Location Choices of Ethanol Firms in the Midwest Corn Belt

Mônica A. Haddad is an associate professor and extension specialist at Iowa State University's department of community and regional planning. Her research interests focus on spatial analysis applications for community and regional planning issue, targeting the U.S. Midwest, and Brazil.

Gary Taylor, AICP is an assistant professor and extension specialist in the department of community and regional planning at Iowa State University. He teaches and publishes on land use planning, and provides educational and technical assistance to planning officials across Iowa.

Francis Owusu is has a PhD in geography and is an associate professor in the department of community and regional planning at Iowa State University. His research and teaching interests include third world development, economic and urban development, and research and planning methods.

Abstract: The Corn Belt has experienced a rapid expansion of corn-based ethanol plants. This has provided researchers the opportunity to examine the relative importance to the renewable fuels industry of several location factors previously identified as important to agro-industries. Using probit regression this study identifies the factors significant to ethanol firms' location decisions in the four-state study area of Iowa, Illinois, Minnesota and Nebraska. In Iowa and Illinois, where corn is largely ubiquitous, firms move beyond corn supply to consider other localized factors in their decision-making process. Factors such as rail access, population density and proximity to blending terminals emerge as significant considerations. Probit regressions comparing states reveals the competitive advantages each offers to ethanol firms. The importance of the findings to economic development professionals is discussed and areas for future research are suggested.

A revised version of this paper is published in *Economic Development Quarterly* Vol. 24, No.1, 2010, pp74 –86

1. INTRODUCTION

Renewable fuels have taken center stage in energy and agricultural policy discussions. Agro-industry products such as ethanol and biodiesel have been promoted as satisfying several national strategic objectives, such as reducing the nation's dependence on foreign oil, increasing the use of cleaner fuel sources, and improving the economic health of the agricultural sector (U.S. Environmental Protection Agency, 2007; Lugar & Woolsey, 1999; Rask, 1998). To help attain these objectives, biofuels production has been incentivized in a number of ways. At the federal level, the Energy Independence and Security Act of 2007 requires 36 billion gallons of renewable fuel be used annually by 2022 – 21 billion gallons of which must come from advanced biofuels (.S. Department of Energy, 2008a). The U.S Department of Energy's Biomass Program provides support for technology development and commercialization (U.S. Department of Energy, 2008a; U.S. Department of Energy, 2008b). A number of other policies including income tax credits, federal excise tax exemptions, loan guarantees and grants have also been enacted (Capehart, Schnepf & Yacobucci, 2008; Clean Fuels Development Coalition, 2006).

State governments have also encouraged the development of the biofuels industry through incentives such as reduced state excise taxes for E10 (90/10 blended gasoline and ethanol motor fuel), various mandates for ethanol fuel use, and economic development incentive grants, loans and tax credits for ethanol producers (Food and Agricultural Policy Research Institute, 2008; Association of State Energy Research & Technology Transfer Institutions, 2006). State policy support is driven by a variety of interests. Biofuels production facilities have been shown to benefit farmers by stimulating local grain prices (McNew & Griffith, 2005). It is believed that this, in turn has been a leading factor in an increase in the value of agricultural land that has benefitted landowners and local taxing authorities (Iowa State University Extension, 2008). The ethanol industry is also seen to benefit rural communities as a source of jobs for skilled workers, a source of capital attraction, and an opportunity capture the economic benefits of a value-added industry (Hendrick, 2008; Pierce, Horner & Milhollin, 2007; Conway & Erbach, 2004; Gallagher, et al., 2001).

Policy support and market forces have resulted in the immediate and rapid expansion of the corn-based ethanol industry in the United States. In 1999, there were 50 ethanol plants nationwide producing 1.47 billion gallons of ethanol. By January 2008, the number of operational plants had grown to 139, with the capacity to produce nearly 7.9 billion gallons of ethanol per year. If all current plans for new ethanol plants and existing plant expansions were realized, this would bring another 5.1 billion gallons per year capacity on-line (Renewable Fuels Association, 2008).

Empirical evidence suggests a spatial relationship between the booming corn-based ethanol industry and the recent rapid increase in farmland values. In Iowa, some of the largest percentage increases in farmland values in recent years have occurred in the counties and crop-reporting districts in the state's interior. Historically, farmland along the state's eastern and western borders, near the Mississippi and Missouri Rivers, has recorded higher per-acre values, reflecting the premium that farmers received for their crops due to low transportation costs to gulf port markets. Now, however, the local demand for corn by ethanol plants in the interior of the state has driven up crop prices and, as a result, farmland prices in interior counties at a greater rate than in border counties (Iowa State University Extension, 2008).

Other spatial dimensions of the renewable fuels boom, however, are not well understood. While differing rates of increase in farmland values is one indicator of the consequences of biofuel firms' location decisions, the location decisions themselves — the relative importance of the location and supply of raw materials inputs, physical infrastructure, natural resources, and product markets in the site-selection process — are only now receiving attention through empirical research. Government policy and continued long-term growth in fuel consumption guarantee that significant levels of investments in the industry will continue for the foreseeable future.[1] Understanding the forces shaping the location decisions of biofuel firms, therefore, is critically important to state and local governments as they assess the degree to which they offer competitive advantages over other jurisdictions in attracting firms, and make choices about the nature and extent of economic development incentives they present to firms.

The objective of this study is to increase our understanding of the spatial dynamics of the biofuels industry by identifying local characteristics that influence the location of new ethanol plants. The overall question this paper addresses is: what location factors do firms take into account when it is time to locate ethanol plants? This study focuses on Illinois, Iowa, Minnesota and Nebraska, the four highest corn-producing states in the nation, and the four states that account for over 60 percent of the existing or planned corn-based ethanol plants in the nation. An analysis of the location decisions of the corn-based ethanol industry is timely because it offers an opportunity to understand the renewable fuels industry in its most advanced state. Other products - soybeans, sugar beets, sugar cane and grain sorghum, for example - can be transformed into renewable fuels, and researchers are continuing to advance science to make

[1] The early release of the 2009 Energy Outlook by the Energy Information Administration of the Department of Energy forecasts continued growth in fuel consumption through 2030 despite the current economic downturn, and that the increased demand will be met largely through domestic production of renewable fuels. http://www.eia.doe.gov/neic/press/press312.html

cellulosic ethanol from woods and grasses profitable. The information gained from the present study will be useful nationally as use of these alternative input sources increases and other regions of the country become viable locations for the next generation of biofuels firms. It is particularly valuable to policy-makers and economic development officials seeking to market the competitive advantages in their jurisdictions, and to invest limited infrastructure dollars in areas that will reap the greatest benefits.

