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Ethanol Marketing and Input Procurement Practices of U.S. Ethanol Producers: 2008 Survey Results[1]

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Abstract

A mail survey was used to collect information about input procurement and ethanol and co-product marketing practices from 60 U.S. ethanol production facilities. Data were used to answer questions about the conduct or behavior of ethanol producers. It was anticipated that firm conduct or behavior would be fairly homogeneous because the ethanol industry was in Stage II of the industry life-cycle, and societal support for ethanol production resulted in large volumes of publicly available information about technology and markets. Age of facility, size of facility, and type of ownership jointly explained a limited number of differences in responses across ethanol facilities, thus supporting the concept of fairly homogeneous conduct or behavior.

Keywords: entry timing, ethanol, farmer-owned cooperatives, industry life-cycle

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Introduction

Rapid growth of U.S. ethanol production after 2002 can be attributed in part to restrictions on MTBE as a fuel-oxygenate (Solomon et al. 2007). The MTBE ban in Connecticut took effect on October 1, 2003 and bans in California and New York took effect on January 1, 2004 (Energy Information Administration 2003). The substitution of ethanol for MTBE coincides with a threefold increase in ethanol production between 1997 and 2005 (Solomon et al. 2007). Further impetus for expansion of the ethanol industry has been attributed to high crude oil prices, low corn prices, and the blenders' tax credit (Conley and George 2008), the Energy Policy Act (EPAct) of 2005 (109th Congress 2005), which created the Renewable Fuel Standard program, and the Energy Independence and Security Act of 2007 (Congressional Research Service 2007), which mandated that 36 billion gallons of renewable fuels be used annually by 2022.

Expansion of ethanol production and increases in the number of firms producing ethanol has resulted in a rapidly evolving industry and an altered industry structure. In 2007, the industry grew from 110 biorefineries in 19 states to 139 biorefineries in 21 states, and in 2008, 68 biorefineries were under construction or expanding (Renewable Fuels Association 2008). Solomon et al. (2007) reported that the ethanol industry had a four-firm concentration ratio of 32 percent and, significantly, the share of annual U.S. production generated by Archer Daniels Midland, one of the earliest and largest producers, had decreased from 75 percent in 1990 to 19 percent in 2005.

Gort and Klepper (1982) described five stages that commonly transpire during the life-cycle of an industry. Stage I begins with the introduction of a product and its length depends upon 1) the ease of copying the innovating firm(s); 2) the size of the market; 3) the number of potential entrants; and 4) the speed with which technological information is dispersed. Subsequently, Stage II includes a rapid increase in the number of firms producing the product. Stage I for the ethanol industry was lengthy because the size of the market remained limited for most of the 20th century. Tetraethyl lead, and later MTBE, were the preferred octane enhancers and oxygenates for gasoline (Solomon et al. 2007) and, with the exception of occasional supply disruptions, inflation-adjusted gasoline prices remained relatively low throughout the 20th century. However, in 2008, the ethanol industry was unabashedly in Stage II of the industry life-cycle.

Gort and Klepper hypothesized that the probability of entry of new firms in Stage II of the industry life-cycle depends upon firms' abilities to maximize returns on organization capital. Organization capital, as distinguished from human capital, consists of information about new product technology. It includes knowledge and skills that pertain to production processes as well as characteristics of the market for the new product, and it may be obtained from two sources: 1) firms operating in the focal market at a given point in time; and 2) entities external to the current set of producers. The former emanates from the experiences of firms producing a particular product, and has both transferable and non-transferable components. The transferable components are available to other firms, whereas the non-transferable components are the property of the producer and accumulate over time. The stock of accumulated, non-transferable information eventually tends to act as a barrier to entry into the industry. On the other hand, information from the latter source, some of which may come from firms in technologically related markets, from non-affiliated inventors, or from equipment manufacturers, has positive effects on firm entry. The authors further hypothesized that most technological innovations in Stage II of the product life-cycle are driven by information from entities external to the current set of producers. Based upon life-cycle observations of 46 products, Gort and Klepper concluded that the number and composition of firms in a market are influenced by technical change and the flow of information among firms, both existing and potential.

Eisenhardt and Martin (2000) viewed the firm knowledge creation process as a crucial dynamic capability, which they defined as:

> *The firm's processes that use resources – specifically the processes to integrate, reconfigure, gain and release resources – to match and even create market change. Dynamic capabilities thus are the organizational and strategic routines by which firms achieve new resource configurations as markets emerge, collide, split, evolve, and die.*

The authors noted that "gatekeepers" at high-technology firms often possess explicit linkages to outside sources, including scientists at other firms, government laboratories, and universities, from whom they may collect information about technologies and markets.

Helfat and Lieberman (2002) discussed resources, defined as stocks of factors that are owned or controlled by a firm, and capabilities, defined as a firm's capacity to organize and utilize resources for desired end results, and the relationship of both to market entry. The authors noted that firms make entry decisions at multiple points during the life-cycle of an industry because shifts in technology or the state of business practices force firms to decide if they will participate in the next phase of the industry. Diversifying entrants, defined as established firms that enter new or established markets by internal growth or acquisition, tend to enter industries where existing firm resource and capability profiles match their own. For entrepreneurial start-ups, firms with no prior employment or financial ties with already-existing firms in the industry, pre-entry knowledge of industry suppliers and customers can be a valuable resource. Helfat and Lieberman discussed specialized resources, which include relationships with buyers and suppliers, and specialized capabilities, which include marketing and distribution activities tailored to the industry. The authors noted that pre-entry resources and capabilities likely affect the initial success of entry as well as long-run survival rates and market shares.

