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Keywords

food-fuel trade-offs, corn producers, market choice, ethanol

Disciplines

Agricultural and Resource Economics | Growth and Development | Other Economics

Comments

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Letter/Communication

Evaluating Food-Fuel Trade-Offs via Market Choice: The Case of Iowa Corn Producers

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Abstract. This study examines food-fuel trade-offs from the perspective of crop producers and their choices in marketing their grain among food, feed and fuel use. Based on a recent survey of Iowa grain producers, this study finds that price competition from ethanol plants has increased the share of the corn marketed directly to ethanol plants and lowered the market share of corn marketed for domestic and international food/feed purposes. Other factors, such as farm size and market distance, affect the share of corn directed to the fuel, food, and feed markets. The results indicate corn producers are willing to bear higher transportation costs to reach food markets over other market outlets.

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1 Introduction

Driven by the increasing demand for energy security and cleaner energy sources, biofuels have been considered as a viable alternative transportation fuel. Over the last decade, the combination of higher energy prices and an array of policy supports, such as tax credits and renewable energy mandates, has supported the quick expansion of the U.S. biofuel sector. Currently, corn-based ethanol is the major biofuel produced in the U.S. As a result, ethanol has been the fastest growing segment of corn utilization over the past several years and competes with the domestic livestock industry, processing companies and foreign consumers for corn. This increasing competition for corn has boosted corn prices. The additional demand for corn from the biofuel sector and the reallocation of scarce resources (e.g. agricultural land) from food/feed purposes to fuel use has quickly drawn an

intense debate about food-fuel trade-offs in recent literature [1–4]. Previous studies have evaluated the potential consequence of the expanding biofuel sector on food-fuel trade-offs at the global and/or national level. However, little attention has been given to how crop producers respond to competing demands for their crops at the local level.

Iowa is the leading state for corn and ethanol production in the U.S. Over the past decade, Iowa corn producers have shifted their marketing patterns to sell more of their corn directly to end users, especially ethanol plants. For the 1999/2000 corn crop, Iowa producers marketed 13% of their crop directly to corn processors, including ethanol plants [5]. For the 2007/2008 corn crop, the proportion of corn directly marketed to processors had jumped to 32%, primarily driven by increasing shipments to ethanol plants [6].¹ Meanwhile, the share of corn sales directly to local country elevators from producers, the traditional dominant marketing channel, has been decreasing. This transition implies that corn producers are expanding their influence on the final use of their corn. The marketing decision of Iowa corn producers tapping into the boom in ethanol production is analyzed in this study to illustrate food-fuel trade-offs. This paper aims to evaluate the food-fuel trade-offs from the crop producers' perspective by examining the impact of price competition for the crops among food, feed and fuel uses and the other factors that shape farmers' choice of markets.

2 Materials and Methods

Using a recently conducted marketing survey of Iowa grain producers in two consecutive marketing years (2006/07 and 2007/08), this study explores the evolution in destination markets during the recent surge in ethanol production. The producers in the survey were randomly selected from across the state. The survey included the questions of farmers' land allocation for their crops (mainly corn and soybeans), their production during the year, marketing/disposal of the crop, utilization of various modes of transportation, evaluation of the transportation system in Iowa and their opinion of possible hindrances to efficient grain marketing [6, 7]. Based on 1,354 survey responses over the two years, the respective share of corn hauled to country elevators, ethanol plants, corn processors, river terminals, and other markets for each

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¹The procurement data of ethanol plants and food processors also presented similar pattern. The detailed survey results for those industries can be found in the survey reports by Yu and Hart [6, 7].

Marketing Shares:	
Country elevators	60 %
Ethanol plants	20 %
Other corn processors	10 %
River terminals	5 %
Other uses	5 %
Average distance to most utilized market	26 miles

Table 1. Selected summary data.

producer is calculated. Table 1 highlights summary data from the survey. As the ethanol plant share shows fuel demand for corn, the corn processor demand highlights food demand, the river terminal demand is a good proxy for international feed demand, and the country elevator demand is a combination of food, feed, and fuel demand. Demographic data of the farms was also collected.

