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Financial Performance Analysis of Corn-based Ethanol Enterprises in the U.S.

Allan P. Bacho*

Agriculturist II

Department of Agriculture, Regional Office 10,
Cagayan de Oro City, Philippines

and

Olga I. Murova

Associate Professor

Department of Agricultural and Applied Economic
Texas Tech University, Lubbock, TX, U.S.A.

Abstract

The objective of this study is to examine the state of financial condition of the corn-based ethanol enterprise in the U.S. from 2009 to 2014. Ethanol enterprises were categorized as small for 50 MGY and large for 100 MGY. Panel data from the annual financial reports submitted to the Securities and Exchange Commission (SEC) was used to calculate the financial ratios of profitability, asset turnover, leverage, liquidity and operating margin. Results have shown that the corn-ethanol enterprise is moving into the direction of positive returns of investment. Associated factors for the profitability were found in age/years of the operation, corn price, plant capacity, operating margin ratio and leverage ratio. Findings of this study have an implication to the development of the cellulosic ethanol enterprise, which suggests the utilization and valuation of its co-products for revenue generation to improve economic financial success.

Key words: financial performance, corn-ethanol, enterprise, profitability, leverage, ethanol
subsidy

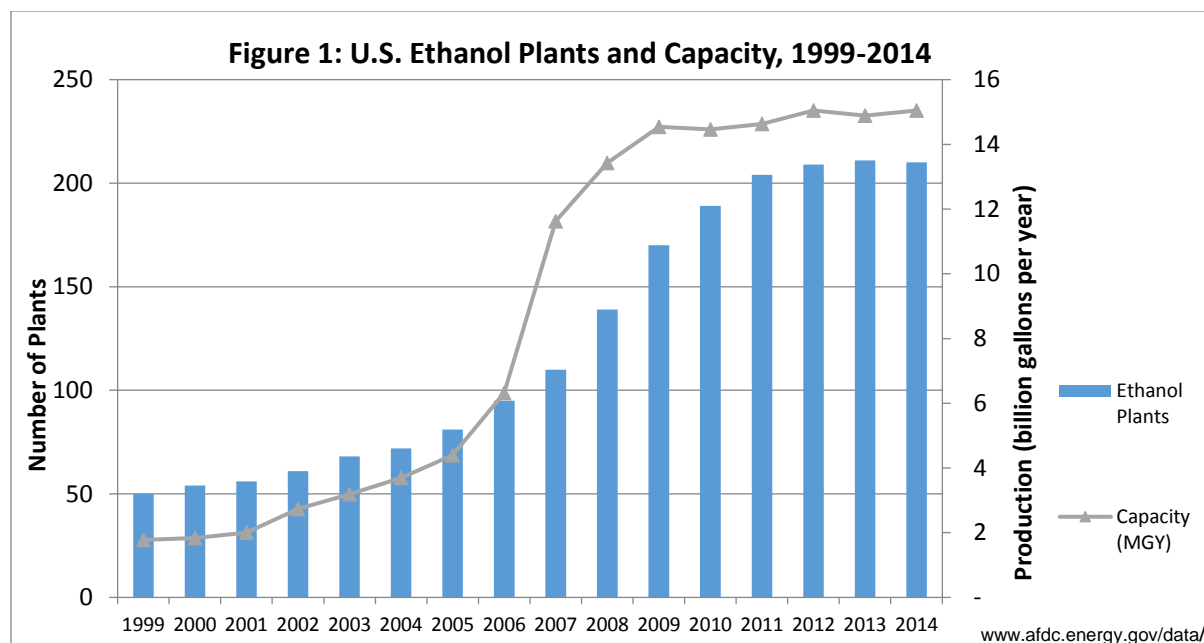
*Equal authorship of both authors in this research

Introduction

The rise of ethanol production has increased agribusiness opportunities for corn farmers in the United States. The ethanol industry is relatively new agribusiness venture that started in the late 1970s with the formalization of legislative support from the government. The rise of the ethanol industry was attributed to unstable supply and high prices of foreign oil due to conflicts in the Middle East, and the ban for gasoline oxidative additive of methyl tertiary butyl ether (MTBE), with ethanol being used as an alternative (Eidman, 2007;Tyner, 2007).

More ethanol enterprises have been built by farmer's associations, cooperatives, and private investors in the last decade that contributed to the increase in ethanol production (Figure 1). Ethanol industry data show that the establishment of ethanol enterprise plants had quadrupled between 1999 and 2014. In 2014, there were 210 ethanol enterprise plants established with total nameplate production capacity of 15,047 million gallons per year (MGY) (RFA, 2014). Iowa is producing around 25% of ethanol, Nebraska - 11.2%, Illinois - 10.4%, and the rest of the states produce around 53%. This data shows that ethanol enterprises located around the supplies of corn. The Midwest states produce most of the ethanol, but its biggest markets are on the West and the East Coastal states. (DOE, 2010; Westcott, 2007).

Enterprise studies conducted on ethanol enterprise production focus on estimation. Some of these studies consider the feasibility of its production (Klose *et al.*, 2003), and investment decisions to expand, exit or to mothball ethanol plant operation (Schmit *et al.*, 2009). The effect on facility size and optimal levels (Gill *et al.*, 2003), response of corn acreage to ethanol plant (Fatal, 2014; Feng and Babcock, 2008), and the effect on the competition of crops and land use for corn (Simla *et al.*, 2007) are also estimated. More so, estimation on the analysis of the ethanol production profitability (Hofstead, 2015), and market analysis of ethanol capacity (Cai and Stiegert, 2014) are also estimated.