This article proceeds in four parts. First, an overview of past literature addressing the location determinants of ethanol firms and other agro-industries is provided. Second, a conceptual framework incorporating classic location theory and its application to the biofuels industry is presented. Third, a series of probit regressions is utilized to explore the importance of a series of infrastructure, input, labor and market factors in determining the location of ethanol plants in the four-state study area. The results are examined state-by-state, and for significant variances between states. Finally the article concludes with a discussion of the implications of the results for economic development strategies, and suggestions of other areas for future research.

2. LITERATURE REVIEW

2.1 Agro-Industry Location Factors

In classic location theory, it is assumed that the ultimate goal of a firm in choosing a location is profit maximization. This is accomplished by finding a site that optimally balances the costs of production inputs, including the transport of those inputs to the firm, with the costs of shipping outputs (Blair & Premus, 1987; Woodward, 1992; Hack, 1999; Karakaya & Canel, 1998). The location choice of a particular firm therefore depends on the nature of inputs used, the market (geographic and socioeconomic) for outputs, and state and local government intervention (regulation, taxes, development incentives). Connor and Schiek (1997) observe that *supply-oriented firms* – firms for which inputs account for a high share of production costs – tend to locate near inputs to reduce procurement costs. *Demand-oriented firms* – firms for which transportation of finished goods accounts for a large share of firm costs – locate near the markets for their goods to decrease distribution costs. *Footloose firms* have cost structures that, for reasons specific to each firm, are dominated neither by production costs nor distribution costs. Footloose firms, therefore, choose locations that provide them the optimal mix of access to labor, capital, business services, transportation, supportive government fiscal policies and/or technology.

A significant body of literature has used classic location theory to understand the location decision of agro-industries – defined as those involved in processing agricultural raw materials, including ground and tree crops as well as livestock (Hsu, 1997). For example, Henderson and McNamara (1997) examined the factors that account for growth in food-processing industries in order to assess the potential for growth or expansion into rural communities. Using Ordinary Least Squares (OLS) methods, the authors explored the relationship between the change in the number of food-processing plants in 936 counties in the Corn Belt from 1987 to 1992 and a number of variables to measure product markets, product market access, labor, agglomeration, infrastructure, transportation, and local government fiscal policy. The results showed that supply-oriented firms tend to expand into areas with easy access to raw materials. Demand-oriented firms, on the other hand, placed greater emphasis on the transportation costs for shipping their outputs. Footloose firms were found to grow in low-cost communities where agglomeration economies associated with a concentration of manufacturing activity existed.

Lopez and Henderson (1989) studied firms that process vegetables, fruits, eggs, poultry, and seafood in five Mid-Atlantic states to identify significant locational factors among six general “business climate” attributes (market, infrastructure, labor, personal, environmental regulation, and government fiscal policy). Their findings showed that plant location choices were driven primarily by market and the adequacy of infrastructure. Fiscal policies such as taxes and development incentives were not found to be significant. They concluded that investments in infrastructure have the greatest potential to attract food-processing plants. Table 1 provides a summary of these and other selected studies that examine location determinants of agro-industry firms and the methods used.

[Table 1 about here]

2.2 Biofuels Industry Literature

Researchers only recently have begun to focus attention on the biofuels industry. Studies are beginning to appear that consider ethanol plant location for a number of purposes. In an unpublished research monograph Eathington and Swenson (2007) utilized geographic information systems (GIS) modeling techniques to evaluate the capacity of counties in Iowa to support ethanol plants beyond those operational at the time of the study. Using recent county corn-production numbers the authors looked at current demands for corn brought about by then-existing ethanol plants and livestock operations. They applied an additional limitation on future ethanol plant location by restricting potential sites to locations along rail lines or paved highways. Based solely on corn production, they speculated that Iowa could support 23 new ethanol plants in addition to the 36 plants in operation as of 2006.

Similarly, a study by Haddad, et al. (2009) assessed the capacity of Green County, Iowa to host additional biofuels plants. Using spatial data analysis and focusing on existing and planned ethanol plants, corn supply, land cover, and transportation networks in a nine-county study area, the study concluded that the county is close to reaching the saturation point for the industry.

Herbst, et al. (2003) evaluated the financial feasibility of ethanol production in four different regions of Texas using capital budgeting and simulation analysis. Capital budgets were developed for construction and operating costs for four alternative size dry milling plants, and using alternative price assumptions for feedstock, dry distillers grain (referred to as DDG – a by-product of the ethanol production process that has value as a livestock feed additive), and energy inputs. The results showed little economic incentive exists to entice equity investment in Texas ethanol production using corn in any region, but that only slight changes in market assumptions would be needed to project profitability.

In a recent research report Sarmiento and Wilson (2007) used logistic regression and spatial autocorrelation techniques to estimate factors impacting location decisions of corn-based ethanol plants in the United States. Using counties in the 48-contiguous states as the units of analysis, they focused on variables that are primarily agricultural in nature, addressing several measures of corn production, livestock inventory, ethanol production subsidies and spatial competition of ethanol plants for corn supplies. They found that counties with more acres planted to corn have a greater likelihood of attracting ethanol plants. They also found spatial competition to be of particular importance, with existing ethanol plants discouraging the location of subsequent plants in close proximity.

In sum, while ethanol firm location is considered in these and other studies, they provide limited insight into how firms weigh the broader range of factors that may impact the site selection process. This study is directed at filling this gap in the literature.

3. CONCEPTUAL FRAMEWORK

3.1 Ethanol Firm Location Factors

Location theory was used as a framework to analyze the location decisions of ethanol plant investments. We hypothesize that the biofuels industry is supply-oriented because the cost of acquiring and transporting the raw agricultural product represents a significant share of total production costs (Lopez & Henderson, 1989; Barkeley & McNamara, 1994; Henderson & McNamara, 1997; Sarmiento & Wilson, 2007). We also assume that the period of our analysis represents an early stage of industry development when firms are not severely constrained by the existence of competitors seeking the same inputs or supplying products to the same market areas (Greenhut, et al, 1987).

