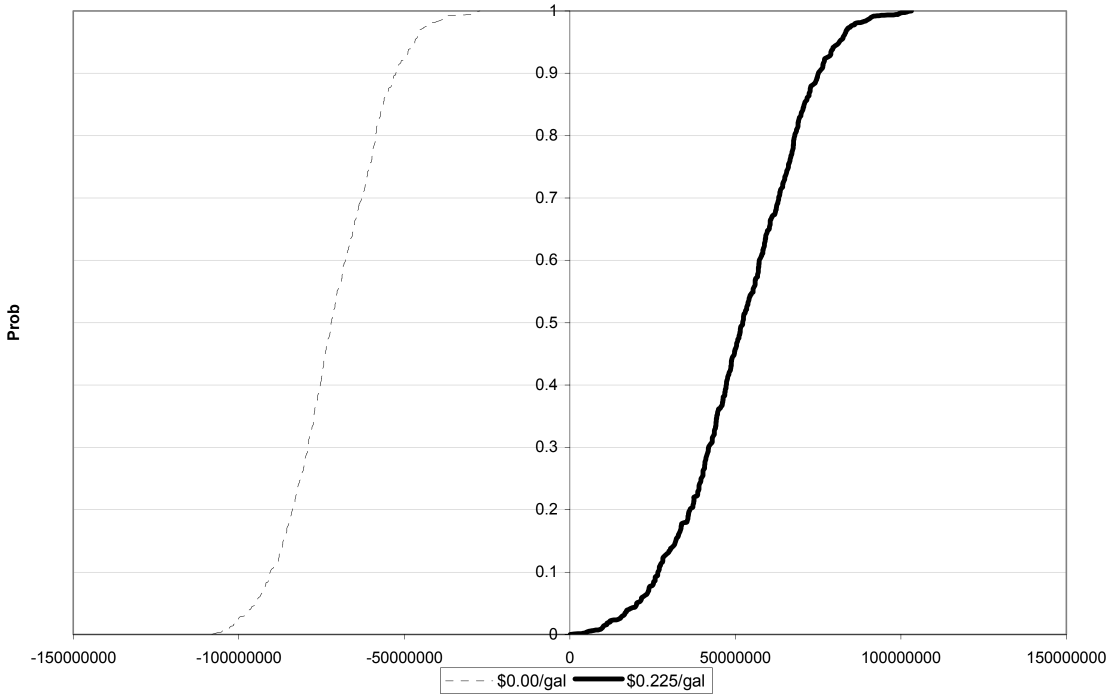

Figure 3. Probability of Economic Success for the 80 MMGPY Ethanol Facility in Texas

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