Framework of financial performance analysis of the ethanol enterprise

The use of financial analysis as a basis of performance is commonly used in the business firms, in the agriculture, and later in agribusiness sector. For example, the profitability of the engineering and construction firms showed that size had no effect on profit, but larger firms tend to be more diversified in nonrelated businesses (Yee and Cheah, 2006). Ratios of profitability and leverage were applied to compare the financial performance of state and publicly-owned firms which showed that public firms were less profitable and incurred higher liabilities than the private firm (Dewenter and Malesta, 2001). The financial performance ratio on the satisfaction of employees' performance in a bank was also applied, but results provided no significant relationship (Johnson *et al.*, 2009). Following these examples on the use of financial performance in business, Wu and Ho (1997), cited the findings of Lev (1969), have investigated the use of financial ratios as a yardstick for industry-wide or strategic performance. The ratios of equity to total debt, sales to asset, net operating income to total asset, quick ratio were applied and found that ratio movement was due to changes in external shocks or an active adjustment by strategic management toward the desired target. More so, the sales to inventory, and net operating income to total asset ratio were suggested for the industry financial performance assessment.

76 In the U.S., the Department of Agriculture conducted the “Financial Performance of U.S.
77 Commercial Farms, 1991-1994”. This comprehensive report used ratios of liquidity, solvency,
78 efficiency, and profitability to evaluate the condition of U.S. commercial farms. Some of the
79 findings were: commercial farms were more profitable in 1994 than in 1993, average liquidity
80 (current asset to current liability) ratio was from 2.4 to 2.9, and about 36 percent of the farms
81 received direct government commodity payments (USDA, 1994). Hishman and Johnson (1998)
82 also used financial performance to evaluate the determinants of commercial dairy farm
83 operation. This study employed net income as a measure of profit and found that liability, the
84 size of the operation, and labor cost were associated factors for profit generation.

85 Using a standardized financial analysis protocol developed by the Farm Financial Standard
86 Council (FFSC), Clark *et al.* (2001) applied financial analysis performance for the Texas High
87 Plains cotton crop using the Standardized Performance Analysis-Multiple Enterprise (SPA-ME)
88 software. Significant to this study, return on asset (ROA), return on equity (ROE), and operating
89 margin were used as profitability measures. Some findings of this study indicated that covered
90 farms had negative ROA, ROE and operating margin and these were attributed to negative net
91 operating income which paid more interest expense in borrowed funds rather than by investing in
92 operation in 1995. However, it made a turn-around of its condition in 1996 which debt was used
93 profitably to earn positive return. These financial conditions were reflected in the regional
94 analysis by which a large increase in ROA and ROE was observed in 1996 due to increasing
95 crop yield. Moreover, financial performance measure was also used to assess the training
96 effectiveness on dairy but found that financial training showed no significant outcomes in the
97 financial performance (Smith *et al.* 2003).

98 Lerman and Parliament (1991) also applied financial analysis to study the effect of size and
99 industry in agricultural cooperative performance. They found the size effects for large and small
100 agricultural cooperative were significantly different in ratios of asset turnover (sales to asset),
101 liquidity (quick ratio), and profitability (return on equity), but not on leverage (debt to equity).
102 Using the same ratios for the industry across the dairy, food, grain, and the supply industry,
103 financial ratios were all significantly different, except on profitability ratio. This was attributed
104 due to the general downturn of the U.S. agricultural sector during the 1980’s where the data
105 covered the period from 1970 to 1987.

These empirical studies of the financial performance of agricultural cooperatives have failed to provide a strong economic theoretical framework. Soboh *et al.* (2009) posited the critique that economists studying cooperative performance focus between profit-maximizing objective and the other goals that reflect the duality of cooperative purpose: serving members' benefits and firm profits. Application of the firm theory which assumed the goal of the cooperative as a profit-maximizing agent had failed to incorporate the combined benefits to members and firm profit. To address the second goal of cooperative's purpose, many empirical studies employed the financial ratios or the efficiency measurement techniques for comparison of cooperatives. This was attributed to the weakness of building the foundation of economic financial theory due to the lack of theoretical approaches that were well developed for empirical application, and difficulty in obtaining the relevant data.

Ethanol Enterprise and the Subsidy

Several studies have been conducted to estimate the effect of subsidy on the ethanol industry using technical economic assumptions in the economic analysis. The purpose of government subsidy is to promote production and/or consumption (Tyner and Quer, 2006). The government subsidy program's development objective was established through policy issuances which define the parameters of the subsidy.

The history of the U.S. ethanol subsidy legislation policies from 1978 to 2005 was presented by Tyner (2007). Starting at the Energy Tax Act of 1978 when ethanol was blended with gasoline and called "gasohol," subsidy started at \$0.40 per gal as an excise tax. It was raised to \$0.50/gal in 1983, added 10 cent more in 1984 at \$0.60/gal, pulled-down in 1990 at \$0.54/gal. Since 1990, the excise tax exemption was reduced further: \$0.53/gal in 2001, \$0.52/gal in 2003, \$0.51/gal in 2005 and \$0.45/gal in 2009 when the Volumetric Ethanol Excise Tax Credit (VEETC) had expired in 2011 (Miller and Coble, 2011). These policies support ethanol subsidy regardless if it was produced from corn or other raw materials.

The current functional biofuel policy is the Energy Independence and Security Act (EISA) of 2007 which covers other sources of ethanol production categories: (1) biomass-based diesel, (2) cellulosic advanced biofuel, (3) other advanced biofuels, and (4) conventional biofuel

135 permitting the corn-based ethanol production (Tyner, 2013). The act is implemented by the
136 Environmental Protection Agency (EPA) which formulates the mandated Renewable Fuel
137 Standard volume for each of the biofuel category covered in the EISA. With its mandated
138 volume quota, it restricts the corn-based ethanol to expand its production capacity at an annual
139 production mandate of 15 billion gallons per year by 2022. However, recent reports stated that
140 the EPA has failed to determine the annual RFS volume on-time (Taxpayers for Common Sense,
141 2015).

142 Other than the EPA, the biofuels and biomass subsidy programs were also implemented by
143 the U.S. Department of Agriculture (USDA) through the Farm Bills (2002, 2008, and 2014)
144 under energy title, Department of Energy (DOE) under the Energy Policy Act of 2005, and the
145 Department of Treasury under the production tax credit (PTC).