The literature cited above helps to identify many locational factors that may influence ethanol firm decision-making. Additional information on ethanol firm decision-making can also be found in biofuels trade publications written to inform industry officials and economic development professionals. Based on our review of this literature and knowledge of the ethanol industry gathered from informal interviews with ethanol industry officials, we assume that the following factors influence ethanol plant site selection:

Inputs include the physical resources that go into the production of the product. Corn is obviously a primary input for corn-based ethanol firms (Sarmiento & Wilson, 2007; Eathington & Swenson, 2006). With a standard ethanol-from corn conversion rate of 2.7 gallons per bushel, a 100 million gallons per year ethanol plant will require over 37 million bushels of corn annually to operate at maximum capacity.[2] As supply-oriented firms, it is expected that these plants are more likely to locate near abundant supplies of corn.

The cost and availability of energy for plant operation are also important inputs for ethanol firms; the expectation being that firms will seek out low cost energy supplies. (Clean Fuels Development Coalition, 2006; Kenkel and Holcomb, 2006; Dhuyvetter, et al., 2005). The availability of abundant water supplies for processing ethanol and for use in the cooking and cooling stages of production is also cited as a significant consideration (Higgins, Richardson & Outlaw, 2008; Zeman, 2006).

Infrastructure is the set of public and private facilities that support industry activities (Henderson & McNamara, 1997). Important infrastructure factors for the ethanol industry include access to highway and rail lines, access to natural gas pipelines and the electric power grid (Clean Fuels Development Coalition, 2006; Kenkel and Holcomb, 2006; Dhuyvetter, et al., 2005). The availability of inexpensive tracts of land of sufficient size to build an ethanol plant (and to support possible future expansion) is also included in the category of infrastructure (Clean Fuels Development Coalition, 2006). We expect that ethanol plants are more likely to locate in areas with convenient access to the appropriate mix of infrastructure.

Labor is the pool of workers with the appropriate training at the lowest-cost wage scale. Although the number of employees at each ethanol plant is relatively small, the workforce

---

[2] Although the ethanol plants in our dataset vary in output capacity, most plants that came into production between 2000 and 2007 were either large capacity plants (100 mgy) or smaller plants (40-50 mgy) that were pre-engineered for future expansion to twice the initial capacity (Ethanol Across America, 2006). We therefore assume that firms seeking to site plants during the time period of our study were basing their decisions on the needs of large capacity plants.

managing and operating a plant must be relatively well-educated (Pierce, Horner & Milhollin, 2007). It is expected that plants are more likely to locate in areas with a relatively well-educated workforce (Schmenner, Huber, & Cook, 1987; McNamara, Kriesel, & Deaton, 1988).

Output markets refer to places where products of the industry can be sold. Ethanol firms have two main outputs — ethanol and the by-product DDG — each of which is marketed differently. Almost all ethanol produced is sent to fuel-blending terminals to be mixed with gasoline for use as motor fuel. The lower value of DDG, coupled with its higher shipping costs, means that almost all of the by-product is sold locally to livestock producers (Sarmiento & Wilson, 2007; Herbst, et al., 2003). It is expected that ethanol plants are more likely to locate near the markets for these outputs to minimize transportation costs (Wheat, 1973).

Community concern refers to the fears of residents of problems of noise, odors, traffic, water quality and others arising from plant location and operation. It is assumed that plant location decisions are affected by the likelihood that citizens will oppose plant siting based on these concerns; i.e., the NIMBY (Not In My Back Yard) phenomenon (Clean Fuels Development Coalition, 2006).

3.2 Data Sources and Limitations

Table 2 identifies the independent variables used in the analysis, the data sources for these variables, and the expected signs for each variable. County-level data for the independent variables are selected from the years of the greatest increase in the number of sited ethanol plants (2000-2007), based on the assumption that these data represent the best information available to decision-makers siting plants at the time locations were being considered. Descriptive statistics for the variables used in the analysis are presented in Appendix 1. Our dependent variable is a dummy variable, *PLANT*, which takes a value of 1 if a county has one or more existing ethanol plants or plants under construction at the time of the study, and 0 otherwise. At the time of this study 86 counties in the study area were home to one or more plants (8 counties had two plants).[3]

[Table 2 about here]

The lack of available county-level data limited the number of variables used in our analysis. Detailed electricity rate data cannot be matched with corresponding geographic information for all potential suppliers (investor-owned companies, public utilities and cooperatives) across all four states to give us reliable county-level data.[4] In addition, information about the location of appropriately-sized transmission lines is proprietary to the companies, and efforts to collect the data were met with resistance. Finally, although we recognize water availability is a potentially significant factor in ethanol plant site selection, similar limitations exist in collecting groundwater data that is sufficiently detailed and at the same time consistent among states.

---

[3] The ethanol firms location data were collected from the following websites: Des Moines Register, Iowa Corn Promotion Board/Iowa Corn Growers Association, and Renewable Fuels Association. In addition, we looked at ethanol firms' websites, and called ethanol firm officials and city workers.

[4] With regard to natural gas prices, we learned through informal interviews with industry officials and utilities regulators that most industrial users, including ethanol firms, purchase natural gas on the wholesale market, rather than from local companies that supply residential and commercial consumers. Thus, natural gas *price* is not spatially-dependent, although *access* to pipelines remains a potentially-important location factor.

3.3 Study Area

The four Corn Belt states of Illinois, Iowa, Minnesota and Nebraska were chosen as the study area for several reasons. First, corn is currently the primary raw input used for ethanol production, and these states are consistently among the top corn-producing states in the nation. According to the 2002 Census of Agriculture, these states were the top four corn producing states during the previous growing season. Not coincidentally, these states are also at the forefront of the biofuels boom. As noted earlier, ethanol plants in these four states account for over 72 percent of the total United States ethanol production capacity (U.S. Department of Energy, 2008c). Finally, despite these commonalities there still exists considerable variation among the 381 counties in the four states, and among the four states themselves, in terms of corn productivity patterns, livestock inventories, urban vs. rural characteristics, and infrastructure development. For example, Figure 1 shows the location of existing and planned ethanol plants in the study area superimposed on a map of corn productivity by county. This map clearly illustrates the variation in corn production among counties considered to be in the heart of the Corn Belt.