Bayus and Agarwal (2007) studied pre-entry experiences, entry timing, product technology strategies, and firm survival in the U.S. computer industry. They concluded that diversifying entrants were more likely to migrate to the industry technology standard when it was known, thus enjoying higher survival rates in the early years of the industry life-cycle. Among later entrants, entrepreneurial startups were more likely to offer the newest technology, thus realizing higher survival rates in later years. The authors suggested that "dominance by birthright" did not exist in the computer industry, but they were unwilling to generalize the results of their study to other industries without further research.

Goldsmith and Gow (2005) discussed establishment of long-jump, value-added ventures as responses to structural change in agriculture. Long-jump ventures were defined as new firms whose required core competencies were outside the core competencies of the principals of the firm, for example, farmers who established value-added cooperatives. The authors emphasized that establishment of such ventures is a challenge to farmers because it forces them to strategically reposition and to acquire the competencies and knowledge necessary to compete in new markets. Vertical integration by farmers requires relationships with agencies outside the firm in order to acquire tacit knowledge, which may be difficult to copy or convey. Such relationships may require producer-owners to exchange ownership or control for knowledge. The concept of long-jump ventures is relevant to the ethanol industry because, as reported by Solomon et al. in 2007, 43 percent of the industry's mills "are owned by 'family-farm' cooperatives."

Input Procurement and Product Marketing in the Ethanol Industry

Mode of entry (diversifying entrant vs. *de novo* entrant) and entry timing (early entrant vs. late entrant) theoretically influence initial success of entry as well as long-run survival rates and market shares of firms. Because the ethanol industry was arguably in Stage II of the industry life-cycle in 2008, it was not feasible to analyze the long-run performance of late-entering firms. However, it was possible to observe the conduct or behavior of existing firms, particularly procurement and marketing activities, from a cross-sectional perspective. Porter (2004) proposed that industry structure and the actions of firms in the marketplace are mutually dependent. Furthermore, Weerawardena (2003) suggested that researchers explore the relationship between marketing capabilities and innovative and entrepreneurial firm behavior.

This study focused on the input procurement and product marketing activities of ethanol producers from a cross-sectional perspective. It was anticipated that because the ethanol industry was in Stage II of the industry life-cycle in 2008, much of the information about technology and markets was obtained from entities external to existing producers, and the information was fairly homogeneous. Subsequently, marketing and procurement conduct or behavior was fairly homogeneous across firms, even when comparing early-entry firms to late-entry firms and when comparing farmer-owned cooperatives to other firms. Results of the study provide cross-sectional information about the ethanol industry during a period of dynamic expansion, and the results should be of interest to active managers, owners, and management scholars.

Methodology

A questionnaire was designed to collect information about ethanol and co-product marketing, feedstock procurement, and related topics. Survey recipients were presented with a list of ethanol co-products and asked to identify those that were produced at their facility. Survey recipients were also asked to identify whether their ethanol and co-product marketing was conducted in-house, through a marketing firm, or through a larger ethanol producer. The term "in-house" was not defined in the questionnaire, but it had been utilized by Sims (2008a) in an *Ethanol Producer Magazine* article entitled Managing Risk Through Marketing Methods. Survey recipients who outsourced marketing were asked to identify terms of sale with the marketer, and those who utilized in-house marketing activities were asked to identify the types of arrangements or agreements that they had utilized. The list of arrangements or agreements from which survey recipients could choose was based upon a list compiled by the Illinois Institute of Rural Affairs (Brown et al. 2007), and it included consortium agreement, marketing agreement, independent marketing entity, exchange agreement, time trades, and credit trading agreement. A consortium agreement allows several smaller producers to physically pool their products and reduce per-unit transportation expenses, and a marketing agreement permits a smaller producer to market its product through a larger producer. An independent marketing entity may be formed by multiple smaller producers to market a larger pool of product, but the entity is subject to anti-trust regulations. An exchange agreement represents a non-physical exchange of product between two producers so that product is closer to the end users and transportation costs are considerably reduced. Time trades allow producers to obtain product from another producer during scheduled maintenance periods or when unplanned production interruptions occur, and credit trading agreements permit credits to be traded so that those blenders in adverse geographic locations relative to ethanol need not blend ethanol. Finally, recipients were asked to identify the modes of transportation utilized to transport their ethanol and co-products.

With respect to feedstock procurement, survey recipients were asked to identify the types of feedstock that they were utilizing, whether they utilized in-house procurement activities or depended upon a marketing firm, and the types of contracts or arrangements that were utilized to procure feedstock. The list of potential contracts or arrangements was derived from a list provided by Dakota Ethanol (n.d.), and it included basis contract, cash forward contract, cash sale, delayed price contract, and minimum price contract. Furthermore, survey recipients were asked to rate statements that pertained to availability of and access to feedstock and to indicate if their facility could switch from one type of feedstock to another. Lastly, recipients were requested to identify the modes of transportation utilized to transport feedstock to their facility.

With regard to general information, survey recipients were asked to rank six items that were presented as potential challenges to ethanol producers and also to rate the importance of ten items that potentially affect plant location decisions. Some of the location factors presented to survey recipients were drawn from a study by Lambert et al. (2008). Finally, survey recipients were asked if the Renewable Fuel Standard (RFS) program impacted their production plans, and if they planned to expand ethanol production. The final draft of the questionnaire was approved by the Institutional Review Board (IRB) at Illinois State University.

