The Spatial Effect of Ethanol Biorefinery Locations on Local Corn Prices

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Selected Paper prepared for presentation at the Agricultural & Applied Economics Association's 2009 AAEA &ACCI Joint Annual Meeting, Milwaukee, WI, July 26-28,2009.

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Abstract

This study examines whether the local competition for corn to produce ethanol has lead to significantly higher prices for farmers located close to ethanol plants. If any, such price premiums for spatial closeness would be in addition to the general level of corn price changes experienced by farmers throughout the U.S. The difference-in-differences estimation method is used to account for both time and location differences in order to measure the interaction of time and location effects. Using the USDA's ARMS data, the results show that while prices in real terms have risen over time, farmers located close to ethanol plants have not received significantly higher prices than farmers living farther away from plants. These findings indicate that there is a lack of evidence for price premiums due to the spatial closeness to ethanol plants.

Key words: corn prices, ethanol, ethanol plant location, difference-in-differences.

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U.S. ethanol production has rapidly expanded over the last few years. In 2007, there were 111 biorefineries in the U.S. with a total production capacity of 5.5 billion gallons of ethanol per year (Renewable Fuels Association statistics). This is up from 68 biorefineries with a capacity of 2.7 billion gallons in 2003. The increased demand for corn for conversion to ethanol has had significant effects felt throughout the agricultural sector. The upward trending corn prices during the last few years (a trend that has been partially reversed lately) have altered farming practices and profitability of producers.

As of 2007, 21 states had ethanol plants, however, most biorefineries are spatially concentrated in the states with most intense production of corn. Naturally, a biorefinery built in a new location will have to compete with previously established marketing channels to secure corn as an input to the ethanol production process.

Several studies have considered various aspects of the relationship between corn production and ethanol production (Eathington and Swenson, 2007; Du, Hennessy, and Edwards, 2008; and Low and Isserman, 2004). McNew and Griffith (2005) studied the impact of ethanol plants on local grain prices with a data set from 2001 to 2002 and found that there were significantly positive responses for corn prices around ethanol plants. Gallagher, Wisner, and Brubacker (2005) examined the pricing systems for corn in the vicinity of processing plants with data from 2003 and found that the pricing systems differ based on the organization of the ethanol plants. Since the construction of ethanol plants and production of ethanol has intensified during recent years, this study will examine these relationships using more recent data that also covers a greater geographical region.

The main objective of this study is to investigate whether the local competition for corn for ethanol production has lead to significantly higher prices for farmers located close to ethanol plants. If any, these price premiums for spatial closeness would be in addition to the general level of corn price changes experienced by farmers throughout the U.S. The study utilizes the difference-in-differences estimation method to find the interaction of time and location effects after controlling for differences over time and across locations. Specifically, the difference-in-difference model estimates differences in prices at two time points for the treated observations (prices for corn contracts near ethanol biorefineries) and for the control observations (those farther away from biorefineries) and then compares the differences between the two groups. The time differences in corn prices due to common factors or structural changes as well as the spatial differences in corn prices due to different locations are accounted for in order to compare the effect of the treatment which is the interaction of time and location effects.

Difference-in-Differences Models

The difference-in-differences (DID) estimator estimates the difference between outcome measures at two time periods for both the treated observations and controls and then compares the difference between the groups. There are two differences considered: one is the difference in outcomes from one period to the next and the other is the difference between treated and control observations, hence the term difference-in-differences. The difference-in-differences model is defined as

(1) $$y_{it} = \alpha + \beta t_{it} + \gamma d_{it} + \delta t_{it} d_{it} + \phi x$$

where y_{it} is the outcome measure for every unit *i* at both periods, t_{it} is a dummy variable equal to 1 if the observation is in the second period and 0 if it is in the initial period, d_{it} is a dummy variable equal to 1 if the observation in the treatment group and 0 if it is not, and $t_{it}d_{it}$ is the interaction term between the time dummy variable and treatment dummy variable, and *x* are other characteristics that influence the outcome variable. The time-treatment interaction term is the difference-in-differences measure for the effect of the treatment on the treated group, controlling for common time differences between the two groups.

Specifically for this study, the outcome of interest is local corn prices. The treatment is whether or not a farmer has an ethanol plant nearby. The treated group is a group of corn contracts that have an ethanol plant nearby and the control group is those contracts that do not. Two time periods are considered to eliminate the common price changes over time. The interaction between the dummy variable for the time period and the dummy variable for the presence of an ethanol plant will be the difference-in-differences effect that we are interested in.

Data and Descriptive Statistics

The data for this study are from two sources. The ethanol biorefineries locations are obtained from the Renewable Fuels Association. The location of each ethanol plant is associated with the county or zip code. Corn prices received by farmers for their marketing contracts are obtained from the USDA's Agricultural and Resource Management Survey (ARMS). Prices are indexed in 2007 dollars using the producer price index for farm products. Two matching criteria are used to merge the two data sets: county and zip code for the location of the ethanol plants and farms. The analysis is conducted with data for Minnesota, Wisconsin, Iowa, Nebraska, Kansas, Missouri, Illinois, and Indiana. The latest year that commodity price data are available is 2007. Because the estimation method requires two periods, the initial period is considered to be 2005.

Several other initial years were considered and the results remain similar. Other variables used in the analysis are from the ARMS data.

Descriptive statistics of the data are presented in table 1. The average corn contract price for the two periods was $3.12, indexed in 2007 dollars. When using county clusters to match the two data sets, 22% of the counties that information on corn contracts had an ethanol plant in the same county and the rest did not. When using zip code clusters, 5% of zip code locations with corn contracts had an ethanol plant in the same location. Fifty one percent of the data are from 2007 (the second period) and the rest of the data are from 2005 (the initial period). The interaction term shows that 10% of the corn contracts are in the second period and have ethanol plant in their county and 2% are in the second period and have ethanol plant in their zip code location. For 7% of the corn contracts, a new ethanol plant was built in the county in the last two years and for 0.6% of the corn contracts, a new ethanol plant was build in the same zip code location.

