How Spatially Clustered are State-level Farmland Values?

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ABSTRACT

Farmland values are influenced by productivity levels, prices of pertinent crops, farm incomes, urban sprawl, and external investment pressure. Since cropping systems in a given region are similar to adjacent regions and soil productivity indexes change slowly across regions, it was expected that farmland values are spatially clustered even at the state level. We tested spatial correlation on US state-level farmland values from 1950 to 2014. Spatial correlation was detected in farmland values and percent changes in farmland values. These results indicate that traditional analysis techniques that ignore values of neighboring states may be dominated by advanced spatial analysis. Evaluation of state-level farmland values provide appraisers with insights into how a shock to farmland values impact values in surrounding states. Future analyses will validate these results by examining available sub-state and county-level data.

Introduction

Farmland values are a constant focus for farmers, investors, farm managers, rural appraisers, and agricultural economists. The value of a specific farm field is expected to be a function of the productivity, prices of crops potentially grown, endowed wealth of nearby farmers, topography, access to water, demand for non-agricultural uses, and other external factors. Many of these factors suggest the location of the farm field is intrinsic to its value just as with any other type of real estate.



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The sales comparison or market approach to valuing real estate takes into consideration the location of the property when determining value. Unless the potential comparable sale has similar characteristics to the property under evaluation, the potential comparable property won't be used in the analysis. Distance from the property under evaluation is a key factor of whether a comparable is used. Utilizing spatial methods could help to clearly identify potential comparable properties, especially in areas where land rarely moves.

Ibendahl and Griffin (2013) evaluated farmland values and rental rates for several US states across time but did not test for any spatial effects. Farmland values are known to be correlated over time; Griffin (2010) used an Arkansas specific subset of the United States' dataset to create indexes of farmland values over time. Although it is understood that spatial location of farm fields have large impact on farmland values, most recent studies have focused on time trends rather than across geographic regions (Ibendahl & Griffin, 2013; Schurle et al., 2013; Kuethe et al., 2013; Paulson, 2013; Nickerson et al., 2012). Several studies evaluated spatial effects of farmland values and rents (Boisvert et al., 1997; Cotteleer et al., 2008; Hite et al., 2006; Huang et al., 2006; Lambert & Griffin, 2004; Schilling et al., 2013; Wang, 2013; Woodard et al., 2010) typically using some sort of hedonic pricing model in a spatial context. Schilling et al. (2013) showed spatial correlation in farmland values in New Jersey, but no spatial effects in the residuals of the fully specified model. Given the prevalence of time series analysis to farmland values which are assumed to be impacted by spatial effects, we evaluated an exploratory spatial analysis of farmland values to determine if in fact advanced spatial analyses should be the norm.

The objective of this study was to determine how spatially correlated farmland values and changes in farmland values are at the state-level. We evaluated only the variable itself without any regard for any additional explanatory variables or model specification to test how farmland values differ across the United States. Results from this study will direct future research on farmland values regarding acceptable analysis techniques.

Data and Analysis

Spatial correlation was tested on state-level, US agricultural land (including buildings) henceforth referred to as farmland values. Sixty-five years of farmland values from the lower 48 states were acquired from USDA NASS via QuickStats (USDA NASS, 2014) from 1950 to 2014. Percent changes in farmland values were calculated by differencing consecutive years and dividing by the value in the earlier year (Equation 1). Farmland values for 2014 were mapped (Figure 1) as an example.

(1) $$\text{percent change} = \frac{\text{current value} - \text{previous value}}{\text{previous value}}$$

Results

Significant spatial correlation among states (see Appendix for additional detail) exists (Figure 3) indicating that traditional analyses may not be appropriate. Spatial correlation indicates how closely related values are given their relative geographic location. Spatial correlation values range from 1 to about -1. When spatial correlation equals 1 then the values are perfectly clustered such that high values are close together and low values are clustered together. When spatial correlation equals -1 then high values are close to low values; an example would be the black and red squares of a checkerboard. When spatial correlation is near 0, then the values are not clustered but are randomly dispersed. The spatial correlation based on first, second, and third order contiguity were statistically significant for all years although the statistic has lower value as order increased indicating spatial correlation exists beyond immediate neighbors but with lower impacts (Figure 4, Figure 5, Figure 6).