The Renewable Fuels Association website was used to identify 191 U.S. ethanol production facilities, and a mail survey was conducted utilizing procedures suggested by Salant and Dillman (1994). A notification post card was sent to the marketing manager of each identified production facility two weeks prior to the first mailing of the questionnaire. At two-week intervals, there was a first-mailing of the questionnaire, a reminder post card, and a second-mailing of the questionnaire. Two weeks after the second-mailing of the questionnaire, all non-respondents of record were contacted by telephone. If the contacted company representative expressed an interest in survey participation during the telephone conversation, a third copy of the questionnaire was sent to the company address. All survey recipients were offered a printed summary of survey responses.

Data collected by the survey were analyzed using SAS procedures (SAS Institute, Inc., Cary, NC). Questions that generated binary or ordinal outcomes were analyzed with PROC LOGISTIC. Independent variables were age of the facility in years as reported by respondents, millions of gallons of ethanol produced annually as reported by the Renewable Fuels Association, and a binary variable that represented type of ownership (farmer-owned cooperative vs. other). The purpose of logistic regression analysis was to determine if time of entry, as reflected by age of facility, and type of ownership impacted the conduct or behavior of ethanol producers after controlling for the possible impact of scale, as reflected by millions of gallons of ethanol produced. For the six challenge items that were ranked by survey respondents, PROC PHREG was used to determine if ranks differed between older facilities (in production for five or more years) and newer facilities (in production for fewer than five years) or between farmer-owned cooperatives and other types of firms. The analysis was based upon procedures outlined by Allison and Christakis (1994). Significance at the 0.01, 0.05, and 0.10 levels was reported.

Summary of Survey Results

Of the 191 questionnaires that were mailed, 60 usable questionnaires were returned for a response rate of 31.4%. The average age of facilities was 6.9 years, and the reported range was 0.08 years (1 month) to 28 years. Respondents produced an average of 61.6 million gallons of ethanol per year, whereas non-respondents produced an average of 57.6 million gallons of ethanol per year. The difference in production between respondents and non-respondents was not significant at the 0.05 level; therefore there did not appear to be a size bias in the collected data. Seventeen of 59 recipients who reported type of ownership indicated that their facility was affiliated with a farmer-owned cooperative. However, of the 24 newest facilities from which responses were received, only three were farmer-owned cooperatives. That result was consistent with the observation by Brown et al. (2007) that farmers had, by and large, shifted their investments from small, farmer-owned dry grind plants that gained popularity in the late 1990s to LLCs due to rising construction costs and larger capital requirements. With respect to age of facilities, there was no difference (P = 0.79) between farmer-owned cooperatives (6.0 ± 4.0 years) and other types of firms (5.5 ± 8.2 years). With respect to quantity of ethanol produced, farmer-owned cooperatives produced fewer gallons numerically (48.3 ± 24.0 million gallons vs. 67.2 ± 44.7 million gallons), but the difference was not significant (P = 0.11). Age of facility and gallons of ethanol produced were positively and significantly correlated ($P > F = 0.002$), but the computed R^2 value was low (0.17).

All reporting facilities utilized corn as a feedstock (Table 1). Less frequently used feedstocks included sorghum, which was utilized by six facilities (10.0%) and sugarcane and waste starches, each used by one facility (1.7%).

Table 1. Types of feedstock utilized by reporting facilities.

Feedstock	*Number of facilities*	*% Responding facilities*
Corn	60	100.0
Sorghum	6	10.0
Sugarcane	1	1.7
Waste starches	1	1.7

With regard to procurement channels, 50 facilities (83.3%) conducted some or all of their feedstock procurement activities in-house, and 15 facilities (25.0%) procured feedstock through a marketing firm (Table 2). The most common procurement arrangement was cash sale, which was utilized by 50 facilities (83.3%), and the second most common arrangement was utilization of basis contracts, which was selected by 47 respondents (78.3%). Cash forward contracts were utilized by 39 facilities (65.0%), delayed price contracts were utilized by 27 facilities (45.0%), and minimum price contracts were utilized by 15 facilities (25.0%). Six facilities (10.0%) used “other” procurement arrangements, including two that utilized hedge-to-arrive contracts.

Table 2. Feedstock procurement procedures and arrangements.

	Number of facilities	*% Responding facilities*
Procurement channel[a]		
In-house	50	83.3
Through a marketing firm	15	25.0
Procurement arrangement[a]		
Cash sale	50	83.3
Basis contract	47	78.3
Delayed price contract	27	45.0
Cash forward contract	39	65.0
Minimum price contract	15	25.0
Other	6	10.0

[a] Respondents could select one or more.

Respondents were asked to gauge access to and availability of feedstock at their facility (Table 3). Specifically, respondents were asked to select either “all of the time,” “sometimes’”, or “never” as responses to the following statements: 1) we have easy access to feedstock, and 2) feedstock is readily available. The terms easy access and readily available were not defined in the questionnaire. The vast majority of respondents believed that they had easy access to feedstock all of the time (87.5%) and they perceived that feedstock was readily available all of the time (90.7%).

Table 3. Respondent perceptions of access to feedstock and feedstock availability.