146 Reports from the Taxpayers for Common Sense (TCS) in September 2015 showed that under
147 the Farm Bill and Trade Titles, the total corn ethanol subsidies reached \$190.2 million from
148 2009-2014. These were implemented in a variety of terms from grants and loans, loan
149 guarantees, reimbursement payments, and solicitations from the USDA. Under the Clean Cities
150 or State Energy Programs (SEP) of the DOE, 18 states were covered with a total cost of \$252.65
151 million from a variety of state incentive program initiatives. Under the Treasury Department, the
152 support was on the use of corn for biodiesel production at \$1 per gallon under the Volumetric
153 Biodiesel Excise Tax Credit and Renewable Biodiesel Tax Credit. With these allocated
154 subsidies, the TCS has opposed the policies and implementation of government subsidies as
155 public expenditure.

156 Thus, the objective of this study is to examine the state of financial performance of corn-
157 based ethanol enterprises in the U.S. It seeks to determine the factors associated in the
158 profitability ratio as a measure of core ethanol enterprise operation. More so, the cellulosic
159 ethanol enterprise can benefit the findings of this study to improve the financial success of its
160 operation.

161 This study refers the ethanol plant as an enterprise and considers the totality of its revenue and
162 operating costs in the analysis.

However, factors that may influence the profitability measure from the market such as the price of ethanol and other external pressures on the ethanol industry were not considered in this paper. This limitation is provided by the nature of data source. Annual financial statements reported to the Securities and Exchange Commission (SEC) do not contain quantity and prices of inputs and outputs. Financial statements typically report asset, liability and equity. This paper uses empirical data from the standard financial ratios to examine the corn-based ethanol enterprise financial performance.

Data and Methodology

Selection of the ethanol enterprise to be included in this study was based on the list from the leading on-line ethanol industry magazine, “Ethanol Producer Magazine”. As of October 06, 2015, the website listed a total of 216 ethanol plants with total nameplate capacity of 15.505 billion gallons per year. Using the industry data, this study categorized small enterprise plant for plant size with 50 million gallon per year (MGY) nameplate capacity and below, large for 100 MGY and super-large for more than 150 MGY.

The on-line link of the company website was searched using the on-line ethanol magazine website for its history of operation, and annual financial statements reported to the Securities and Exchange Commission (SEC). All annual reports submitted to the SEC is deposited on the EDGAR archives under the Form 10-K file. The 10-K form is the company’s annual report which uses prescribed accounting principles and methods for firms where shares are sold to the public on the American stock exchange (Wolfe, 1994).

Resulting data collected from the EDGAR archives generated 15 ethanol companies: 6 companies representing the small capacity plants, 6 from large companies, and 3 from super-large companies. Further review of these companies showed detailed characteristics of the company structure, scope of operation, and plant location.

Thus, the selection of the representative ethanol enterprises were based on the following criteria: 1) corn-based ethanol operation in the U.S., 2) single-plant operation, not branched operation as branched operation has a consolidated financial reporting, 3) ethanol enterprises which listed ethanol as primary product, excluding vertically integrated companies with multiple

operations in corn commodity trading and marketing, ethanol marketing, gasoline blending, and gasoline stations, and 4) covers only financial data from 2009 to 2014 as most large plants were established after 2009.

Using the above criteria, the super-large plants were taken out in the database. The primary reason is that most super-large ethanol enterprise plants have complex operation in several businesses and its financial performance cannot be ascertained to ethanol revenue as it is often consolidated to the larger business operation of the company.

By narrowing the plants included in the analysis, it resulted to an equal representation of 6 small and 6 large corn-ethanol capacity enterprises. This covers the period from 2009 to 2014 that generated 72 observations for the database. Thus, the database represents ethanol plants in operation in the mainland U.S. The unit of analysis in this study is at the enterprise firm level.

Financial Statements and Ratios

The foundation of the data used in this study is based on the Audited Financial Reports which follow the Generally Accepted Accounting Practices (GAAP). The financial statements used by the Farm Financial Standard Council (FFSC, 2015) in the agriculture sector also complies with the GAAP with modification relevant to the agriculture industry. The foundation of the financial analysis is based on the assumption as shown in equation 1 (Clarke, 2009; Jablonsky and Barsky, 2001).

$$\text{Asset} = \text{Liabilities} + \text{Equity}, (1)$$

where economic resources = amounts owned to creditors + capital provided by shareholder

Financial ratios utilized in this study examine the performance of the ethanol enterprises. These financial ratios were used to assess the utilization of its economic financial resources as expressed by the ratios of profitability, return on equity, asset turnover, liability, leverage, and operating income (Table 1).

Profitability ratio or the return on equity is one of the two most representative financial ratios for return on investment to stakeholders. It represents the efficient utilization of investment fund

to generate net income (White *et al.*, 1998; Placencia *et al.*, 1989). The higher the ratio, the higher the net income generated than the equity invested.

Asset turnover is one of the most representative financial ratios for capital turn-over. It measures how well a company converts its assets into revenue (Clarke, 2009; White *et al.* 1998). The higher the ratio, the higher the revenue generated from its asset value.

Leverage ratio measures the debt-to-equity proportion of the ethanol enterprise. It indicates the financial risk of the enterprises using borrowed money to run the business (Clarke, 2009; Jablonsky and Barsky, 2001). The lower the ratio, the better the enterprise gets out from debt in proportion to equity investment.

Table 1. Financial ratio measures of performance

Performance criteria	Ratio	Definition
Profitability	Rate of return on equity	$\frac{\text{Net Income}^*}{\text{Total Equity}}$
Efficiency	Asset Turn-over	$\frac{\text{Total Revenue}}{\text{Total Asset}}$
Leverage	Debt to equity	$\frac{\text{Total Liabilities}}{\text{Total Equity}}$
Liquidity	Quick ratio	$\frac{\text{Current Asset}}{\text{Current Liability}}$
Operating Income Margin	Operating Income	$\frac{\text{Operating Income}}{\text{Total Revenue}}$

*Net income is before-tax rate as observed in the submitted annual financial reports of these companies. Most cooperatives and/or farmers' associations are registered as limited liability corporation (LLC) by which the income is taxable is when shareholders received their dividends. Lerman and Parliament (1991) also reported the same observation.