[Figure 1 about here]

4. REGRESSION RESULTS

4.1 Aggregate Results

To identify the factors that help explain the location of ethanol plants, we estimate a series of probit regressions. After examining the variables for multicollinearity we eliminated the independent variable highway miles because of its high correlation with railroad miles. The resulting equation to be tested is:

$$(PLANT{=}1) = F(\beta_0 + \beta_1 CORN + \beta_2 PIPE + \beta_3 RR + \beta_4 LANDVALUE + \beta_5 EDUCATION + \beta_6 CATTLE + \beta_7 TERMINAL + \beta_8 POPDENSE)$$

Table 3, Column 1 presents results of our regression analyzing data for all 381 counties. The results are consistent with our characterization of ethanol firms as supply-oriented, in that corn is a significant factor influencing the location of ethanol plans in the study area. The dominance of corn as a factor in the location of ethanol plants also reflects a first-stage decision by firms to locate in the Corn Belt. This finding is consistent with a large body of literature on agro-business firms that suggests that location decisions in the industry are made in two stages (see e.g., Schmenner, Huber, & Cook, 1987; Woodward, 1992; Henderson & McNamara, 2000). In the first stage, the firm identifies a general region for investment based upon a set of favorable factors common to most locations within the region. Once the region with the preferred characteristics is identified, the firm moves to the second stage, searching for a specific site based on a favorable set of local factors different from those considered during the first stage. The decisions made during the second stage are independent of those made during the first stage. In other words, "what is important, and how it is important, varies considerably from one stage to the next" (Schmenner, Huber, & Cook, 1987, p. 101).

[Table 3 about here]

4.2 Individual State Results

Although this regression is helpful for identifying important location factors for the four-state region as a whole, state and local economic developers are more interested in identifying the factors that attract plants into their respective states. To achieve this objective, we run probit regressions for each of the four states. The full results of the state regressions are presented in Table 3, Columns 2 – 5 for Iowa, Minnesota, Nebraska and Illinois, respectively. It is worth noting at this point that corn – the factor of primary significance in the aggregate regression – is significant in only two of the four states in the study area. Corn is *not* significant in the Iowa or Illinois regressions, likely due to the fact that corn is largely ubiquitous in those two states (see Figure 1). These results substantiate our previous assertion that location decision-making for ethanol firms is a two-stage process. By choosing to locate in Iowa and Illinois, firms are already making the first-stage decision to locate near abundant supplies of corn and are now weighing local factors, while corn supply is still the factor of primary importance driving firms to counties in southern Minnesota and eastern Nebraska.

Iowa

Iowa has more operating and planned ethanol plants than any other state in the study area. The Iowa regression (Table 3, Column 2) identified railway lines ($p<0.01$) land values ($p<0.05$) and population density ($p<0.05$) as significant location factors for ethanol plants in the state. The nature of effect of railway lines and population density were as expected; that is, firms are seeking locations with access to rail lines, and seeking to avoid highly populated areas. The result with regard to land values, however, was contrary to our hypothesis. It is possible that land values in Iowa are more closely influenced by the land's agricultural productive capacity than by the effect of urbanization in those few counties experiencing significant growth. The narrow range between minimum and maximum land values in Iowa, in comparison to those in Minnesota and Illinois where high land values in many counties reflect urbanization of the Twin Cities and Chicago areas, tends to supports this theory (see Appendix 1) (see also Plantinga, Lubowski, & Stavins, 2002).

Minnesota

According to the regression for Minnesota (Table 3, Column 3) corn production ($p<0.01$), number of cattle ($p<0.05$), population density ($p<0.05$) and miles of gas pipeline ($p<0.10$) are significant location factors for plants in the state, and the nature of these effects are all consistent with our hypotheses. Many of the counties in northern Minnesota are low corn producers; thus firms are actively seeking to locate in the higher corn-producing counties of southern Minnesota. Within these counties with high corn productivity there is a concentration of cattle numbers that ethanol firms find to be attractive markets for DDG. At the same time, these firms are actively avoiding the seven-county Twin Cities metropolitan area where population densities are far above those found throughout the rest of the state. Proximity to gas pipelines also appears to be a mild influence on ethanol plant site selection.

Nebraska

In the Nebraska regression (Table 3, Column 4) corn proved to be the only statistically-significant factor ($p<0.01$) in the location decisions of ethanol plants in the state. The importance of corn in Nebraska is similar to the situation in Minnesota in that firms favor the high corn producing counties of eastern Nebraska over the low producing counties of western Nebraska. Unlike Minnesota, however, firms in Nebraska are not significantly influenced by population density, likely because Nebraska does not have a dominant metropolitan area like Minnesota's Twin Cities.

Illinois

The Illinois regression (Table 3, Column 5) presents yet another set of different and interesting results. Distance to ethanol blending terminals ($p<0.01$) is significant in the location decisions of ethanol plants in the state, and the nature of its effects was as predicted. Illinois is the state in our study area with the fewest blending terminals; thus it appears that ethanol firm decision-makers placed a premium on finding sites within close proximity to those terminals. It suggests that Illinois economic development officials interesting in attracting the ethanol industry may wish to take action to assist gasoline wholesale marketers to expand the number of blending terminals in the state.

The regression also showed that miles of natural gas pipeline ($p<0.05$) is significant; however, the finding that counties with more miles of natural gas pipelines are negatively associated with ethanol plant location is contrary to our hypothesis and inconsistent with results in Minnesota. One plausible explanation for this result is the fact that the variable pipeline miles per county, at least in Illinois, does not capture the true proximity of existing ethanol plants to existing pipelines. As Figure 2 illustrates, several of the plants in Illinois are located in counties with low observed values for pipeline miles, but the plants themselves border counties with high observed values. An examination of a map that shows the actual location of gas pipelines[5] confirms that these ethanol plants are, in fact, located close to the actual pipeline routes.

---

[5] When providing data, the U.S. Department of Transportation Office of Pipeline Safety limits user's rights to reproduce maps showing pipeline locations.

[Figure 2 about here]

4.3 State Interactions

In order to help state officials identify locational factors that offer their state competitive advantages (or disadvantages) relative to other states, a probit interaction regression is estimated to test whether the differences between the states are statistically significant. In the regression Iowa is used as the comparison state. Such a regression may suggest how a state can better target economic development efforts and incentives. For instance, if a firm is looking to locate a new plant in Iowa or Minnesota, state economic development officials in Iowa would like to know what factors currently make Iowa more attractive relative to Minnesota, and where economic development dollars could best be spent to overcome existing deficiencies. The summary results of the interaction model are presented in Table 4 (see Appendix 2 for the detailed results).