	All of the time		**Sometimes**		**Never**	
	Number of facilities	*Percent*	*Number of facilities*	*Percent*	*Number of facilities*	*Percent*
Easy access to feedstock	49	87.5	6	10.7	1	1.8
Feedstock readily available	49	90.7	4	7.4	1	1.9

When asked about flexibility related to feedstock utilization, 22 respondents (36.7%) stated that their facility could switch from one feedstock to another, whereas 44 respondents (73.3%) indicated that they were limited to one type of feedstock (Table 4). Thirteen of the 44 respondents who reported a feedstock limitation indicated that their limitation was wholly or partially due to lack of access to an alternative feedstock, and 33 of the 44 stated that their feedstock limitation was wholly or partially due to the technology that they had in place. Sixteen respondents (26.7%) reported that they were exploring alternative feedstocks, and 10 respondents (16.7%) indicated that they were planning to update their facility at some unspecified time in the future in order to accommodate multiple feedstocks.

Table 4. Flexibility of feedstock utilization and activities related to potential upgrades.

	Yes	
	Number of facilities	*% Responding facilities*
Ability to switch from one feedstock to another?	22	36.7
Limited to one type of feedstock?	44	73.3
Exploring alternative feedstocks?	16	26.7
Planning to update facility to accommodate multiple feedstocks?	10	16.7

The most common co-product marketed by surveyed ethanol facilities was dry distillers grain (83.3%), and the least common co-product was whole stillage (5.0%) (Table 5). Wet distillers grain was marketed by 38 facilities (63.3%), modified distillers grain was marketed by 26 facilities (43.3%), and CO_2 was marketed at 17 facilities (28.3%). Fourteen respondents reported marketing “other” co-products, eight of whom reported extraction and sale of corn oil and five of whom reported production and sale of syrup.

Table 5. Marketed co-products.

Co-product	*Number of facilities*	*% Responding facilities*
Distillers grain - dry	50	83.3
Distillers grain - wet	38	63.3
Modified distillers grain	26	43.3
CO_2	17	28.3
Other	14	23.3
Thick stillage	7	11.7
Thin stillage (sweetwater)	7	11.7
Whole stillage	3	5.0

Most facilities marketed ethanol and co-products through a marketing firm (Table 6). Forty-five facilities (75%) marketed ethanol through a marketing firm, whereas 20 facilities (33.3%) marketed ethanol in-house, and two (3.3%) marketed ethanol through a larger ethanol producer. Thirty-seven facilities (61.7%) marketed co-products through a marketing firm, and 32 facilities (53.3%) marketed co-products in-house. As with ethanol, only two facilities reported the marketing of co-products through a larger producer.

For facilities that utilized marketing arrangements or agreements, marketing agreements were most common for both ethanol and co-products. Twenty facilities (33.3%) utilized marketing agreements when marketing ethanol, and 15 facilities (25.0%) utilized marketing agreements when marketing co-products. The second most common type of marketing arrangement for ethanol was the consortium agreement, utilized by 12 facilities (20.0%). The least commonly used arrangement for both ethanol and co-products was the credit trading agreement, where three facilities (5.0%) used the agreement for ethanol and one facility (1.7%) reported using the agreement for co-products. Eight facilities reported using “other” types of marketing arrangements for ethanol, and 10 facilities reported using “other” marketing arrangements for co-products, the most common of which were direct sale or cash.

Table 6. Marketing channels and marketing arrangements for ethanol and co-products.

	Ethanol		Co-products	
	Number of facilities	*% Responding facilities*	*Number of facilities*	*% Responding facilities*
Marketing channel[a]				
In-house	20	33.3	32	53.3
Through a marketing firm	45	75.0	37	61.7
Through a larger ethanol producer	2	3.3	2	3.3
Marketing arrangement[a]				
Consortium	12	20.0	7	11.7
Credit trading	3	5.0	1	1.7
Independent marketing	8	13.3	6	10.0
Exchange agreement	5	8.3	3	5.0
Time trade	4	6.7	3	5.0
Marketing agreement	20	33.3	15	25.0
Other	8	13.3	10	16.7

[a] Respondents could select one or more.

For facilities that outsourced marketing, the most common terms of sale agreement with the marketer was cash (Table 7). Twenty-four facilities outsourced using cash terms, while 20 outsourced using credit terms, one outsourced using collateral, and two outsourced using "other" terms of sale.

Table 7. Terms of sale for facilities that outsource marketing.

Terms of sale	*Number of facilities*	*% Responding facilities*
Cash	24	40.0
Credit	20	33.3
Collateral	1	1.7
Other	2	3.3

Truck was the dominant mode of transportation when transporting feedstock and co-products (Table 8). Fifty-eight facilities (96.7%) transported feedstock by truck and 57 facilities (95.0%) transported co-products by truck. For ethanol, modes were more evenly split between truck and rail. Fifty-seven facilities (95.0%) utilized trucks to transport ethanol, and 55 facilities (91.7%) utilized rail to transport ethanol. Barges were utilized infrequently, but co-products were more likely than feedstock or ethanol to be transported by that mode. Ten respondents (16.7%) reported shipping co-products by barge.

Table 8. Modes of transportation for feedstock, ethanol, and co-products.