The liquidity ratio using the current asset over current liability is one of the two most representative financial ratios for short-term liquidity. Current refers to the payable requirement for a year from the easily converted asset to pay the existing liability. A higher ratio suggests that

an enterprise is able to meet its current payable within a year. The generally accepted ratio is greater than 1, but it can vary by industry (White *et al.*, 1998).

Operating margin ratio is calculated from the reported operating income and total revenue. It measures the efficiency of the operation to generate internal income from the operation. It provides information on enterprise profitability from the operation of its core business, excluding the effects of its income from affiliates or asset sales, and interest expense (White *et al.*, 1998).

The benefit of using a set meaningful financial ratios is the reduction of ratios to be computed and monitored. For example, liquidity ratio is highly used by enterprise and corporate managers to know if their current asset can immediately respond to payables for the operation of the enterprise (Soboh *et al.*, 2009; White *et al.*, 1998).

Factors associated in the profitability measure of ethanol enterprise operation

Soboh *et al.* (2009) posited two categories in the analysis of empirical data on the financial performance of agricultural enterprises. First, is to evaluate financial performance using ratios that represent the ability and the efficiency of equity to generate returns, that is, measuring profitability and efficiency. The other category is concerned with the nature of financing the equity capital or capital financing (Soboh *et al.*, 2009; Lerman and Parliament, 1990).

The measure of profitability in this study is based on the core business of operating an ethanol enterprise from corn. One variable in the assessment of the profitability measure is age (β_1 Age) as represented by years in operation. It is postulated that as plant years in operation increases, the operation is becoming more efficient.

Corn is the major input in the production of ethanol and its co-products. Since the annual financial statements do not contain the actual price and quantity of corn used, the USDA annual corn price is used instead. The corn price (β_2 CornPrc) is used as a value of the input to generate revenue from the primary product of ethanol, and co-products such as the dried/wet distillers' grains soluble (DDGS), corn oil, and other co-products. Using the corn price instead of quantity, it was postulated that the corn price represents the cost technology efficiency in ethanol production. It also consider corn price as an indicator for total revenue generator as primary cost of the raw material to produce all revenue generating products.

The ethanol enterprise plants were classified as small for 50 MGY capacity and 100 MGY for large capacity ethanol operation. This study employs the dummy variable to represent (β_3 DumSz1) for small enterprise plants. The economies of scale principle suggests that small capacity plants have lower profitability ratio than large capacity plants.

The operating margin ratio (β_4 OpMaR) represented a plant internal operating efficiency as it is the income generated from efficient operation of the enterprise plant. It is expressed as percent of operating income over total revenue. Higher OpMaR means less plant operation shut down, efficient use of corn to convert to ethanol and its co-products, and the efficient use of energy.

The financial ratios employed in this study were selected based on meaningful function and expressed in percentage to determine its contribution to the profitability measure. One of these ratios is the percent asset turnover (β_5 AsTurnO) which contributed to the profitability measure in the asset function of the balance sheet equation. Higher asset turnover means better financial performance as it generates higher total revenue from the asset utilization.

The leverage ratio (β_6 Lev) measured the percent on the magnitude of liability incurred over its equity value. The leverage ratio was postulated to decline as liabilities have been paid-up during the years of operation.

The liquidity ratio was expected to increase as current liabilities have been paid-up for the year it was needed to pay. The percent liquidity (β_7 Liquidity) ratio was an assessment of its capability to meet current payables.

Horrigan (1965) mentioned that there only few needed financial ratios to effectively capture vital information on the financial condition of the enterprise.

Subsidy (β_8 Subsidy) measured the contribution of government support received by the ethanol enterprise. Subsidy is postulated to improve production efficiency and contributes to asset value of the enterprise.

Finally, profitability ratio (Υ) is measured as the percent of net income over total equity or the return on equity as dependent variable. This ratio is selected for measuring how much net income is generated from the equity invested. Using the balance sheet, the ratio is the net effect of reducing liabilities, building up the asset value and contributing to the investors' equity financial portfolio.

This relationship is presented as:

$$\text{Profitability} = \alpha + \beta_1 \text{Age} + \beta_2 \text{CornPrc} + \beta_3 \text{DumSz1} + \beta_4 \text{OpMaR} + \beta_5 \text{AsTurnO} \\ + \beta_6 \text{Lev} + \beta_7 \text{Liquidity} + \beta_8 \text{Subsidy} + \mu$$

The error term (μ) or the disturbance is an unobserved random term that does not depend on the value of explanatory variables (Mirer, 1995). Using panel data from the annual financial reports of the ethanol enterprise plants, the error term (μ) or the disturbance in the OLS regression contributes to statistical errors of collinearity, heteroskedasticity, and autocorrelation of the model (Wang and Atabay, 1994). White *et al.* (1998), cited Horrigan in 1965, on the presence of collinearity in using the financial ratios from the financial report. Thus, the presence or absence of these error term was captured in the OLS regression with the Variance Inflation Factor (VIF) for collinearity test, White Test for heteroskedasticity, and Durbin-Watson for autocorrelation using the SAS 9.4 version.

Results and Discussion

The financial characteristics of corn-based ethanol enterprises in the U.S. was described based on enterprise capacity plant size (Table 2). Using 2014 as the end year reference period, large plants have 6.2 years and small enterprise plants have 9.0 years in an average of plant operations. This indicated that the average large plant was newly operational in 2009 as the data is based from 2009 to 2014 or the 6-year period.

Financial characteristics of corn-based ethanol enterprises indicated that the total asset build-up for large enterprise capacity plants was 1.89 higher than small enterprise capacity plants or \$153.4 million for large plants capacity and \$82.0 million for small plants capacity. Part of this asset build-up was the infusion of equity from investors with an average of \$89.6 million for large plants capacity and \$51.3 million for small plants capacity. As more asset and equity were required for large plants, its operational total liability had doubled (2.05 times higher) than the small plants at \$63.7 million compared with \$31.06 million, respectively.