[Table 4 about here]

Iowa – Minnesota

The regression results for the Minnesota interactions suggest that, all else being equal, cattle, corn productivity, population density, and railway are statistically-significant to firms in Minnesota when compared to Iowa. The positive coefficients for cattle and corn reflect the fact that there are fewer counties with high agricultural productivity in Minnesota than in Iowa, thus making these factors significant in Minnesota when compared to Iowa. The negative coefficient for population density suggests that firms locating plants in Minnesota place a greater emphasis on avoiding highly populated areas. In contrast, firms locating in Iowa find access to rail lines to be a significant location factor when compared to those locating in Minnesota. This suggests that rail access is more widely available in Minnesota, and may indicate that incentives for building rail siding and acquiring sites with mainline access would be prudent investments of economic development dollars in Iowa.

Iowa – Nebraska

The Nebraska interactions show that corn productivity is statistically-significant in Nebraska in comparison to Iowa, again likely reflecting the greater difference in corn productivity among Nebraska counties than among Iowa counties, and the need for Nebraska economic development officials to direct ethanol firm decision-makers to eastern Nebraska locations. Land values shows marginal significance ($p<0.10$) in Iowa when compared to Nebraska. Population density is statistically significant to firms in Nebraska, when compared to Iowa, with the expected sign.

Iowa – Illinois

The Illinois interactions show the proximity to blending terminals is significant for firms locating in Illinois relative to those locating in Iowa, and suggests that Illinois economic development officials interesting in attracting ethanol plants may wish to consider incentives to petroleum companies to expand the number of blending terminals in the state. Population density shows marginal significance ($p<0.10$) in Iowa when compared to Illinois.

5. CONCLUSIONS AND FUTURE RESEARCH

This study confirms that the corn-based ethanol industry, like other agro-industries, exhibits the characteristics of a supply-oriented business. Firms have actively sought to minimize commodity acquisition costs by locating close to the source. Previous studies, however, also have found that agro-industries tend to locate in communities that are attractive to manufacturing firms generally, and that rural counties do not necessarily provide locational advantages for such industries simply because they are the loci of commodity supplies (see, e.g., Henderson & McNamara, 1997; Henderson & McNamara, 2000). While the present study does not contradict these previous results, it does suggest that rural counties are not disadvantaged when vying for corn-based ethanol industry investment. The high value that biofuel firms place on access to corn seems to favor these counties, while counties with higher population densities are not attractive to the industry, at least in two of the four states in our study area. Other factors such as education levels that favor more urban counties are not significant to ethanol plant siting decisions. Although the workforce managing and operating an ethanol plant must be relatively well-educated, the number employed at each ethanol plant is simply too small for the educational-attainment level of the workforce to be a factor in siting decisions.

The results examining the influence of output markets and infrastructure factors highlight the importance of conducting state-level and cross-state comparisons. Despite general perceptions to the contrary, the “Corn Belt” is not a homogeneous region when it comes to the factors commonly evaluated by firm decision-makers. Ethanol firms in Illinois are attracted to locations close to the few blending terminals found in the state, while firms seeking locations in Minnesota are attracted to the concentrations of livestock operations found in the corn-growing regions of the south. Similarly, the value firms place on land values and access to rail lines differ from state to state. These comparisons can help to inform a state economic development policy-maker of the competitive advantages/disadvantages her state may have relative to other states competing for the same private investment.

The dominance of corn as a factor in two of the four individual state regressions suggests that location decisions in the industry are made in two stages. In Iowa and Illinois, where corn is largely ubiquitous, our analysis shows that firms consider factors beyond corn supply in their decision-making process. In contrast, in Nebraska and Minnesota where corn production is primarily confined to distinct regions, the availability of corn remains a primary consideration in firm's decision to locate in these states. Future research that focuses on the two stages of the decision process independently would require a larger dataset and an expanded number of variables from that utilized in the present study, but would help economic development professionals in targeting appropriate incentives to different stages in the decision-making process.

Future research employing surveys of local government officials and ethanol plant executives could provide further insights into the influence that state and local economic development incentives actually have on plant siting. The literature is mixed on the influence of both types of incentives on industrial location decisions (Plaut & Pluta, 1983; Vesecky & Lins, 1995). We did not include variables representing state or local government incentives in our analysis. Although a number of states incentivize ethanol *consumption* with reduced taxes on ethanol blends, the incentive packages offered by state and local governments to attract ethanol firms - including grants, tax incentives and the extension of needed infrastructure - are highly-individualized (see, e.g., Brichacek, 2008; Food and Agricultural Policy Research Institute, 2008). Easily-accessed state- and county-level data generally cannot capture the individualized nature of these incentive packages.

While the present study focuses on the most advanced sector of the renewable fuels industry, it is nonetheless still an industry in transition. Kenkel and Holcomb (2006) suggest that while grain acquisition costs have driven the location of current plants, the long-run cost structure (including grain and by-product prices, utility costs and transportation economics on both the input and output sides) may play a greater role in firm location decisions in the future. Dhuyvetter et al. (2005) assert that the location of future ethanol plants will be dictated by rising natural gas and diesel fuel prices, and the advantages of locating future plants closer to the markets for wet distillers grains and dry distillers grains such as the High Plains regions of southwest Kansas and the Texas Panhandle. Because of groundwater contamination concerns refiners are moving away from MTBE and toward ethanol as the primary fuel additive required to meet Clean Air Act standards (McNew & Griffith, 2005). Because most of the cities subject to the most stringent standards are located on the coasts, this means that a large share of future ethanol production will either need to be shipped long distances, or production will need to be moved closer to those markets. Thus as market forces and technological advances continue to impact the dynamics of ethanol sales and production, the factors affecting the location of these firms will continue to be an important topic for the foreseeable future.

ACKNOWLEDGEMENTS

We specially thank Elizabeth Asiedu for her suggestions on the modeling, and three anonymous referees for their valuable comments. We would also like to thank Brad Schmidt and Bethany Wilcoxon for their valuable research assistance. The support by the Institute for Design, Research and Outreach is greatly appreciated.

REFERENCES

Association of State Energy Research & Technology Transfer Institutions. (2006). *Summary of state incentives for biofuels (Fall 2006)*. Retrieved January 2009 from http://www.asertti.org/committees/bioenergy/incentives_summary.pdf

Barkley, D., & McNamara, K.T. (1994). Manufacturers' location decisions: do surveys provide helpful insights? *International Regional Science Review, 17*(1), 23-47.

Biomass Research and Development Board. (2008). *National biofuels action plan 2008*. Retrieved January 2009 from http://www1.eere.energy.gov/biomass/pdfs/nbap.pdf

Blair, J.P., & Premus, R. (1987). Major factors in industrial location: A review. *Economic Development Quarterly, 1*(1), 72-85.