Since farmland values themselves were spatially correlated, the percent change in farmland values were evaluated. Similar to farmland values, percent changes in farmland values were strongly correlated between states (Figure 3). Relative to the spatial correlation for farmland values, the spatial correlation for percentage difference in farmland values were more erratic indicating that some changes in farmland values may have occurred together in some years and sporadically in other years. The erratic behavior of percentage difference in farmland values may have been in response to a recent shock to farmland values that had not found equilibrium indicating a ripple effect radiating from the origin of the shock.

Discussion

The a priori expectations for farmland values were to be spatially correlated across the region. Diagnostics indicated that spatial correlation existed in the data itself, suggesting that advanced spatial analysis techniques should be used to evaluate farmland values. We have shown that the connectedness of farmland values has further reach than merely immediate neighbors although the linkages weaken as distance or contiguity increases. Our results also indicate that the spatial correlation in farmland value changes is more erratic than for farmland values themselves that tend to be "sticky".

Implications for Appraisers

Rural appraisers strive to find geographically nearby properties to use as a comparable. The question often arises as to "how close is close enough" regarding selecting comparison properties. Although it is intuitive that geographically closer properties have more in common than properties further apart, the distance decay function is not well understood, i.e., how quickly similarities diminish as distance increases. Furthermore, when a shock to the farm real estate market occurs, such as a record high cash rent bid, appraisers often consider how quickly and how far away the shock impacts the whole system. Results presented here indicate that although weaker than first order neighbors, second and third order state-level neighbors still have statistically significant correlation across space; sales in one location can impact values across state lines. Future research evaluating county-level and field-level values is being conducted to address the spatial correlation at differing spatial scales in an effort to identify how shocks impact farmland values. It is known that shocks to farmland values and rental rates cause ripple effects throughout large regions with nearby properties being influenced more quickly and with greater impact; but to what extent is largely unknown.

Implications for Researchers

Researchers evaluating farmland values or rental rates without addressing spatial effects may arrive at under or over-stated conclusions by not taking into account available information regarding how values are impacted across geographic areas. A sizable portion of prior research ignored the spatial component of farmland values. We have shown that at least on the surface, advanced spatial analyses may be required for evaluation of farmland values. However, advanced spatial statistical methods may be needed pending additional diagnostics for the research at hand; but this can only be determined once the researcher defines the research problem. To address issues regarding scale with respect to spatial effects in the future, county-level data from select states' farm business management programs will be evaluated for spatial clustering.

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Methodology Appendix

Spatial analyses rely upon a set of neighbors to be defined. For our purposes, a queen contiguity neighborhood structure was chosen. The terminology of queen contiguity is based on the game of chess; with "a queen defines a location's neighbors as those with either a shared border or vertex (in contrast to a rook contiguity, which only includes shared borders)" (GeoDa Center, 2014). First, second, and third order queen contiguity definitions were created for the lower 48 states. Each definition did not include lower order neighbors. The first order queen contiguity defined states to be neighbors if they share a common border or corner with another state, and are considered the immediate neighbors. The second order queen contiguity included neighbors of neighbors but not the immediate neighbors themselves. The third order matrix included neighbors of neighbors of neighbors but not the first order or second order neighbors.

As an example of contiguity, consider the state of Iowa. Iowa has six immediate neighbors sharing a border including Illinois, Minnesota, Missouri, Nebraska, South Dakota, and Wisconsin (Figure 2). Iowa has 11 second order neighbors and 13 third order neighbors. The second order neighbors include Arkansas, Colorado, Indiana, Kansas, Kentucky, Michigan, Montana, North Dakota, Oklahoma, Tennessee, and Wyoming (Figure 2). The third order neighbors are neighbors of second order neighbors. Notice that Arizona is a neighbor of Colorado even though it only shares a corner or vertex.

The US map data stored 48 shapes comprised of the lower 48 states excluding the District of Columbia. As the order of contiguity increases, so does the connectedness although neighbors were not immediately connected. Given the 48 states, the average number of connections or links was 4.46 for the first order queen, 7.33 for the second order, and 8.9 for the third order continuity definition (Table 1).