	Truck		Rail		Barge	
	Number of facilities	*% Responding facilities*	*Number of facilities*	*% Responding facilities*	*Number of facilities*	*% Responding facilities*
Feedstock	58	96.7	30	50.0	3	5.0
Ethanol	57	95.0	55	91.7	6	10.0
Co-products	57	95.0	44	73.3	10	16.7

With regard to factors that potentially affect the locations of ethanol facilities, the factor that was most often identified as "not important" was access to a river (Table 9). That outcome was consistent with responses pertaining to modes of transportation in Table 8, where barges were reportedly used less frequently than truck or rail. On the other hand, location factors that were identified as "very important" by at least 90% of respondents included access to rail (96.6%), access to highways (94.9%), and access to feedstock (93.3%). Those results were consistent with Lambert et al. (2008), who reported that transport infrastructure and access to feedstock represented two of the more important factors in the ethanol plant location decision. Other location factors that were identified as "very important" by less than 50% of respondents included ease of obtaining permits (35.6%), local and state taxes (15.3%), and tax incentives (33.9%).

Table 9. Perceived importance of ethanol facility site factors.

	Not important		**Somewhat important**		**Very important**	
Factor	*Number of facilities*	*Percent*	*Number of facilities*	*Percent*	*Number of facilities*	*Percent*
Access to rail	1	1.7	1	1.7	57	96.6
Access to river	33	56.9	18	31.0	7	12.1
Access to highways	0	0.0	3	5.1	56	94.9
Access to water	3	5.1	5	8.5	51	86.4
Access to feedstock	0	0.0	4	6.7	56	93.3
Ease of permits	3	5.1	35	59.3	21	35.6
Local/state taxes	7	11.9	43	72.9	9	15.3
Tax incentives	7	11.9	32	54.2	20	33.9
Community support	6	10.2	19	32.2	34	57.6
Distance to feedstock	2	3.3	14	23.3	44	73.3

Respondents perceived input costs to be the most challenging of six potential challenges presented to them (average rank = 1.7) (Table 10). The second most challenging was government policy (average rank = 3.0) followed by the media (average rank = 3.5) and public perception (average rank = 3.7). The least challenging of the six potential challenges, as perceived by respondents, were competition (average rank = 4.0) and livestock producers (average rank = 5.0).

Table 10. Ranks of potential challenges to ethanol producers.

Challenge	**Average rank**[a]
Input costs	1.7
Government policy	3.0
Media	3.5
Public perception	3.7
Competition	4.0
Livestock producers	5.0

[a] 1 = most challenging; 6 = least challenging.

Statistical Analysis

Statistics provided for logistic regression analysis (Tables 11 through 13) include: 1) a regression parameter estimate (β) for each of the three explanatory variables, age of facility, size of facility (millions of gallons of ethanol produced), and type of ownership (farmer-owned cooperative vs. other); 2) an odds ratio (exp(β)) for each of the three explanatory variables; 3) the likelihood ratio χ^2 statistic for testing the hypothesis that the explanatory variable βs jointly equal zero; 4) the probability of a larger likelihood ratio χ^2 value; and 5) number of observations used to estimate each equation. Statistics were reported separately for variables related to feedstock procurement (Table 11), ethanol and co-product marketing (Table 12), and more general survey items (Table 13).

Of 14 equations related to feedstock procurement activities, four had at least one significant estimated parameter (if PROC LOGISTIC indicated that the validity of the model fit was questionable, parameter statistics were not reported). Age of facility was statistically significant in equations for 1) in-house procurement activities ($P < 0.10$) and 2) utilization of minimum price contracts ($P < 0.10$). The signs of both β values were positive indicating that older facilities were more likely to utilize in-house procurement activities and minimum price contracts for feedstock procurement. The estimated odds ratios indicate that the odds of a facility using in-house procurement activities increase by approximately 45% with each additional year of age, and the odds of a facility using a minimum price contract increase by approximately 10% with each additional year of age after controlling for quantity of ethanol produced and category of ownership.

Size of facility (millions of gallons produced) was statistically significant in equations for 1) utilization of minimum price contracts ($P < 0.10$) and 2) transport feedstock by truck-only ($P < 0.05$). Larger facilities were less likely to utilize minimum price contracts and less likely to transport feedstock by truck-only, or alternatively, smaller facilities were more likely to utilize minimum price contracts and more likely to transport feedstock by truck-only. The odds that a facility would utilize minimum price contracts for feedstock procurement increase by approximately 3% for every million gallon decrease in ethanol production, and the odds that a facility would transport feedstock by truck-only increase by approximately 4.5% for every million gallon decrease in ethanol production.

Type of ownership was a statistically significant binary explanatory variable in equations for 1) utilization of basis contracts ($P < 0.10$) and 2) transport by truck-only ($P < 0.05$). Farmer-owned cooperatives were less likely to utilize basis contracts for feedstock procurement and more likely to transport feedstock by truck-only. The odds that a farmer-owned cooperative would utilize basis contracts are 0.27 times the odds that another type of firm would use basis contracts, and the odds that a farmer-owned cooperative would transport feedstock by truck-only are 8.1 times the odds that another type of firm would transport feedstock by truck-only.

Table 11. Logistic regression results for questionnaire items related to feedstock procurement.