Brichacek, L. (2008, January 29). Wahoo OKs incentives for ethanol plant. *Omaha World-Herald.*

Capps, O., Fuller, S.W., & Nichols, J.P. (1998). Assessing opportunities in food and fiber processing distribution. *American Journal of Agricultural Economics, 70*(2), 462-468.

Clean Fuels Development Coalition & The Nebraska Ethanol Board. (2006). *A guide for evaluating the requirements for ethanol plants*. Sioux Falls, SD: American Coalition for Ethanol. Retrieved January 2008 from www.ethanol.org/pdf/contentmgmt/guide_for_evaluating_the_requirements_of_ethanol_plants.pdf

Capehart, T., Schnepf, R., & Yacobucci, B.D. (2008). *CRS report for Congress. Boiofuels provisions in the 2007 energy bill and the 2008 farm bill: A side-by-side comparison*.

Washington, D.C.: Congressional Research Service. Retrieved January 2009 from http://www.ncseonline.org/nle/crsreports/08July/RL34239.pdf

Connor, J., & Schiek, W. (1997). *Food processing: An industrial powerhouse in transition, 2nd edition*. New York: John Wiley & Sons.

Conway, R. & Erbach, D. (eds) (2004). The economics and rural development of bioenergy, In *The pros and cons of bioenergy: Pointing to the future*, Issue Paper No. 27, Ames, IA: Council of Agricultural Science and Technology.

Dhuyvetter, K.C., Kastens, T.L., & Boland, M. (2005). *The US ethanol industry: Where will it be located in the future?* Davis, CA: Agricultural Marketing Resource Center, University of California.

Eathington, L., & Swenson, D. (2006). *Ethanol plant location in Iowa – GIS modeling exercise.* Unpublished manuscript, Department of Economics, Iowa State University, Ames, IA.

Ethanol Across America. (2006). *Issue brief: Economic impacts of ethanol production*. Retrieved August 2008 from http://www.ethanolacrossamerica.net/CFDC_EconImpact.pdf.

Food and Agricultural Policy Research Institute. (2008). *State support for ethanol use and state demand for ethanol produced in the Midwest.* Colunbia, MO: University of Missouri Food and Agricultural Policy Research Institute.

Gallagher, P., Otto, D., Shapouri, H., Price, J., Schamel, G., Dikeman, M., and Brubacker. H. (2001). *The effects of expanding ethanol markets on ethanol production, feed markets,* *and the Iowa economy.* Staff Paper #342. Department of Economics, Iowa State University.

Greenhut, M.L., Norman, G. & Hung, C.-S. (1987). *The economics of imperfect competition: A spatial approach.* Cambridge, UK: Cambridge University Press.

Hack, G.D. (1999). *Site selection for growing companies, 1st edition.* Westport, CT: Quorum Books.

Haddad, M., Anderson, P., Thol, S., Hertel, C. & Schmidt R. (2009). Assessing the future of the bioeconomy in Greene County, Iowa. *Journal of Rural and Community Development, 4(1), TBD.*

Henderson, J.R., & McNamara, K.T. (1997). Community attributes influencing local food processing growth in the US Corn Belt. *Canadian Journal of Agricultural Economics, 45*(3), 235-250.

Henderson, J.R., & McNamara, K.T. (2000). The location of food manufacturing plant investments in Corn Belt counties. *Journal of Agricultural and Resource Economics, 25*(2), 680-697.

Hendrick, S. (2008). Biofuels drive rural development. Washington, D.C.: National Conference of State Legislatures.

Herbst, B.K., Outlaw, J.L., Anderson, D.P., Klose, S.L., and Richardson, J.W. (2003). The feasibility of ethanol production in Texas. Paper presented at Southern Agricultural Economics Association 35th Annual Meeting, Mobile, AL, February 1-5.

Higgins, L.M., Richardson, J.W., and Outlaw, J.L. (2008). The potential impact of a Texas high plains ethanol plant on local water supplies. Paper presented at the American Agricultural Economics association Annual Meeting, Orlando, FL, July 27-29.

Hsu, S. (1997). The agroindustry: a neglected aspect of the location theory of manufacturing. *Journal of Regional Science, 37*(2), 259-274.

Iowa State University Extension. (2008). *Iowa land value survey*. Ames, IA: Iowa State University Extension. Retrieved January 2008 from www.extension.iastate.edu/landvalue/

Karakaya, F., & Canel, C. (1998). Underlying dimensions of business location decisions. *Industrial Management and Data Systems, 98*(7), 321-329.

Kenkel, P., & Holcomb, R.B. (2006). Challenges to producer ownership of ethanol and biodiesel production facilities. *Journal of Agricultural & Applied Economics, 38*(2), 369-375.

Leistritz, L.F. (1992). Agribusiness firms: location determinants and economic contribution. *Agribusiness, 8*(4), 273-286.

Lopez, R.A., & Henderson, N.R. (1989). The determinants of location choices for food processing plants. *Agribusiness, 5*(6), 619-632.

Lugar, R., & Woolsey, R.J. (1999). The new petroleum. *Foreign Affairs, 78*(1), 88-102.

McNamara, K.T., Kriesel, K.T., & Deaton, B. (1988). Manufacturing location: The impact of human capital stocks and flows. *Review of Regional Studies, 18*(1), 42-47.

McNew, K. & Griffith, D. (2005). Measuring the impact of ethanol plants on local grain prices. *Review of Agricultural Economics, 27*(2), 164-180.

Perkins, J. (2008, January 22). Iowa farmland prices rose nearly 23% in 2007. *The Des Moines Register.*

Pierce, V., Horner, J. & Milhollin, R., (2007). Employment and economic benefits of ethanol production in Missouri. Columbia, MO: University of Missouri Extension Commercial Agriculture Program.

Plantinga, A.J., Lubowski, R.N., & Stavins, R.N. (2002). The effects of potential land development on agricultural land prices. *Journal of Urban Economics, 52*(3), 561-581.

Plaut, T.R., & Pluta, J.E. (1983). Business climate, taxes and expenditures, and state industrial growth in the United States. *Southern Economic Journal, 50*(1), 99-119.

Rask, K.N. (1998). Clean air and renewable fuels: the market for fuel ethanol in the U.S. from 1984 to 1993. *Energy Economics 20*(3), 325-345.

