Crop Choice and Proximity to Ethanol Plants

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Outline

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- Models and Data
- Result
- Conclusion

Background

- The strength of the production cluster between corn, livestock, and processing facilities (e.g., ethanol plants) depends on the density of corn production in proximity to an ethanol plant.

- Proximity to ethanol plants influences the net prices received by crop producers.

- We estimate how the proximity to processing facilities impacts crop choice.

Literature Review

- **McNew and Griffith (2005)** introduce a spatial equilibrium model that estimates the regional impact on grain prices from new opening ethanol plants

- **Motamed et al. (2016)** show that an understanding of the optimal crop choice can be achieved as satellite data on crop location and land use are accessible

- Using cropland and spatial soil data, **Secchi et al. (2011)** estimate crop rotations and yields and find that farmers may conduct continuous corn rotations

Literature Review

- **Zhao, S., Wang C., Bordovsky, J, Sheng, Z. and Gastelum, J. (2011)** show when cotton price increases, land planted to corn, sorghum and wheat will be converted to cotton.

- **Carpentier, A. and Letort, E. (2014)** use a multinomial logit model including acreage management cost functions and show patterns of crop choice by producers.

- The literature, however, do not include information on the distance of farms to local crop processors, which can have a substantial influence on the net prices received.

Contribution to Literature Review

- Utilize travel distance to local processors into this crop choice literature.

- Apply an alternative data source, which is widely available due to GIS databases, to our crop choice model which utilizes parcel characteristics and land use patterns over time.

  - This new approach mitigates the need for producer surveys, lowering the cost of developing a model which reflects the unique local processing market of a particular region.

- Employ the example of local markets, such as animal food manufacturers and cattle on feed as well as ethanol plants, in a central Nebraska region with a concentration of grain production.

Models and Data

- **Multinomial Logistic Model**

$$\text{Prob}\,(Y_i = \text{j}) = \frac{\beta_j X_i}{1 + \sum_{j=1}^{j} e^{\beta_j X_i}} \text{ for j=0, 1, …, J,.}$$

Assign a dependent variable,

Y_i = 1 if the largest share is corn cultivation,

Y_i = 2 if the largest share is soybean cultivation,

Y_i = 3 if grassland/pasture accounts for the largest share,

Y_i = 4 if the largest share is developed land, and

Y_i = 5 if all other land uses (collectively) account for the largest share of land.

And, X_i is a vector of variables of interest, including proximity to local markets.