To evaluate corn producers' marketing decision, the share of the crop marketed to major destination markets is modeled as follows:

$$S_i = \beta_0 + \beta_1 P_{\text{ETH-ELE}} + \beta_2 P_{\text{ETH-RIV}} + \beta_3 \text{Farm} + \beta_4 \text{Mileage} + \beta_5 d_{2007/08} + \varepsilon_i, \quad (1)$$

where S_i represents the share of the corn crop delivered to each market i , $P_{\text{ETH-ELE}}$ is the difference of bid prices for corn between ethanol plants and country elevators, $P_{\text{ETH-RIV}}$ is the difference of bid prices for corn between ethanol plants and river terminals, Farm is the size of each farm based on corn area, Mileage measures the distance between the farm and its most utilized (but not necessarily the closest) market, $d_{2007/08}$ is an indicator variable for the 2007/08 crop year, and ε_i is the residual. The price premiums ($P_{\text{ETH-ELE}}$ and $P_{\text{ETH-RIV}}$) are measured in US\$ per bushel and are obtained from daily USDA-AMS pricing reports [8–10]. These price premiums capture the incentive of the farmer to shift corn delivery among the various markets. In this study, the annual average of both price premiums in the region of the state where the farm is located is generated for analysis. An indicator variable for 2007/08 is also added in the model to capture time specific effects between the two years.

Since the share for each competing market is related with the other shares, a system estimation method, seemingly unrelated regression (SUR), is used to account for cross equation error correlations and to enable the cross equation statistical tests. The SUR consists of a set of individual equations as one equation system that is estimated simultaneously. It allows contemporaneous correlation between the error terms across equations, i.e. the variance-covariance matrix of the error terms is non-diagonal. The SUR estimator has the potential to be more efficient than single-equation ordinary least squares and it enables consis-

tent cross-equation restriction testing in the case of cross-equation error correlations. However the efficiency gain will diminish if there are no cross-equation error correlations or the explanatory variables are exactly identical across equations [11].

3 Results

The parameters of the market share equations are presented in Table 2. The values in parentheses are the p -values associated with the parameters. The statistical significant Breusch–Pagan test suggests that the residuals in the system equations are highly correlated even though direct cross equation restrictions are not imposed in the system and all four equations have the same set of explanatory variables. This confirms efficiency gain from employing the SUR method. The R -squared values for the estimates are low as there is a great deal of individual variation in market choice. However, the results offer guidance in the factors that affect the trade-offs among the market choices of corn producers and highlight that price is not the only factor shaping the choice.

For the share of farmers' direct corn sales to ethanol plants, the price premium offered by ethanol plants over the river terminals had a positive and statistically significant relationship. The price difference motivated corn producers to shift sales from food/feed markets (river terminals) to fuel markets (ethanol). The parameter estimates indicate that a one cent price premium from ethanol plants is associated with a 0.58 percent increase in the ethanol plant share at the individual farmer level *ceteris paribus*. The price premium variable between ethanol plants and country elevators has an unexpected negative sign but is not statistically significant. Farm size has a positive and statistical significant impact on ethanol plant share, indicating larger farms have a higher likelihood of choosing ethanol plants as their preferred market. Also, the impact of market distance is positive and statistical significant, implying that farmers are willing to travel further to reach ethanol markets.

As expected, the share of corn marketed to country elevators is negatively affected by the ethanol–country elevator price premium. Interestingly, an increase in the ethanol–river terminal price premium expands the share of corn headed to country elevators. One explanation for this result is that county elevators also market corn to ethanol plants. The increase in the ethanol–river terminal price premium may be reflected in the country elevator bids of those elevators marketing to ethanol plants and the higher bids in those cases increases the elevator's market share. Both farm size and distance to market are negatively related to corn producers' utilization of country elevators, the conventional local hub for corn. This suggests that smaller farms with limited transportation options have been more likely to re-