Renewable Fuels Association. (2008). *Changing the climate: Ethanol industry outlook 2008*. Washington, DC: Renewable Fuels Association. Retrieved January 2009 from http://www.ethanolrfa.org/objects/pdf/outlook/RFA_Outlook_2008.pdf

Sarmiento, C., & Wilson, W.W. (2007). *Spatial competition and ethanol plant location decisions. Agribusiness and Applied Economics Report No. 604*. Fargo, ND: North Dakota State University Department of Agribusiness and Applied Economics.

Schmenner, R. W., Huber, J.C., & Cook, R.L. (1987). Geographic differences and the location of new manufacturing facilities. *Journal of Urban Economics, 21*(1), 83-104.

U.S. Department of Energy (2008a). *2007 year in review. U.S. ethanol industry: The next inflection point.* Washington, D.C.: Office of Energy Efficiency and Renewable Energy. Retrieved January 2009 from http://www1.eere.energy.gov/biomass/pdfs/2007ethanolreview.pdf

_____. (2008b). *Federal biomass policy*. Washington, D.C.: Office of Energy Efficiency and Renewable Energy Biomass Program. Retrieved January 2009 from http://www1.eere.energy.gov/biomass/federal_biomass.html#alcoholfuels

_____. (2008c). *Renewable energy data book.* Washington, D.C.: Office of Energy Efficiency and Renewable Energy. Retrieved January 2009 from http://www1.eere.energy.gov/maps_data/pdfs/eere_databook_091208.pdf

U.S. Environmental Protection Agency (2007). *Greenhouse gas impacts of expanded renewable and alternative fuels use.* Washington, D.C.: Office of Transportation and Air Quality. Retrieved January 2009 from http://www.epa.gov/otaq/renewablefuels/420f07035.pdf

Vesecky, M., & Lins, D. (1995). Factors influencing expansion and contraction decisions by Illinois agribusiness firms. *Agribusiness, 11*(5), 405-413.

Wheat, L.F. (1973). *Regional growth and industrial location*. Lexington, MA: Lexington Books.

Winkler-Stirm, J.E., & St-Pierre, N.R. (2003). Identification and characterization of location decision factors for relocating dairy farms. *Journal of Dairy Science, 86*(11), 3473-3487.

Woodward, D.P. (1992). Locational determinants of Japanese manufacturing start-ups in the United States. *Southern Economic Journal, 58*(3), 690-708.

Zeman, N. (2006). Running dry? *Ethanol Producer Magazine*, October.

Table 1: Summary of studies focusing on locational factors of agro- and other industries

Author(s)	Industry	Locational Factors	Methodology
Schmenner et al. (1987)	Manufacturing	Inputs, government, geography, demographic factors , type of product, mission of plant, production process	Survey, regressions
Capps et al. (1998)	Food and fiber processing	Material, market, technology, policy consideration	Econometric models
Lopez and Henderson (1989)	Food processing	Market, infrastructure, labor, personal, environmental, fiscal policies	Survey
Leistritz (1992)	Agribusiness	Labor, labor availability, transportation, markets, utilities, quality of life, higher education, state and local taxes, incentives and infrastructure	Survey
Woodward (1992)	Japanese manufacturing firms in US	*State level:* market, unionization, unemployment benefits, climate, taxes, geography *County level:* agglomeration, population density, infrastructure, wages, demographics, education, taxes, unemployment, poverty	Econometric models
Barkeley and McNamara (1994)	Manufacturing firms	*Regional factors:* proximity to inputs and output markets, labor availability and costs, taxes, government incentives, quality of life *Local factors:* labor, education, land, existing facilities, proximity to markets, proximity to schools, proximity to airports, proximity to metro areas, water and waste facilities, local government incentives, housing, recreation	Survey, regressions
Vesecky and Lins (1995)	Agribusiness	Markets, infrastructure, inputs, environmental, government incentives, taxes	Survey
Henderson and McNamara (1997)	Food processing	Raw material market access, product material market access, labor, agglomeration, infrastructure, fiscal policy	Econometric models
Henderson and McNamara (2000)	Food manufacturing	Market, labor, infrastructure, agglomeration, fiscal policies	Econometric models
Winkler Stirm and St-Pierre (2003)	Dairy farms	Natural resources, waste management, public perception, marketing, tax structure and economic incentives, infrastructure	Survey

Table 2: Independent variable definitions, expected signs, and data sources.

Locational Factor	Independent Variable	Description	Hypothesis	Expected Sign	Source	Year of Data
Input	*CORN*	Total number bushels of corn per county	Counties with high corn productivity are more attractive to biofuel plants.	+	Census of Agriculture: National Agricultural Statistics Service	2002
Infrastructure	*PIPE*	Gas pipeline miles per county	Counties with more miles of gas pipeline are more attractive to biofuel plants.	+	U.S. Dept. of Transportation, Office of Pipeline Safety	2007
	RR	Railroad miles per county	Counties with more miles of railroad are more attractive to biofuel plants.	+	U.S. Dept. of Transportation, Bureau of Transportation Statistics	2007
	LANDVALUE	Estimated market value of undeveloped land and buildings	Counties with high land values are less attractive to biofuel plants.	−	Census of Agriculture: National Agricultural Statistics Service	2002
Labor	*EDUCATION*	Percentage of county population with 4-year degree	Counties with highly educated population are more attractive to biofuel plants.	+	U.S. Bureau of Labor Statistics	2000
Market	*CATTLE*	Total inventory of cattle and calves per county	Counties with high numbers of cattle and calves are more attractive to biofuel plants as market for DDG.	+	Census of Agriculture: National Agricultural Statistics Service	2002
	TERMINAL[a]	Distance from county centroid to ethanol blending terminals	As distance from ethanol blending terminals increases, the less attractive the location becomes for biofuel plants.	−	Energy Supply Logistics U.S. Department of Energy, Energy Information Admin.	2007
Community Concern	*POPDENSE*	Population density per square mile	Counties with high population densities are less attractive to biofuel plants.	−	U.S. Census Bureau	2000

[a] Data collected from website of the Energy Information Administration of the U.S. Department of Energy (www.eia.doe.gov) and a private firm – Energy Supply Logistics –confirmed that the vast majority of blending terminals mapped and used in the study predated the location of the ethanol firms the authors used as dependent variables.