	Years in production		Mil. gallons produced		Farmer-owned coop		Global H_o: β=0		
Dependent variable	Estimate (β)	Odds ratio	Estimate (β)	Odds ratio	Estimate (β)	Odds ratio	Likelihood ratio[a] χ^2	Pr> χ^2	n
Procurement channel:									
In-house	0.371*	1.449	0.048	1.049	-0.203	0.667	9.216	0.027	55
Marketing firm	-0.104	0.901	-0.009	0.991	0.336	1.959	3.988	0.263	55
Procurement arrangement:									
Procurement: cash	0.014	1.014	-0.001	0.999	0.532	2.899	1.221	0.748	55
Procurement: basis contract	0.012	1.012	-0.002	0.998	-.0661*	0.267	3.429	0.330	55
Procurement: delayed price contract	-0.017	0.983	0.002	1.002	0.312	1.867	1.120	0.772	55
Procurement: cash forward	0.006	1.006	-0.005	0.995	0.057	1.121	0.632	0.889	55
Procurement: minimum price contract	0.096*	1.101	-0.031*	0.970	0.220	1.553	9.042	0.029	55
Feedstock:									
Easy access feedstock	0.016	1.016	0.012	1.012	-0.120	0.787	0.739	0.864	51
Feedstock readily available	0.172	1.187	0.007	1.007	-0.697	0.248	2.211	0.530	50
Flexibility to switch feedstock	0.028	1.029	-0.010	0.990	-0.345	0.502	2.149	0.542	54
Limited to one feedstock	0.064	1.066	-0.000	1.000	-0.398	0.451	3.670	0.299	55
Exploring alternative feedstock	-0.001	0.999	-0.006	0.994	0.310	1.859	1.646	0.649	55
Planning to update facility	-0.043	0.958	0.008	1.008	0.469	2.555	1.569	0.667	52
Transport by truck-only	0.022	1.023	-0.045**	0.956	1.045**	8.091	22.610	<0.0001	55

[a] 3 degrees of freedom.
* indicates significance at 0.10 level; ** indicates significance at 0.05 level.

Table 12. Logistic regression results for questionnaire items related to ethanol and co-product marketing.

	Years in production		Mil. gallons produced		Farmer-owned coop		Global H_o: β=0		
Dependent variable	Estimate (β)	Odds ratio	Estimate (β)	Odds ratio	Estimate (β)	Odds ratio	Likelihood ratio[a] χ^2	Pr> χ^2	n
Co-products:									
Distillers grain-wet	-0.010	0.990	0.000	1.000	0.176	1.420	0.345	0.951	55
Distillers grain-dry	-0.101*	0.904	0.015	1.015	0.804	4.993	5.630	0.131	55
Modified distillers grain	-0.227**	0.797	0.013	1.013	0.238	1.610	12.517	0.006	55
Thick stillage	-0.002	0.998	-0.008	0.992	0.244	1.628	0.854	0.837	55
Whole stillage	-0.111	0.895	0.011	1.011	0.224	1.565	0.918	0.821	55
Thin stillage (sweetwater)	-0.113	0.893	0.004	1.004	0.062	1.131	1.723	0.632	55
CO_2	0.016	1.016	0.003	1.003	0.036	1.074	0.438	0.932	55
Ethanol marketing channel:									
In-house	0.192**	1.212	0.026**	1.026	-0.102	0.815	16.549	0.001	55
Marketing firm	-0.162**	0.850	-0.007	0.993	0.589	3.249	14.399	0.002	55
Co-product marketing channel:									
In-house	0.164**	1.178	0.027**	1.027	-0.283	0.568	12.310	0.006	55
Marketing firm	-0.136**	0.873	-0.011	0.989	0.332	1.941	11.040	0.012	55
Outsource marketing, terms of sale:									
Cash	-0.104	0.901	-0.008	0.992	0.071	1.152	4.936	0.177	55
Credit	-0.128	0.880	-0.010	0.990	-0.524	0.351	8.558	0.036	55
Marketing arrangement:									
Ethanol: consortium	0.050	1.052	-0.008	0.992	-0.270	0.583	1.527	0.676	55
Co-products: consortium	-0.044	0.957	-0.039	0.962	-0.083	0.848	2.977	0.395	54
Ethanol: independent marketing	0.011	1.011	-0.019	0.981	0.175	1.419	1.979	0.577	55
Co-products: independent marketing	-0.040	0.960	-0.019	0.981	-0.396	0.453	1.601	0.659	55
Ethanol: exch. agreement	0.131*	1.140	0.000	1.000	0.696	4.025	4.783	0.188	55
Co-products: exch. agreement	-0.699	0.497	-0.174	0.840	0.033	1.067	5.673	0.129	55
Ethanol: marketing agreement	-0.051	0.950	0.006	1.006	0.292	1.792	1.688	0.640	55
Co-products: marketing agreement	-0.174**	0.840	0.019*	1.019	0.615	3.422	7.754	0.051	55
Transport by truck-only:									
Ethanol	0.022	1.022	0.004	1.004	0.880	5.808	1.989	0.575	53
Co-products	-0.015	0.985	-0.007	0.993	-0.469	0.392	1.856	0.603	52

[a] 3 degrees of freedom.

* indicates significance at 0.10 level; ** indicates significance at 0.05 level.

Table 13. Logistic regression results for questionnaire items generally related to procurement and marketing.

