Local Geography of Row-Crop Quality Land and Cropland Cash Rental Rates

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Motivation

LAND IS AN IMMOBILE factor of production while tenant farmers, who typically own some land, are also generally tethered to their operation base. Economic efficiency has required larger and more expensive machines, while genetically modified seeds and other innovations have enabled farmers to operate more acres. Farmers need to spread operation costs over a large acreage base in order to survive. Since agricultural machinery is costly to transport, less fragmented land allows farmers to reduce production costs. For these reasons, farmland rental markets are likely to be spatially differentiated.

Presumably, while land scarcity near a tenant's farming operation endows the landlord with some bargaining power, more dispersion in row-crop quality land will lower cash rents. This is because dispersion increases both i) operating costs and so reduces tenant demand, ii) tenant bargaining power. Within this theory-of-firm framework, the objective of this study is to provide a rigorous empirical understanding of the effect of land spatial heterogeneity on cash rental rates. We focus on Iowa because that state has collected state-wide parcel-level measures of land quality in row-crop uses and also because county-level data on cropland rents are available since the 1980s. Cash rental rates for the 83 counties in 2009 are shown in Figure 1. The 16 counties in the state's southeast corner are omitted because of data limitations.

The issue of local geography has been largely neglected in the agricultural land rent literature. In the related literature seeking to quantify the incidence of government subsidies on farmland cash rental rates, several studies find low pass-through, in the range of $0.13-$0.57 per acre for a $1 additional government payment (e.g., Lence and Mishra 2003). Based on county-level rental market concentration measures, Kirwan (2009) suggests that imperfectly competitive rental markets may play a role in incomplete cash rent pass-through. In this study we seek to evaluate how spatial fragmentation in row-crop quality land affects competition for such land, and so affects cash rental rates.

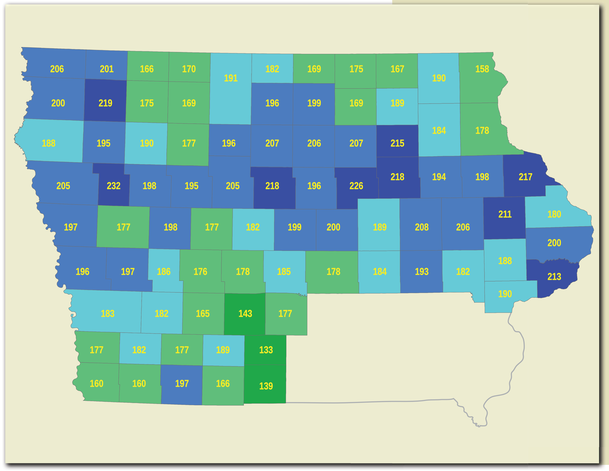

Figure 1. Cash rental rates in 2009

Spatial Heterogeneity Measure

THE LACUNARITY INDEX IS employed to measure spatial heterogeneity of land quality. In this study a land lacunarity index is built directly upon a soil quality measure, the land parcel's corn suitability rating index (CSR). The chosen measure is strongly correlated but qualitatively different from indices based on land cover data, which reflect farmers' crop choices and thus are endogeneously determined with cash rents.

The commonly applied "gliding box" algorithm is used for calculation. Basically, a gliding box of a given size r (the side of a square box), is first placed at one corner of a landscape. Then the box mass $S(r)$, the sum of the values of the pixels within the box, is determined. The box is systematically moved through the landscape one pixel (cell) at a time and the box mass is determined for each of these overlapping boxes. Lacunarity for box size r is defined as $1+\text{var}[S(r)]/(E[S(r)])^2$, where $E[S(r)]$ is the mean and $\text{var}[S(r)]$ the variance of the box mass values for box size r. A high lacunarity value indicates a more heterogeneous landscape with the cropland plots being less clustered. The lacunarity indices for the selected 83 counties in Iowa are shown in Figure 2.