Table 3: Probit Regression: Estimated Coefficients

	(1)	(2)	(3)	(4)	(5)
Variables	**All**	**Iowa**	**Minnesota**	**Nebraska**	**Illinois**
Pipe	-0.000418	0.000126	0.00313*	0.000456	-0.00150**
	(0.174)	(0.859)	(0.062)	(0.494)	(0.039)
Rr	-0.000229	0.0136***	-0.00148	0.00281	0.00566
	(0.887)	(0.005)	(0.556)	(0.545)	(0.209)
Landvalue	-0.151	1.026**	1.098	-0.321	0.396
	(0.335)	(0.039)	(0.165)	(0.543)	(0.385)
Education	0.00391	0.0458	0.101	-0.0495	-0.094
	(0.891)	(0.357)	(0.180)	(0.595)	(0.195)
Corn	0.0720***	0.00508	0.0880***	0.139***	0.0248
	(2.8e-10)	(0.859)	(0.003)	(8.9e-5)	(0.303)
Cattle	0.0191	0.0279	0.217**	-0.0609	0.208
	(0.332)	(0.560)	(0.0127)	(0.123)	(0.151)
Terminal	-0.00632	-0.00342	-0.0019	-0.00245	-0.0439***
	(0.127)	(0.666)	(0.873)	(0.783)	(0.008)
Popdense	-0.104	-5.245**	-20.06**	0.241	-0.567
	(0.822)	(0.036)	(0.012)	(0.833)	(0.296)
Constant	-1.346***	-3.808***	-4.873***	-1.34	-0.88
	(0.001)	(0.000)	(0.005)	(0.244)	(0.373)
Observations	381	99	87	93	102
Chi2	65.01	25.52	42.28	34.04	22.34
Prob > chi2	0.000	0.001	0.000	0.000	0.004

Robust p values in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 4: Summary table, comparing to Iowa (see appendix 2)

Variables	**Minnesota**	**Nebraska**	**Illinois**
Constant	0	0	neg***
Pipe	pos*	0	0
Rr	neg***	0	0
Corn	pos**	pos***	0
land value	0	neg*	0
Education	0	0	0
Cattle	pos*	0	0
Terminal	0	0	neg**
Popdense	neg*	pos**	pos*

Robust p values in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Appendix 1: Summary statistics of independent variables

Variable	Mean	Std. Dev.	Min	Max
All States (n=381)				
Pipe	324.6766	381.6797	0	3923.473
Rr	91.09102	90.24586	0	1115.73
Landvalue	1.845966	1.279472	.195	19.011
Education	10.84964	3.521597	4.559	27.147
Corn	13.56393	10.16938	0	48.332
Cattle	3.507564	3.94749	0	29.154
Terminal	37.03107	21.35818	0	98.3907
Popdense	.1485724	.5921013	.001	8.7449
Iowa (n=99)				
Pipe	344.588	219.8166	0	1011.273
Rr	80.0305	40.6234	17.01	239.16
Landvalue	1.982444	.4627621	.926	3.003
Education	10.75542	3.236601	7.446	26.953
Corn	18.69974	8.261169	2.784	45.744
Cattle	3.571737	2.789792	.486	22.165
Terminal	43.30162	20.23115	.8975	86.4735
Popdense	.0806455	.1284168	.0159	.9896
Minnesota (n=87)				
Pipe	179.3511	161.9485	0	934.988
Rr	94.78655	105.9602	1.32	945.71
Landvalue	1.916931	2.104608	.524	19.011
Education	11.50962	3.920814	6.419	25.928
Corn	11.37769	10.33986	0	40.263
Cattle	2.604287	2.49841	0	17.493
Terminal	36.54756	21.32523	0	98.3907
Popdense	.1776977	.5980905	.004	4.6973
Nebraska (n=93)				
Pipe	257.6759	280.0696	0	1503.221
Rr	65.55796	47.0615	0	276.57
Landvalue	1.005935	.7003933	.195	3.9
Education	11.00833	2.590727	6.61	19.874
Corn	9.765151	8.310492	0	31.491
Cattle	6.669892	5.72009	.736	29.154
Terminal	36.87529	25.70439	0	97.7957
Popdense	.0588946	.236562	.001	2.1307
Illinois (n=102)				
Pipe	490.394	597.4838	0	3923.473
Rr	121.9543	125.5757	0	1115.73
Landvalue	2.418882	.8539238	1.155	6.286
Education	10.23345	4.062168	4.559	27.147
Corn	13.9075	11.20485	.174	48.332
Cattle	1.332422	1.124331	.007	5.725
Terminal	31.49939	16.13739	.4893	71.0157
Popdense	.2714245	.9589399	.0096	8.7449

OBS: In order to have comparable magnitude for the coefficients in the regression models, the original values *Landvalue*, *Corn* and *Cattle* were divided by 1,000, 1,000,000 and 10,000 respectively.

Appendix 2: Interaction Results

Variables	*Coefficients*	*Robust p values*
Pipe	0.000126	(0.859)
Rr	0.0136***	(0.00499)
Corn	0.00508	(0.859)
Landvalue	1.026**	(0.0386)
Education	0.0458	(0.355)
Cattle	0.0279	(0.559)
Terminal	-0.00342	(0.665)
Popdense	-5.245**	(0.0354)
Ne	2.468	(0.111)
Mn	-1.064	(0.595)
Il	2.929**	(0.0409)
Nepipe	0.00033	(0.734)
Nerr	-0.0108	(0.107)
Necorn	0.134***	(0.00319)
Nelandvalue	-1.347*	(0.0623)
Needucation	-0.0954	(0.364)
Necattle	-0.0887	(0.151)
NEterminal	0.000967	(0.935)
Nepopdense	5.486**	(0.0452)
Mnpipe	0.00300*	(0.0979)
MNrr	-0.0151***	(0.00567)
Mncorn	0.0829**	(0.044)
Mnlandvalue	0.0728	(0.938)
Mneducation	0.0553	(0.539)
MNcattle	0.189*	(0.0559)
MNterminal	0.00152	(0.915)
Mnpopodense	-14.82*	(0.0763)
Ilpipe	-0.00163	(0.109)
Ilrr	-0.00794	(0.229)
Ilcorn	0.0197	(0.597)
Illandvalue	-0.63	(0.349)
Ileducation	-0.14	(0.111)
Ilcattle	0.18	(0.236)
ILterminal	-0.0405**	(0.0273)
Ilpopdense	4.678*	(0.0667)
Constant	-3.808***	(0.000255)
Observations	381	

Note:***p<0.01, **p<0.05, *p<0.1