	Years in production		Mil. gallons produced		Farmer-owned coop		Global H_o: β=0		
Dependent variable	Estimate (β)	Odds ratio	Estimate (β)	Odds ratio	Estimate (β)	Odds ratio	Likelihood ratio[a] χ^2	Pr> χ^2	n
Importance of site factors:									
Rail access	0.097	1.101	-0.018	0.982	-0.584	0.311	1.193	0.755	54
River access	0.068	1.070	0.007	1.007	0.291	1.788	6.742	0.081	53
Access to water	0.055	1.057	0.018	1.019	-0.215	0.650	1.975	0.578	54
Access to feedstock	0.492	1.635	0.046	1.047	-0.170	0.712	4.348	0.226	55
Ease of obtaining permits	-0.018	0.982	0.006	1.006	-0.106	0.809	0.946	0.814	54
Local/state taxes	-0.037	0.964	0.005	1.005	0.083	1.180	0.707	0.872	54
Tax incentives	-0.056	0.946	0.004	1.004	0.050	1.105	1.817	0.611	54
Community support	-0.052	0.949	-0.003	0.997	0.110	1.245	3.156	0.368	54
Distance to feedstock	0.041	1.042	-0.007	0.993	-0.384	0.464	1.736	0.629	55
Planning:									
RFS impacts production plans	0.058	1.060	0.007	1.007	0.874**	5.748	10.949	0.012	54
Planning to expand	-0.020	0.981	-0.004	0.996	0.102	1.227	0.775	0.855	53

[a] 3 degrees of freedom.

* indicates significance at 0.10 level; ** indicates significance at 0.05 level.

Of 23 equations related to ethanol and co-product marketing activities, eight contained at least one statistically significant explanatory variable. Age of facility was statistically significant in equations for 1) marketing of dry distillers grain ($P < 0.10$), 2) marketing of modified distillers grain ($P < 0.05$), 3) utilization of in-house ethanol marketing activities ($P < 0.05$), 4) utilization of a marketing firm when marketing ethanol ($P < 0.05$), 5) utilization of in-house co-product marketing activities ($P < 0.05$), 6) utilization of a marketing firm when marketing co-products ($P < 0.05$), 7) utilization of exchange agreements when marketing ethanol ($P < 0.10$), and 8) utilization of marketing agreements when marketing co-products ($P < 0.05$). Older facilities were less likely to market dry distillers grain and modified distillers grain, less likely to utilize a marketing firm when marketing either ethanol or co-products, and less likely to utilize a marketing agreement when marketing co-products. On the other hand, older firms were more likely to utilize in-house activities when marketing either ethanol or co-products and more likely to utilize an exchange agreement when marketing ethanol. For each additional year of age, the odds that a facility would market dry distillers grain decrease by approximately 10%, the odds that a facility would market modified distillers grain decrease by approximately 20%, the odds that a facility would utilize a marketing firm for ethanol marketing decrease by approximately 15%, and the odds that a facility would utilize a marketing firm for co-product marketing decrease by approximately 13%. Lastly, for each additional year of age, the odds that a facility would use in-house ethanol marketing activities increase by approximately 21%, the odds that a facility would use in-house co-product marketing activities increase by approximately 18%, and the odds that a facility would utilize an exchange agreement when marketing ethanol increase by approximately 14%.

Size of facility (millions of gallons produced) was a significant explanatory variable in equations for 1) in-house ethanol marketing activities ($P < 0.05$), 2) in-house co-product marketing activities ($P < 0.05$), and 3) utilization of marketing agreements when marketing co-products ($P < 0.10$). Larger firms were more likely to utilize in-house activities when marketing either ethanol or co-products, and they were more likely to utilize marketing agreements when marketing co-products. The odds that a facility would utilize in-house marketing activities for either ethanol or co-products increase by approximately 3% for each additional million gallons of ethanol produced, and the odds that a facility would utilize marketing agreements when marketing co-products increase by approximately 2% for each additional million gallons of ethanol produced.

With regard to more general survey items, only one of 11 equations contained a single significant explanatory variable. Respondents from farmer-owned cooperatives were more likely to agree with the statement that the RFS program impacted their production plans. The odds that a farmer-owned cooperative respondent would agree with that particular statement were 5.7 times the odds that a respondent from another type of firm would agree with the statement. There were no significant variables in nine equations representing perceived importance of plant site factors.

Logit analysis of six potential challenges to ethanol producers revealed that the average ranks of input costs, government policy, media, public perception, and competition were significantly different from the average rank of livestock producers (Table 14). The odds that a respondent would rank input costs first were approximately 10.6 times the odds that a respondent would rank livestock producers first, and the odds that a respondent would rank government policy first were approximately 5.4 times the odds that a respondent would rank livestock producers first. All possible pairs of challenges, other than media and public perception, exhibited unequal ranks ($P < 0.05$). The latter result is reflected by the similarity of odds ratios between media and public perception.

Table 14. Logit analysis of challenges ranked by respondents[a].

Challenge	Mean rank	Estimate (β)	Wald χ^2	Odds ratio
Input costs	1.71	2.359***	90.747	10.576
Government policy	2.96	1.694***	47.111	5.441
Media	3.47	1.088***	20.047	2.969
Public perception	3.73	0.983***	16.257	2.673
Competition	4.04	0.535**	4.418	1.708
Livestock producers[b]	5.00			

[a] "Please rank the following from 1 to 6 with 1 being the biggest challenge you face as a producer."
[b] Reference category in Logit model.
** indicates rank is significantly different from rank of livestock producers at 0.05 level; *** indicates rank is significantly different from rank of livestock producers at 0.01 level.

Table 15. Logit analysis of challenges ranked by respondents[a] with tests for differences by age of facility[b] and type of ownership[c].