Models and Data

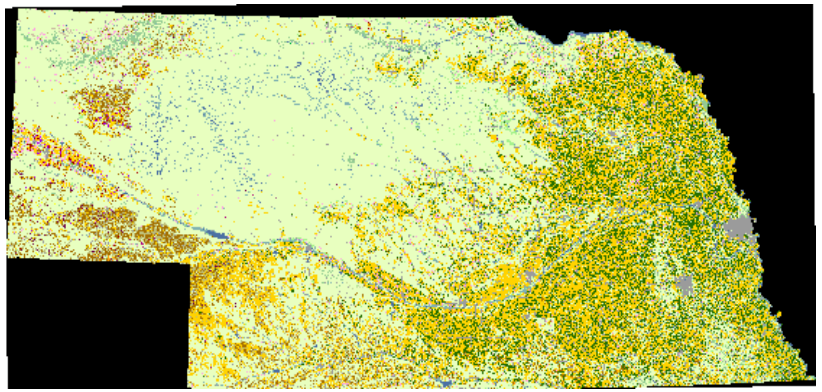
- **Tobit Regression Model**

$$Y_i = \boldsymbol{X}_i\boldsymbol{\beta} + \varepsilon_i$$

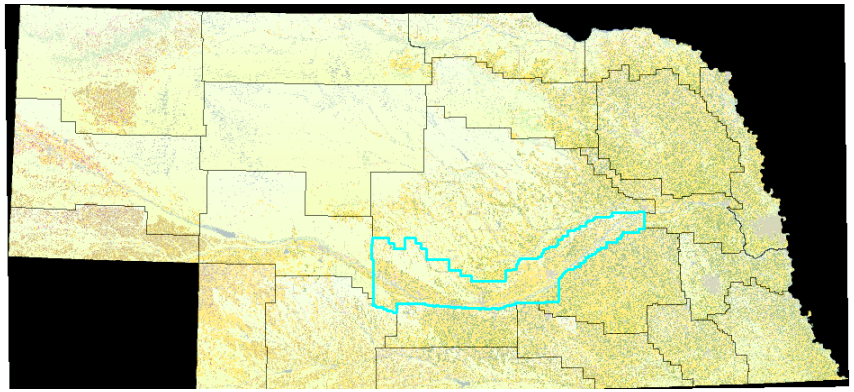
, where the dependent variable is *percent of crops of interest* within a parcel (bounded between 0 to 100), and

X_i is a vector of variables of interest, including proximity to local markets.

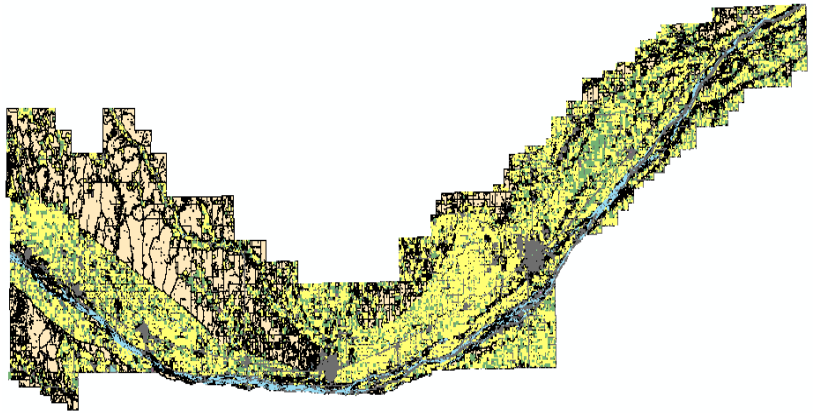
Models and Data



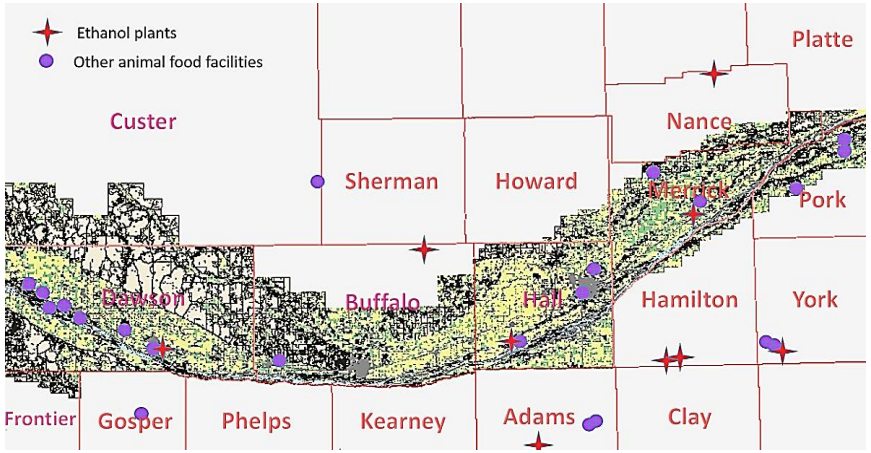
Cropland classification



Select study area



Parcels Cropland classification



Locations of Local Markets

Models and Data

- **32,000 Micro-level Parcels*** analyzed in ArcGIS from 2011 and 2014.
(Restriction: all parcels with at least .5 percent undeveloped land)
- **Cropland Classification** from Natural Resources Conservation Service (NRCS).
- **Crop Productivity** from Gridded Soil Survey Geographic (gSSURGO).
- **Well Capacity** from Nebraska Department of Natural Resources (DNR).
- **Futures Crop Prices** (at market closest to parcel) from UNL EXTENSION.
- **Electricity Price** from Energy Information Administration (EIA).