Likewise, the total revenue for large ethanol enterprise plants was about two times (1.93 times) higher at an average of \$285.7 million compared with small enterprise plants at \$147.5 million. Correspondingly, large ethanol enterprise plants net income uptake was 2.38 times

higher than small enterprise plants in an average amount of \$6.69 million compared with large enterprise plants net income average of \$15.93 million (Table 2).

Table 2: Comparison of Means of Small and Large Ethanol Plants Financial Performance, U.S., 2009-2014

Variables	Small Plants			Large Plants		
	Mean	Minimum	Maximum	Mean	Minimum	Maximum
Age (years in existence)	9.0 (4.26)	5.0	18.0	6.2 (1.36)	5.0	9.0
Total Asset in \$	82,077,271 (23,550,961)	44,998,730	139,662,533	153,423,765 (31,880,514)	98,549,714	222,367,701
Total Liability in \$	31,068,978 (22,144,243)	3,904,658	73,835,530	63,792,558 (45,107,551)	8,334,254	163,760,357
Total Revenue (in \$)	147,550,754 (49,035,606)	18,983,802	300,954,984	285,690,050 (77,834,029)	99,986,005	419,312,560
Total Equity in \$	51,304,113 (15,470,953)	17,549,447	103,152,157	89,628,232 (34,415,673)	41,597,000	159,223,561
Net Income in \$	6,696,294 (15,630,860)	-32,352,643	59,090,503	15,934,752 (28,485,597)	-43,917,042	87,261,674
Subsidy	23,647 (116,017)	0.00	697,000	1,499,894 (6,647,395)	0.00	40,000,000

*Values in parenthesis is the SD of the mean.

Subsidy received by ethanol enterprises in the United States is one of the most contested support to the industry. The average subsidy received by a large enterprise capacity plants was at \$1.49 million compared with small enterprise capacity plants at \$23,647. These subsidies were the reported amount in their respective financial statements as grants received.

The profitability ratio was based on the net income generated for every dollar of equity invested or return of equity. It showed on average that large corn-ethanol enterprise plants registered a return of 10.2% per dollar of equity invested compared with small enterprise capacity plants at 5.5%. The range of the profitability ratio indicated that an ethanol enterprise has a maximum potential to generate net income by 50% of its equity (Table 3). On its downturn, Figure 2 showed that the profitability ratio for small capacity ethanol enterprises deep to (-) 0.34 points while large capacity enterprises deep to (-) 0.02 in 2012, the same trend was observed in 2009. Wu and Ho (1997) found that small firms tend to be more prone to external effects. This trend suggests the susceptibility of the small ethanol capacity enterprises for changes in net

*Equal authorship of both authors in this research

income against its equity-based resources. However, over-all group difference T-test showed that there is no significant difference in the profitability ratio between small and large size ethanol enterprises.

Asset turnover ratio measured the efficiency of the enterprise to convert asset to generate total revenue. On average, nearly twice of the total revenues were generated from their asset value in both large (1.9619) and small (1.9497) ethanol enterprise plants (Table 3). This suggests that both ethanol enterprise plants showed comparable technology assets to be financially efficient. Statistical comparison using the t-test showed that there was no significant difference between small and large ethanol enterprise plants in asset turnover ratio.

Table 3: Comparison of Financial Ratios of Small and Large Ethanol Enterprise Plants in the U.S., 2009-2014.

Ratios	Small Plants			Large Plants			T-Test Value Difference Small-Large
	Mean	Min	Max	Mean	Min	Max	
Profitability Ratio (Net Income/Total Equity)	0.05531 (0.3777)	-1.8435	0.5728	0.1019 (0.3231)	-1.0381	.57031	-0.72
Asset Turn Over (TotalRevenue/Total Asset)	1.9497 (0.8054)	0.1647	4.0549	1.9619 (0.7106)	0.4496	3.5005	0.11
Leverage Ratio (Total Liability /Total Equity)	0.7214 (0.6518)	0.0699	2.7939	1.0008 (1.0046)	0.0523	3.2894	2.28**
Liquidity Ratio (Current Asset /Current Liability)	2.3499 (1.4916)	0.1675	6.5170	2.1893 (1.4896)	0.2463	9.0194	-0.50
Operating Margin Ratio (Operating Income/Total Revenue)	0.0447 (0.0808)	-0.1766	0.2219	0.0552 (0.0958)	-0.2005	0.2608	0.93

Note: Values in parenthesis is the SD of the mean.

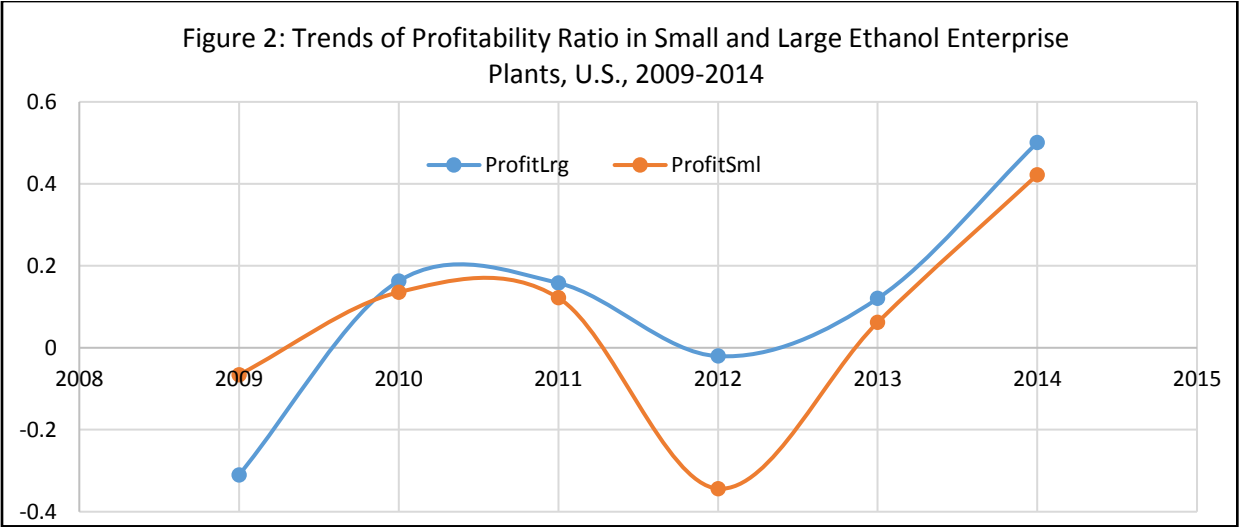
Significance: * significant @ 0.10 level; ** significant @0.05 level; *** significant @.01 level.