Depending on whether county or zip code clusters are used, the average quantity of corn contracted is 22,524 or 23,480 bushels, the average farm size measured in total assets is $1,618,056 or $1,692,659, the average operator age is 50.39 or 51.57 years, and the average education is 2.53, which is measured as a categorical variable. There are 2,851 corn contract observations in the data, which are from 632 distinct counties. Likewise, there are 2,758 corn contracts in the data, which are from 1,549 distinct zip codes. The number of observations is not the same in the two analyses because for some ethanol plants either the county or zip code location was missing.

Difference-in-Differences Model Results

Two difference-in-differences models are estimated based on whether clusters for the analysis are counties or zip codes. When farms are located in the same county or zip code, it is expected that the corn prices that the farmers received on their contracts will be more similar than if living farther apart. To account for the clustering effects of farms that located in the same areas, the standard errors are corrected using clusters as the county or zip code locations.

The results show that the time dummy variable is significant, indicating an upward trend in prices between 2005 and 2007. Since the prices are indexed in 2007 dollars, the increase in prices between the two periods shows increase in real terms. Corn prices have risen by $0.76 to $0.79 cents between 2005 and 2007. The ethanol plant dummy is not significant in the model using county clusters and is negative and significant in the model using zip code clusters. On average, corn contract prices are 10.9 cents lower for farmers located in the same zip code as ethanol plants. This effect reflects spatial differences in prices and is not necessarily an indication that ethanol plants have a negative influence on local corn prices.

The interaction term of the ethanol plant dummy and time dummy is not significant in the two models. The term measures the difference-in-differences effect of ethanol plants on local corn prices while controlling for changes in prices from one period to the next that may be common for both groups regardless of whether an ethanol plant is located nearby. These results provide an indication that while prices in real terms have risen over the last few years across the U.S., farmers located close to ethanol plants have not been able to secure even higher prices due to their proximity to ethanol plants.

Other variables are also included in the models as control variables. The quantity that farmers contract has a negative relationship with the corn price received, which is expected. Larger farms are able to secure higher prices. Operator age has a positive effect and operator education has a negative effect on corn prices but only in one of the models, while in the other model this effect is insignificant.

The main finding here that there are no significant price responses for farms located close to ethanol plants is different than the previously obtained result in McNew and Griffith (2005). They found that there are positive corn price responses around the plants. However, they used data from 2001-2002 and since then ethanol production and biorefinery construction have intensified.

Conclusions and Policy Implications

This study analyzes the spatial effect of ethanol biorefinery locations on local corn prices. Difference-in-differences models are estimated to show that farmers located spatially close to ethanol plants have not received significantly different prices from farmers who are located at least one county or zip code location away from an ethanol plant. These results are obtained after accounting for changes over time in corn prices and only comparing the effect of the ethanol plant presence in the farmer's county or zip code location on corn prices. In other words, this study does not show any evidence that ethanol plants have had a significant effect by raising local corn prices beyond the price changes experienced by farmers across the nation.

These findings have several implications. The profitability and long-term survival of the biorefineries critically depend on input prices paid for corn. As corn production nears its capacity to provide for local production of ethanol, the competition may drive local corn prices higher and make ethanol production less profitable. Therefore, it is important to consider future plant construction sites as to not reach the capacity point in a local area and thus bid up local prices. In addition, because of transportation costs, farmers located close to biorefineries may not be able to transport their production to farther processors to obtain higher prices after accounting for transportation costs. Finally, as alternative sources of biofuels are utilized and conversion technologies are developed, these local effects may change in the future.

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Table 1. Descriptive Statistics

	Measurement Unit	County Clusters	Zip Code Clusters
Corn contract price	1997 dollars	3.12	3.12
Ethanol plant dummy	Unitless	0.22	0.05
Time dummy	Unitless	0.51	0.51
Ethanol plant dummy * time dummy	Unitless	0.10	0.02
New ethanol plant dummy	Unitless	0.07	0.006
Corn quantity contracted	Bushels	22,524	23,480
Farm size (total assets)	Dollars	1,618,056	1,692,659
Operator age	Years	50.39	51.57
Operator education	Category	2.53	2.49
Number of observations	Unitless	2,851	2,758
Number of clusters	Unitless	632	1,549

Table 2. Difference-in-Differences Models

	Corn Contract Price	
	County Clusters	Zip Code Clusters
Intercept	2.6451	2.5201
	(0.1453)	(0.1688)
Ethanol plant dummy	-0.0420	-0.1099*
	(0.0522)	(0.0577)
Time dummy	0.7914**	0.7647**
	(0.0611)	(0.0590)
Ethanol plant dummy * time dummy	0.0892	0.0413
	(0.1012)	(0.1714)
New ethanol plant dummy	-0.1354	-0.0636
	(0.1103)	(0.0941)
Corn quantity contracted	-4.e-07**	-4.e-07*
	(2.e-07)	(2.e-07)
Farm size	1e-08*	1.e-08**
	(6.e-09)	(6.e-09)
Operator age	0.0043	0.0061*
	(0.0027)	(0.0031)
Operator education	-0.0508*	-0.0442
	(0.0307)	(0.0324)
Number of observations	2,851	2,758
Number of clusters	632	1,549
R squared	0.31	0.29

Note: * and ** denote significance at the 10% and 5% significance level, respectively.