Models and Data

- Descriptive Data (2014)

Table 1. Descriptive Statistics of Explanatory Variables for 2014

Variable	Mean	Standard Deviation	Min	Max	Sample Size*
Distance to Nearest *Ethanol Plant* (miles)	13.53	6.37	.09	36.1	31,642
Distance to Nearest *Animal Food Facility* (miles)	14.75	9.53	0	41.15	31,642
Number of Cattle in County (head)	122,326.4	79,214.7	27,500	285,000	31,642
Crop Productivity Index	.406	.101	.05	0.8	31,642
Well Capacity (gpm)	69.3	1,205.9	0	2,471.4	31,642
Electricity Price ($/megawatt)	.115	.029	.060	.189	31,642
Corn Futures Price ($/bushel)	3.34	.094	3.24	3.43	31,642
Soybeans Futures Price ($/bushel)	9.75	.153	9.63	9.95	31,642

Results

Table 2. Result from Multinomial Logistic Model for Each Category in 2014

Explanatory Variable	**Corn** (base outcome)	**Soybeans** (base outcome)	**Grassland/ Pasture land** (base outcome)	**Developed area** (base outcome)
	Soybeans (a possible alternative)	**Corn** (a possible alternative)	**Corn** (a possible alternative)	**Corn** (a possible alternative)
Distance to Nearest Ethanol Plant	.032** (.022)	-.030** (.013)	-.088*** (.009)	-.015 (.011)
(Distance to Nearest Ethanol Plant)^2	-.001*** (.001)	.001*** (.0004)	.0020*** (.0003)	.0009** (.0004)
Distance to Other Animal Food Facilities	.019** (.014)	-.022** (.0099)	.0233*** (.006)	.0456*** (.008)
(Distance to Other Animal Food Facilities)^2	-.001*** (.0006)	.0007*** (.0002)	-.0004** (.0001)	-.0008*** (.0002)
Number of cattle (head)	-.00001*** (3.08E-06)	.006 (.008)	.0182*** (.005)	.0324*** (.006)
(Number of cattle)^2	5.08E-11*** (9.02E-12)	-.0002* (0001)	-.0005*** (.0001)	-.0006*** (.0001)
Well Capacity (WC)	-.001 (.0007)	.001 (.0007)	-.0490*** (.002)	-.034*** (.003)
Crop Productivity (CP)	.891*** (.233)	-.811*** (230)	3.664*** (.142)	1.11*** (.174)
Corn Futures Price	1.907** (.780)	-.2960 (.673)	-.439 (.466)	-2.06*** (.716)
Soybeans Futures Price	-1.39*** (.441)	1.15** (.450)	1.758*** (.307)	1.117** (.442)
Electricity Price (EP)	-1.89* (1.072)	1.71 (1.083)	-4.185*** (.720)	23.718*** (.977)
Intercept	6.544 (6.5003)	-8.66 (6.61)	-16.95*** (4.52)	-7.398 (6.66)
Pseudo R^2	0.12			
Sample Size	31.642			

The table reports coefficients from multinomial logistic models. Standard errors are in parentheses. *** Significant at the 1 percent level.** Significant at the 5 percent level.* Significant at the 10 percent level.