Challenge	Estimate (β)	Wald χ^2	Odds ratio
Input costs	1.904***	30.822	6.715
Government policy	1.764***	23.260	5.841
Media	1.074***	9.198	2.926
Public perception	1.025***	8.568	2.786
Competition	0.659*	2.888	1.934
Age x input costs[d]	0.807**	6.442	2.242
Age x government policy[d]	-0.234	0.497	0.792
Age x media[d]	-0.083	0.064	0.920
Age x public perception[d]	-0.041	0.016	0.960
Age x competition[d]	-0.055	0.022	0.947
Ownership x input costs[d]	0.011	0.001	1.011
Ownership x government policy[d]	0.487	1.833	1.627
Ownership x media[d]	0.314	0.776	1.369
Ownership x public perception[d]	-0.050	0.020	0.951
Ownership x competition[d]	-0.303	0.557	0.739

[a] "Please rank the following from 1 to 6 with 1 being the biggest challenge you face as a producer."
[b] Facilities that had been in production for 5 or more years = 1; others = 0.
[c] Farmer-owned cooperatives = 1; others = 0.
[d] Hypothesis that βs jointly equal 0 cannot be rejected ($P >$ Wald χ^2 with 10 d.f. = 0.301).
* indicates significance at 0.10 level; ** indicates significance at 0.05 level; *** indicates significance at 0.01 level.

A test designed to determine if ranks of potential challenges differed between older (≥ 5 years of age) and newer facilities or between farmer-owned cooperatives and other types of firms failed to reveal differences (Table 15). The computed Wald χ^2 statistic associated with the hypothesis that all βs associated with age of firm and type of firm were jointly equal to zero was not significant, indicating that there were no differences in ranks across the two age categories or across the two firm-type categories.

Discussion

This study provided a cross-sectional view of the ethanol industry during a period of rapid expansion, or what is oftentimes referred to as Stage II of the industry life-cycle. The study also represented an attempt to answer questions about the impact of time of entry and cooperative ownership on firm conduct or behavior during Stage II of the industry life-cycle. Results of previous studies imply that information about new technologies and markets comes predominantly from external agencies during Stage II, and this notion is particularly relevant to the ethanol industry. Societal interests in developing alternative fuels have fostered government support for growth of the ethanol industry in the form of tax incentives and government sponsored research at public agencies and institutions. Research findings from the USDA, land grant universities, and other government supported research institutions should flow freely to ethanol firms, thus contributing a degree of homogeneity to firm conduct or behavior.

Empirically, this study revealed that there were a limited number of variables for which age of facility, size of facility, as measured by millions of gallons of ethanol produced, and the type of ownership (farmer-owned cooperative vs. other) could jointly explain observed differences among firms, even when recognizing statistical significance at the 0.10 level. In those situations where relationships were significant, the directions of relationships were generally intuitively appealing, thus lending support to the legitimacy of the estimated models as evidence of fairly homogeneous behavior.

In this study, older facilities were found more likely to utilize in-house feedstock procurement activities and in-house ethanol and co-product marketing activities. Newer facilities, on the other hand, were more likely to take advantage of the services of marketing firms when marketing ethanol and co-products. Those results were consistent with Qian et al. (2010), who concluded that later entrants into the ethanol industry were able to take advantage of a more developed market and avoid internalization of value chain activities such as feedstock procurement and ethanol and co-product marketing. Newer facilities were more likely to market dry distillers grain and modified distillers grain, which is consistent with the fact that most of the recent expansion in ethanol capacity has come from dry mill facilities (U.S. Department of Energy 2010). Finally, larger facilities were more likely to utilize in-house ethanol and co-product marketing activities, presumably because they could economically justify employing marketing staff members.

With regard to transportation, smaller facilities and farmer-owned cooperatives were more likely to depend solely upon truck transport for feedstock procurement. Smaller facilities may not be able to justify rail transport due to the limited quantities of feedstock processed, and farmer-owned cooperatives generally procure feedstock from patrons who are geographically concentrated.

Respondents from farmer-owned cooperatives were more likely to agree that the RFS program impacted their production plans. That result reflects the value-added philosophy that supported the establishment of many farmer-owned cooperatives during the expansion of the ethanol industry. Fred Yoder, then President of the National Corn Growers Association, testified before the U.S. Senate Subcommittee on Clean Air and Nuclear Safety that RFS would create more value-added opportunities for farmer-owned cooperatives (U.S. Senate 2003).

Conclusions

Subsequent to the completion of the survey described in this paper, the ethanol industry has observed further structural changes. Due to deteriorating macroeconomic conditions that began in 2008, multiple companies have ceased production or filed for bankruptcy protection (Sims 2008b). A consultant in the industry recently reported that many producers in the industry have been operating without profits since the economic downturn began and predicted that the industry would shrink to approximately 25 firms in 10 years (Burns 2010).

Future ethanol industry research should include cross-sectional analysis of the industry as it continues to evolve. Such information would be of interest to managers, owners, and management scholars. Statistical analyses of collected data should be based upon procedures described in the literature that pertains to industry life-cycles and firm behavior and performance. To expand on the procedures utilized in this study, diversifying entrants should be distinguished from entrepreneurial startups, and farmer-owned cooperatives should be distinguished from both publicly-held firms and other privately-held firms as per Qian et al. Other interesting information could be derived from comparisons of facilities that have ceased operations with facilities that have had continuous production.

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