The liquidity ratio or the current ratio measured the ability of the enterprise to pay current debts from its current asset. Data showed that both ethanol enterprises have more than twice (2x) of its current financial asset value to cover for its current liability (Table 3). At the liquidity ratio of 2.19:1 for large enterprise and 2.35:1 for small enterprise, it indicated that most ethanol

*Equal authorship of both authors in this research

enterprises were building a fundamental current asset base to cover for current risks liability. Significantly, the data showed that ethanol enterprises had not reached a negative liquidity ratio. A T-test indicated that there was no significant difference between small and large enterprises in the liquidity ratio performance.

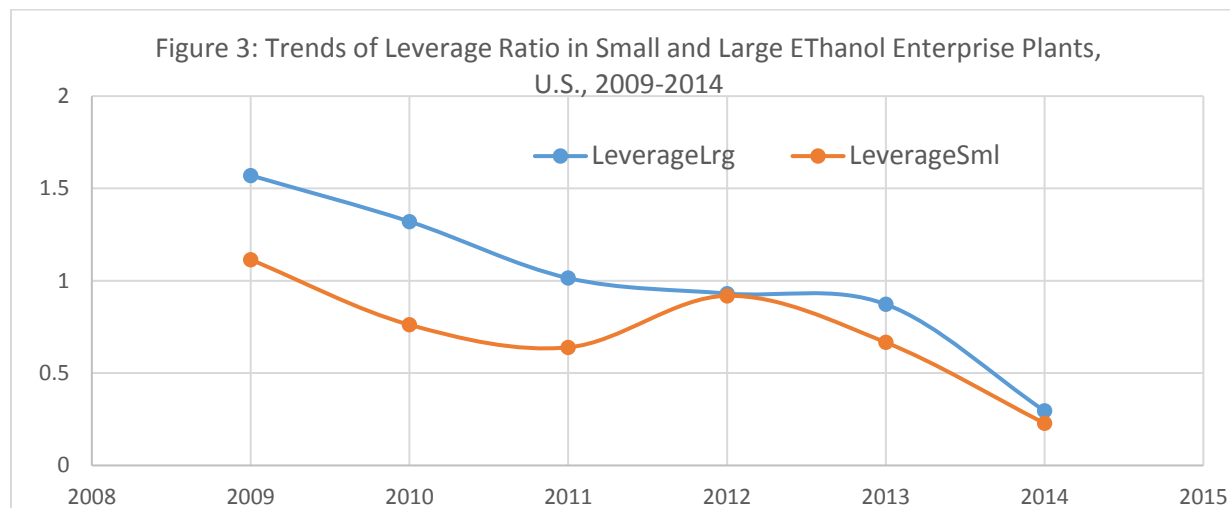
Presentation data from Christianson and Associates (2015) showed the general US ethanol plants have a current ratio (current assets/current liabilities) at an average of 2.09:1 from 2010 to 2015.



The leverage ratio assessed the debt-to-equity performance of the ethanol enterprise. Total liability was expected to decline against its own equity as ethanol enterprise plants pay-off its liability from the implementation of an appropriate financial management strategies. Data showed that large enterprise plants have an average leverage ratio of 1.0008:1 (Table 3). This means that every dollar of equity was guaranteed to cover the total liability for large enterprise ethanol capacity plants. For small capacity enterprise plants, the leverage ratio was at the level of 0.7214:1, which suggests that 30% of the equity value was free from total liability. On average, small capacity ethanol enterprises have lower total liability to roll-over the plant operation than a large enterprise. However, the trends on leverage ratio for large and small ethanol enterprise plants were showing a decline over the period at 0.30 and 0.23 is to 1 ratio level in 2014 (Figure 3). Over all, this characteristic explains the statistical significant difference between large and small ethanol enterprises in the leverage financial performance.

*Equal authorship of both authors in this research

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392

393 Operating margin ratio measured the efficiency of the plant operation. It was determined by
 394 the operating income over total revenue generated by the plant. Data showed a 5.52% of the total
 395 revenue was generated operating income for a large ethanol enterprise, and 4.47% for small
 396 enterprise capacity (Table 3). T-test showed that there was no significant difference between the
 397 large and small enterprise plants. This result suggests that both enterprise plants use similar corn-
 398 ethanol cost efficient technologies in plant operation to generate operating income from ethanol
 399 and its co-products.

400

401 *Factors affecting profitability of the corn-based ethanol enterprises in the U.S.*

402 Regression analysis using the ratio of profitability as dependent variable responded
 403 significantly to the variable of age as the number of years in operation, corn price, plant size,
 404 operating margin ratio, and the leverage ratio. However, the analysis showed that subsidy, asset
 405 turnover, and liquidity do not exhibit a significant impact on the profitability ratio (Table 4).

406 The resulting econometric model has significant ($p=0.0001$) explanatory power of 81.84
 407 percent ($r^2=0.8184$) and a Durbin-Watson value of 2.051 ($p=0.4216$), suggesting the absence of
 408 autocorrelation. Detecting the presence of collinearity using the VIF showed no significant effect
 409 on the variables used in the model. Likewise, the effect of heteroskedasticity using the White

*Equal authorship of both authors in this research

Test significantly supports the variables with the explanatory power to the null hypothesis, that is, there is no significant presence of heteroskedasticity.

Regression analysis calculated the overall profitability ratio or return on equity of a corn-based ethanol enterprises at a rate of 7.86%.

Table 4. Regression Analysis of Corn-based Ethanol Enterprises in the U.S.