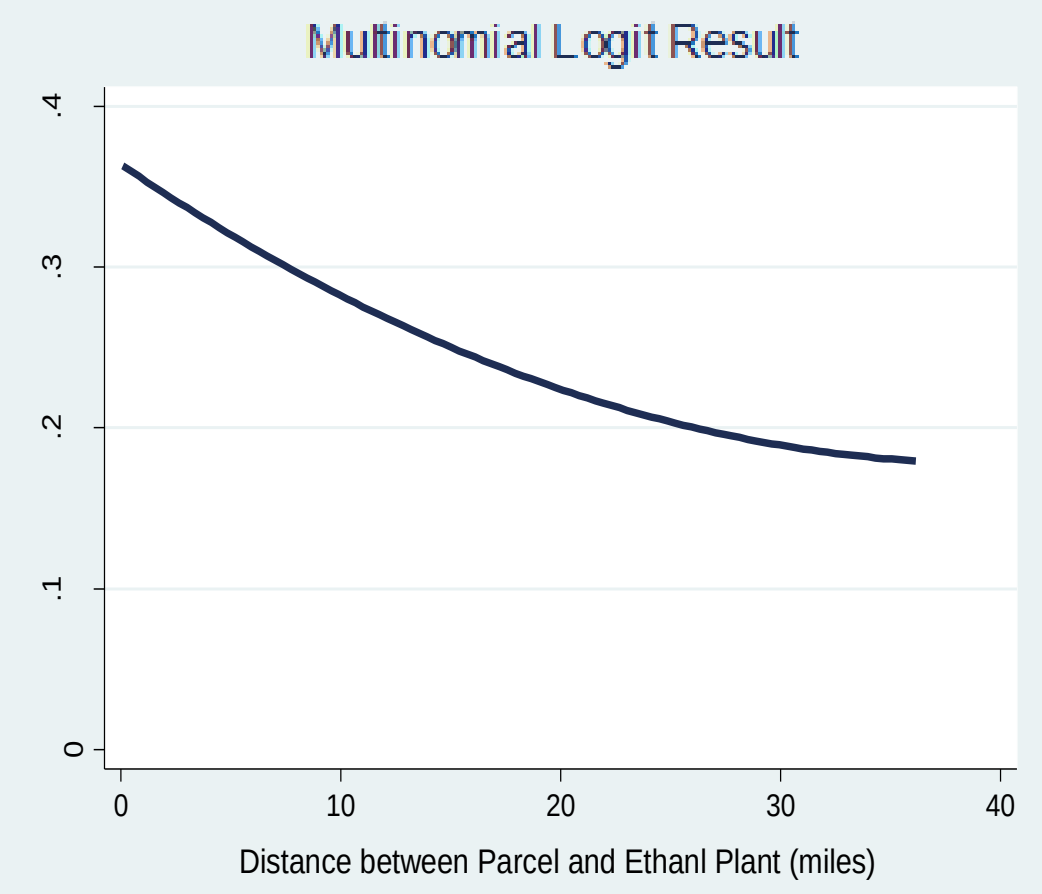
Results

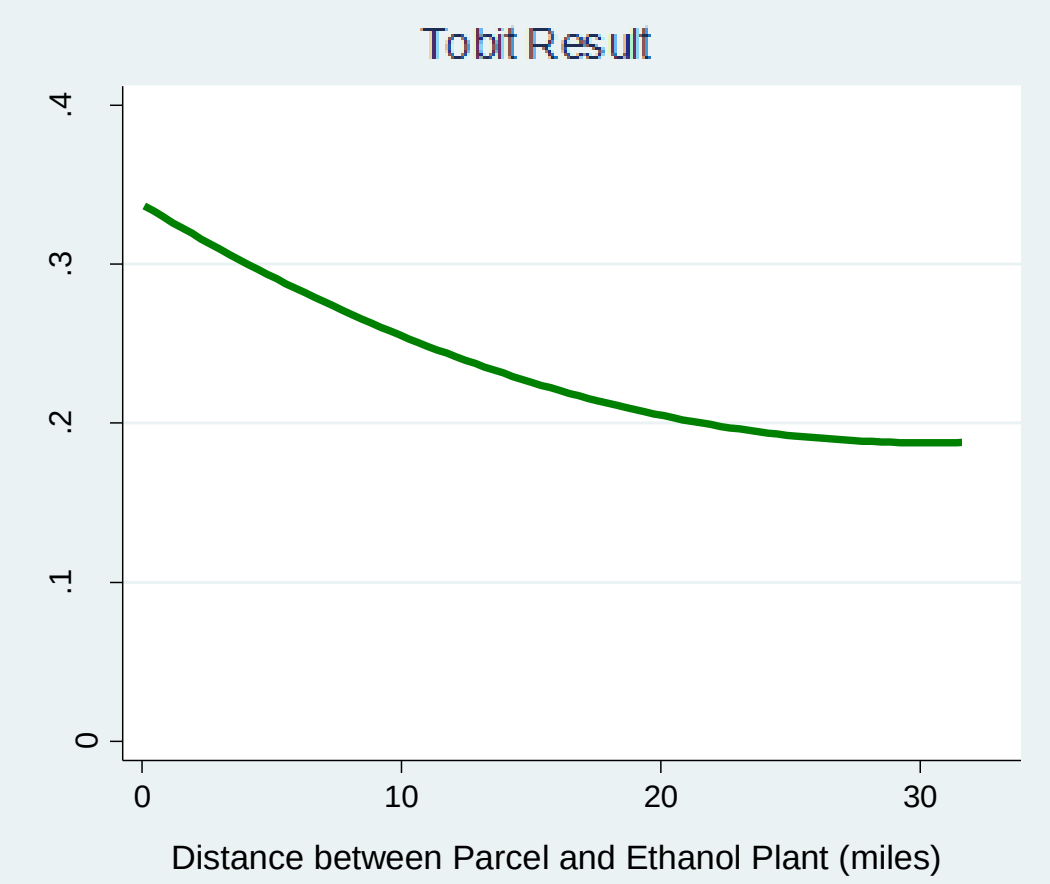
Table 3. Result from Tobit Regression Model for Corn and Soybeans in 2014