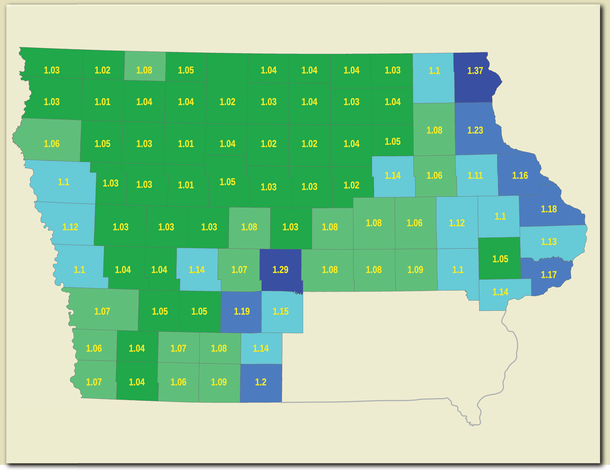

Figure 2. Lacunarity indices of selected counties in Iowa

Empirical Model

WE PROPOSE A PANEL data random effect model to quantify the impact of spatial distribution of land fragmentation on land cash rents, which is denoted by y_{it}. Annual survey data of Iowa crop land cash rental rates over 1987-2009 are employed. Cash rents are modeled as a function of *i*) regional effects $\alpha_i = \mu L_i + \lambda Z_i$, where L_i denotes the lacunarity measure and Z_i represents a vector of regional characteristics, *ii*) temporal effects of related prices P_t, and *iii*) a set of explanatory variables X_{it}:

$$(1)\quad y_{it} = \mu L_i + \lambda Z_i + \beta P_t + \phi X_{it} + \varepsilon_{it},\ \varepsilon_{it} \sim N(0,\sigma_\varepsilon^2);\quad i \in \{1,2,\dots,n\};\ t \in \{1,\dots,T\}.$$

For each county, average soil quality is included in variable vector Z. Prices of corn, soybean, nitrogen fertilizer, seed and agricultural chemicals are included as the major input/output prices. Explanatory variables include other important crop/land demand factors such as livestock production, market closeness, government subsidies, and ethanol production. The error terms ε_{it} are assumed to be independently and normally distributed with mean 0 and variance σ_ε^2. Our testable hypothesis is that $\mu<0$.

One complication for estimation is that input/output prices are likely simultaneously determined and endogenous. To correct for endogeneity bias, we define a set of instrumental variables for the prices and specify a simultaneous system to apply the two-stage estimation method. Fitted values of the system equations substitute for the input/output prices in Equation (1) to correct for endogeneity biases. Table 1 presents the estimation results for Equation (1).

Table 1. Estimation Results for Panel Random Effect Model in Equation 1

Variable	Estimate	Variable	Estimate
ln(output price)†	0.46***	Scale of livestock industry	0.006
ln(fertilizer price)†	-0.21***	Ethanol plant effect†	0.002
ln(seed price)†	-0.07*	Urbanization effect	-0.007***
ln(ag chemicals price)†	-0.003	Expected subsidies	0.001
Soil quality (*CSR*)	0.003**	GMO adoption	0.0007***
Location effect before 2005	-0.0002	Lacunarity index (μ)	-0.37***
t	0.02***	Constant	4.59***
Adjusted R^2	0.66		

Notes: (1) † indicates that variables have been instrumented.
(2) Single (*), double (**), and triple (***) asterisks denote significance at the 0.10, 0.05, and 0.01 levels, respectively.

Results

AS EXPECTED, LAND SPATIAL heterogeneity has a statistically significant and negative effect on local cash rent rates. The effect's origin warrants further research. We hypothesize that two factors are particularly relevant: local transportation infrastructure, which could be represented by rural road density, and access to markets. The finding has important implications for agricultural policy. Commodity program payments are mailed to and intended for agricultural operators, rather than land owners. Standard economic analysis has long maintained that, since land is viewed as the essential input most inelastic in supply, most program payments and shifts in supply/demand functions would eventually pass through to landowners. However a large variety of pass-through studies have identified incomplete pass-through, where much of the effect rests with land operators. Why this is the case is not at all clear. We suggest that tenants are not nearly so elastic in supply as has been assumed. Our novel test of this theory is to instrument tenant competition by the spatial distribution of row-crop grade land.

References:

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Lence, S.H., and A.K. Mishra. 2003. The Impacts of Different Farm Programs on Cash Rents. *American Journal of Agricultural Economics* 85:753–761.