Label	Parameter Estimate	Standard Error	T Value	Pr > t
Intercept	-8.2068	13.6034	-0.60	0.5485
Age*	1.3184*	0.6855	1.92	0.0590
CornPrc*	4.3062*	2.5287	1.70	0.0935
DumSz1*	-8.5871*	4.3932	-1.95	0.0551
OpMar***	3.2224***	0.2703	11.92	<.0001
AsTurnO	-0.0697	0.0447	-1.56	0.1231
Leverage***	-0.1091***	0.0344	-3.17	0.0024
Liquidity	-0.0182	0.0158	-1.15	0.2531
Subsidy	-5.03E-7	4.18E-7	-1.20	0.2329
r ²	0.8184	Profit Mean	7.8623	
Adjusted-r ²	0.7954			
F-value	35.50	p-value	0.0001	
Durbin-Watson	2.051	p-value	0.4216	

Note: ***significant at 0.01 level; **significant at 0.05 level; *significant at 0.10 level

Years in operation as indicated by age variable demonstrated a significant ($p=0.0590$) positive impact on the profitability ratio. Data indicated that, as the plant increases its operation by 1 year, profitability ratio increases by 1.31%. In other words as plant operation becomes more efficient in its operation over time. Plant efficiency operation contributes to net income portion of the profitability ratio.

Corn price as an input to the operation of ethanol production and its co-products showed a significant positive association at 10% level to the profitability ratio. It means that for 1-dollar per bushel increase in the price of corn, profitability ratio increases by 4.3%. The positive sign

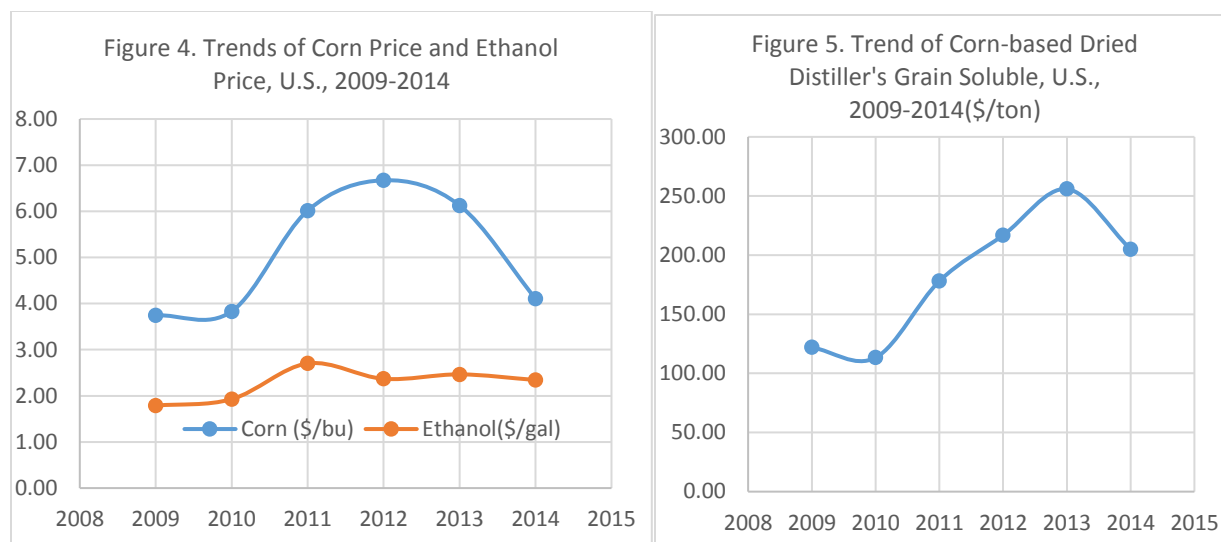
*Equal authorship of both authors in this research

associated with corn price on the profitability ratio suggests two things: technical cost efficiency of the plant operation and total revenue generation.

Recent technical data of corn conversion to ethanol has improved at an average of 2.65 gallons per bushel of corn in 2005 (Bothast and Schlicher, 2005) to 3.36 gallons per bushel in 2014 or increased 27%, added 0.71 ethanol gallons more efficient since 2005 (NCGA, 2014). For every dollar per bushel of corn utilized in the operation, the corn is efficiently “squeezed” or converted efficiently to generate ethanol and its co-products. As the generalized national corn price was used in this study, the significant positive sign indicated that the profitability ratio remained positive even when the corn price stretched between \$3.66/bu and \$6.96/bu due to its technical efficiency. This suggests that technical cost efficiency contributes the profitability ratio.

The relationship of corn price with the profitability ratio was closely examined. This study is also interested in finding out if corn price was associated with net income or total revenue, as corn is used to generate ethanol and other revenue generating co-products. Using linear regression, the statistical result showed that corn price is not associated with the net income as a dependent variable. The resulting net income-corn price model has the following parameters: F value of 2.40 (F p -level=0.1257), r^2 =0.0332 and corn price coefficient of (-) 3,765,453 at p -value of 0.1257. However, when the total revenue was regressed with the price of corn it showed a significant model relationship (F -value=8.92, p -level=0.0039; r^2 =0.1130). More so, corn price is positively significant (coefficient =1, 1017,204, t =2.99, p -value=0.0039). This result suggests that corn price behaves as a revenue generating function as it produces multiple co-products that contribute to the total revenue of the enterprise.

The pathway for corn price contribution in the model is attributed to the total revenue generation, a donating factor in net income increase of the profitability ratio.



In addition, Figures 4 and 5 showed the annual price trends of corn, ethanol and dried distillers' grain soluble (DDGS). The trends showed that as the price trend of corn moves upward and ethanol price moves relatively constant, the price of DDGS also moves upward. In a typical 100 MGY corn-based ethanol, it produced 90 MGY of ethanol and about 230,000 tons of dried grains soluble (DDGS). Using the average 2014 prices of ethanol at \$2.343/gal and \$157.69/ton for DDGS, ethanol generated 85% of the total revenue and 15% revenue from the DDGS. When the price of ethanol is down, the share of DDGS revenue contribution is compensating the ethanol revenue loss from the price changes. This trend suggests that DDGS price contributes significantly to the over-all revenue of the enterprise when ethanol price is down, making corn price variable as a total revenue generator.