Share Equation	Explanatory variables						
	$P_{ETH-ELE}$	$P_{ETH-RIV}$	Farm	Mileage	$d_{2007/08}$	Constant	R^2
Ethanol plants	-2.22E-01 (0.372)	5.76E-01 (0.019)	7.78E-05 (0.000)	9.90E-04 (0.003)	-1.43E-02 (0.685)	1.03E-01 (0.000)	0.05
Country elevator	-1.01E+00 (0.003)	2.00E+00 (0.000)	-9.52E-05 (0.000)	-4.21E-03 (0.000)	-2.05E-01 (0.000)	8.66E-01 (0.000)	0.15
River terminals	9.06E-01 (0.000)	-8.37E-01 (0.000)	4.36E-06 (0.621)	6.50E-04 (0.005)	7.01E-02 (0.004)	-2.78E-02 (0.025)	0.07
Processing facilities	2.28E-01 (0.284)	-1.56E+00 (0.000)	1.45E-05 (0.182)	2.41E-03 (0.000)	1.72E-01 (0.000)	-1.15E-02 (0.454)	0.12

Breusch-Pagan test of independence: Chi-square statistic: 737.432, p -value: 0.000

Table 2. Estimated SUR model.

main within historically conventional marketing channels and less likely to explore new marketing outlets.

The river terminals' share of corn is declining as ethanol plants offer higher bids versus the river terminals themselves. Also, a rising market share of river terminals is observed when the ethanol bids rise versus country elevators, which may reflect the choice of alternative marketing to the standard of the county elevator. The relatively higher ethanol plant bid may be paralleled by relatively higher bids from river terminals, etc., in comparison to the elevator bid. Distance to market and the time variable are also positively related to the river terminal share.

The share of corn delivered to local corn processing companies is significantly affected by the ethanol-river terminal price premium and the distance to market. The negative impact of ethanol-river terminal price premium on the corn share for processing companies may result from the quickly emerging fuel demand over both domestic food and international feed use. This again suggests that the close competition for corn between the food, fuel and feed demand. Also, many of the corn processing facilities and river terminals in Iowa are located in the southeast portion of the state. Thus, lower relative river terminal bids may also be reflective of lower relative corn processing bids given that these two markets would face similar pricing competition. Given the results on market distance, Chi-square tests were performed to test the equivalence of the market distance impact on corn market share. The tests show statistically significant differences among ethanol plants, river terminals, and corn processors. The results also suggest that farmers are willing to travel additional distances to reach food markets (corn processing facilities) than fuel or feed markets (ethanol plants and river terminals) after accounting for price differences.

For the marginal impact of price premium variables on the share equations, the cross equation Chi-square tests show that the negative impacts of the ethanol-river terminal

price premium on the corn processing share and the river terminal share are statistically different at the 5% significance level with a larger absolute impact on corn processing companies. Test results also suggest that the ethanol-river terminal price premium makes statistically significantly larger positive contributions on the share of corn delivered to ethanol plants than to country elevators. This result makes sense given the direct impact the price premium would have for ethanol plants, as opposed to the indirect impact for country elevators. In addition, the ethanol-country elevator price premium has a larger positive influence on the river terminal share than on the corn processing share at the 5% significance level.

4 Discussion and Summary

This paper offers an alternative analysis of food-fuel trade-offs from the perception of crop producers. By analyzing how Iowa corn producers respond to the competing demands among fuel (ethanol plants), food (corn processing facilities) and feed (river terminals) uses, it is shown price differences across the uses affect market choice. Specifically, price competition from ethanol plants has increased the share of the corn marketed directly to ethanol plants and lowered the market share of corn marketed for domestic and international food/feed purposes. Also, the influence of price premiums on corn producers' decisions of reallocation of corn to the fuel, food and feed markets varies.

In addition to price premiums, other factors such as farm size and market distance also have an impact on market choice. While ethanol has gained significantly in corn market share over the past decade, lowering the shares headed to food/feed purposes, Iowa corn producers have shown a willingness to bear higher transportation costs to reach food markets over fuel and feed markets after accounting for price differences.

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