Explanatory Variable	Dependent Variable (Percent of Crop in Parcel): Corn	Dependent Variable (Percent of Crop in Parcel): Soybeans
Distance to Nearest Ethanol Plant	-.017*** (.001)	-.0007 (.00087)
(Distance to Nearest Ethanol Plant)^2	.0004*** (.00006)	-.00007 (.00005)
Distance to Other Animal Food Facilities	.008*** (.00098)	.008*** (.00034)
(Distance to Other Animal Food Facilities)^2	-.00007** (.00004)	-.0001*** (.00001)
Number of cattle (head)	2.94E-06*** (1.85E-06)	-1.08E-06*** (3.23E-07)
(Number of cattle)^2	-7.71E-12*** (1.16E-11)	3.61E-12*** (9.78E-13)
Well Capacity (WC)	-.001*** (.00009)	-.001*** (.00003)
Crop Productivity (CP)	1.22*** (.024)	.860*** (.007)
Electricity Price (EP)	.816*** (.05404)	.925*** (.035)
Corn Futures Price	-1.23** (.0366)	
Soybeans Futures Price		.027 (.012)
Intercept	3.498*** (.370)	-.853** (.363)
Sample Size	31,642	31,642
Pseudo R^2	0.10	0.07

The table reports coefficients from Tobit regression models. Standard errors are in parentheses. *** Significant at the 1 percent level.** Significant at the 5 percent level.* Significant at the 10 percent level.

Results


Multinomial Logit Result
0
.1
.2
.3
.4
0
10
20
30
40
Distance between Parcel and Ethanl Plant (miles)


Tobit Result
0
.1
.2
.3
.4
0
10
20
30
Distance between Parcel and Ethanol Plant (miles)

Conclusions

- We utilize proximity to local processors into previous crop choice models and identify whether distance to local crop processors has a substantial influence on land use decisions by farmers.

- With 2011 – 2014 period within the State of Nebraska, we find that farmers take into account that distance is a significant cost for these bulky crop commodities.

- Our approach via GIS software can complement periodic surveys of agricultural producers and allow more regions of the country to develop localized crop choice models.

Conclusions

- The ethanol industry is the crop processing sector in our central Nebraska crop choice model, but the focus in other regions could include major feed mills, or cereal plants.

- The concentration of crop production around major processing plants also has implications for energy and irrigation policy.

- For example, clusters of crop and processing activity economize on energy use in hauling bulky crops, by expanding crop production in proximity to the processing plant. (limit regulatory barriers to locating processing plants)

- Likewise, irrigation policy can be shaped to accommodate incentives faced by farmers located near major processing facilities. (allow for the purchase of irrigation rights)