Plant size showed a negative but significant ($p=0.0551$) association with the profitability ratio. Dummy variable as shown in the analysis used the 50 MGY capacity for small ethanol plant size category. This result supported the concept of economies of scale. A small ethanol enterprise plant capacity contributes 8.58% lower to the profitability ratio than a large plant. At constant equity value, it suggests that net income is 8.58% lower in small enterprise than in large enterprise.

Internal efficiency of plant operation was exhibited in the operating margin ratio (OpMaR). It contributes directly to the net income function in the profitability ratio. The OpMaR generated a

highly significant ($p=0.001$) and positive impact in the profitability ratio. Assuming at constant total revenue, it suggests that for every 1 percent increase of dollar generated from the operating income, it contributes 3.22% to the profitability ratio. This ratio supports the positive sign contributed by year of operation, and the revenue generating function of corn price in the profitability ratio model. More so, the magnitude of its contribution highly indicates that by controlling expenses and maximizing use of resources, increase in net income generates higher return of equity for the investors.

Westcott (2007) posits that ethanol demand is very inelastic, and the profitability of the plant is highly responsive to operating cost and revenue generation. This proposition is found in the OpMaR variable.

The leverage ratio provided a highly negative and statistically significant ($p=0.0024$) effect on the profitability ratio model. By increasing the leverage ratio by 1%, profitability ratio decreases by 0.11% points. Reduction of total liability in the leverage ratio contributes to equity portion of the profitability ratio and builds up asset value of the enterprise. Liability takes off the pressure on capital infusion in the operation of the ethanol plant enterprises. Though the magnitude is small it significantly signals that liability reduction contributes to the profitability ratio.

However, subsidy received by ethanol enterprises during the period did not show significant impact on the profitability. Earlier results in this study indicated that large plants received higher subsidy amounts than small capacity plants. Subsidy received by the ethanol enterprises was expected to boost the capital structure in the asset balance of the financial statement. This result either suggests that the impact of subsidies received by ethanol enterprise plants was not substantial to contribute to the profitability ratio as subsidy was not uniformly received by these enterprises or the data was not sufficient to make a definitive conclusion of its association with profitability ratio.

An emerging ethanol enterprise that has to take-off in massive production is the cellulosic ethanol enterprise. Current search on the operation of the cellulosic ethanol enterprise in the U.S. showed the existence of 3 operational plants. One is operated by DuPont, a 30-MGY capacity plant in Nevada, Iowa. The DuPont plant uses corn stover as feedstock. The second is the Abengoa plant in Hugoton, Kansas. It is a 25-MGY capacity plant and operated by a 1,000-ton daily feedstock of corn stover and wheat straw. The third plant is operated by Sioux Falls plants

which is managed by the POET and the Royal DSM in Emmetsburg, Iowa. It is a 25-MGY capacity plant and operated by 770 tons per day of corn cobs, husk, and stalks (Gies, 2014). The Bloomberg New Energy Survey stated that it cost 40% more to produce ethanol from cellulosic materials compared with the existing corn-based ethanol (Isola, 2013; Voegelé, 2013). An intensive search of these companies' financial operations to compare with the corn-based ethanol plants was done, but not available as its financial statements were consolidated to its respective parent companies.

According to the PEW Center on Global Climate Change (2009), one of several obstacles to the development of the cellulosic ethanol is cost: high capital investment (\$375 million for a 50-MGY which is 6-fold higher than corn-ethanol of the same size) and the uncertain feedstock cost which is estimated between \$25 and \$50 per dry ton.

Converging information on the cellulosic ethanol production and findings from the financial data of the corn-based ethanol production indicated that the financial success of the cellulosic ethanol enterprise maybe associated with the efficiency of its core operation and the total revenue generating capacity of its co-products. With the uncertainty of feedstock cost, the ability of the plant to generate other revenue source from its co-product like the cellulosic material stillage may improve operating income by using it as its own biomass feedstock to generate its own energy or improve total revenue by selling its stillage as a biomass to other bio-refinery or energy refinery. Stillage is a co-product of the cellulosic process. It has a high value when processed as a biomass material for boiler to generate steam and as a biomass feedstock for coal burning facility (Wilkie *et al.*, 2000). Unfortunately, stillage is not a publicly traded or marketed biomass fuel feedstock. Thus, as the price of ethanol varies over the time, the quality and value of stillage it produced is an option to generate additional operating income and/or contributes to the total revenue of the cellulosic ethanol plant to be more financially viable.

528

529 **Conclusion**

530

531 The direction of the average resulting financial performance ratios of the corn-based ethanol
532 enterprises signals a positive return of investment. As leverage ratio declines over time, it
533 indicates higher return of investment will be deposited to the investors' accounts.

534 The positive return of investment is attributed by the economic cost/technical efficiency of
535 the corn-ethanol technologies. The technical efficiency as indicated by the financial ratios of
536 asset turnover and operating margin, have shown signs of technology improvements over time.
537 As the technology improves in extracting ethanol from corn, it also brings improved quality of its
538 co-products that contributes to the total revenue. As ethanol is considered a commodity, it is
539 suggested that its DDGS co-products be differentiated with quality and price premium to cushion
540 revenue loss from the ethanol price changes.

541 Likewise, this study suggests to the ethanol industry for the establishment of a financial
542 benchmark of its performance to gauge how far the industry has improved overtime.

543 Findings of this study suggest similar consideration that may affect the viability of the
544 advanced cellulosic enterprise to be financially feasible. The value-addition from the raw
545 materials of switchgrass, sugar bagasse, corn stover, and other cellulosic materials to its resulting
546 stillage co-product is significant to consider to be utilized in the operation of plant and/or for
547 revenue generation. Technology investment for a more efficient process or processes of ethanol
548 extraction from cellulosic materials is a valuable pathway to increase cellulosic ethanol
549 production, but the value-addition and utilization of its co-products can greatly improve its
550 sustained economic financial success.

551

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