The Moran's *I* test statistic (Eq. A1) tests for global spatial autocorrelation in a random variable (Anselin, 1988; Cliff & Ord, 1981) and is given by:

(A1) $$I = \frac{n}{S_o} \frac{\mathbf{x}'\mathbf{W}\mathbf{x}}{\mathbf{x}'\mathbf{x}}$$

where x is an $n \times 1$ vector of deviations from the mean, W is an $n \times n$ spatial weights matrix as before and S_o is the sum of the elements of W (Anselin, 1988; Cliff and Ord, 1981). If Moran's *I* is positive, neighboring values are interpreted as being large (small), if it is negative neighboring values are both large and small, and if zero the distribution is spatially random. Moran's *I* test statistic of OLS residuals indicates whether estimation could be improved by correcting for spatial structure in the data. Moran's I has upper bound equal to 1 and a lower bound near -1.

Figure 1. Map of 2014 US State-level Farmland Values

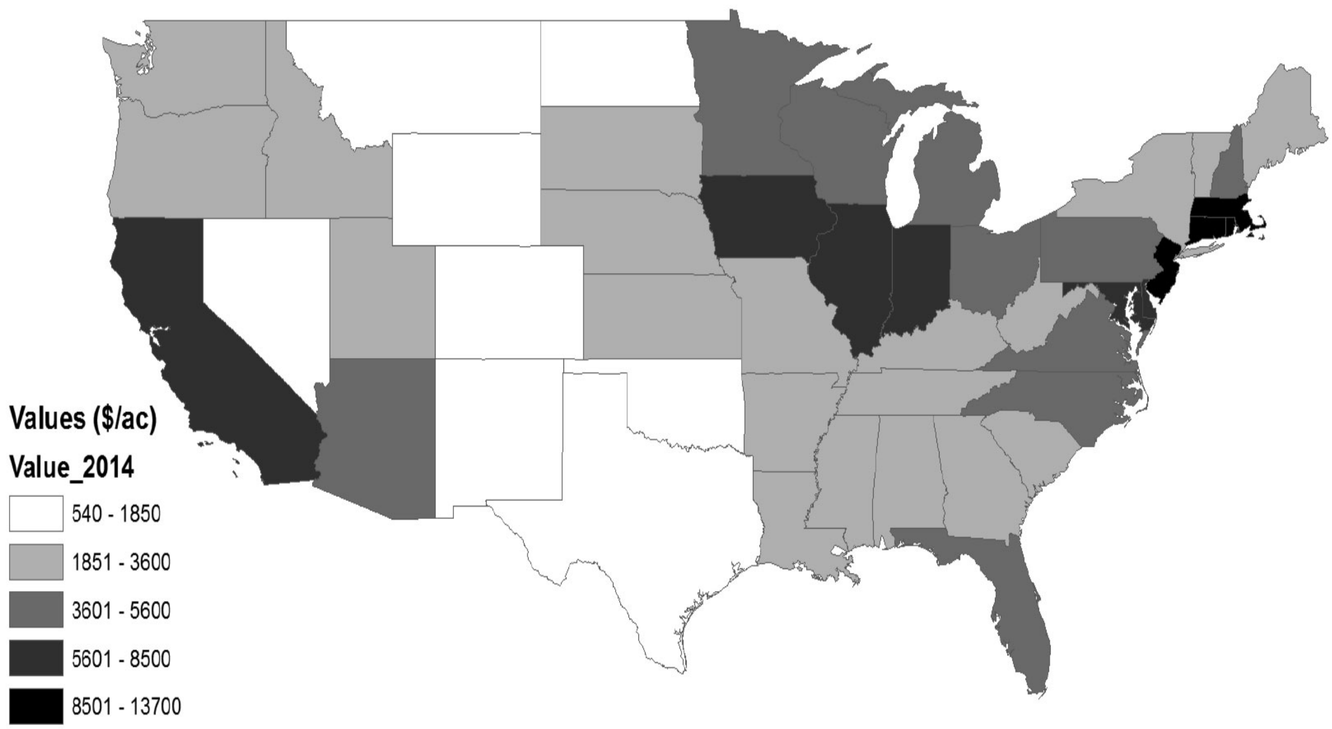

Figure 2. Example of first, second, and third order queen contiguity for Iowa

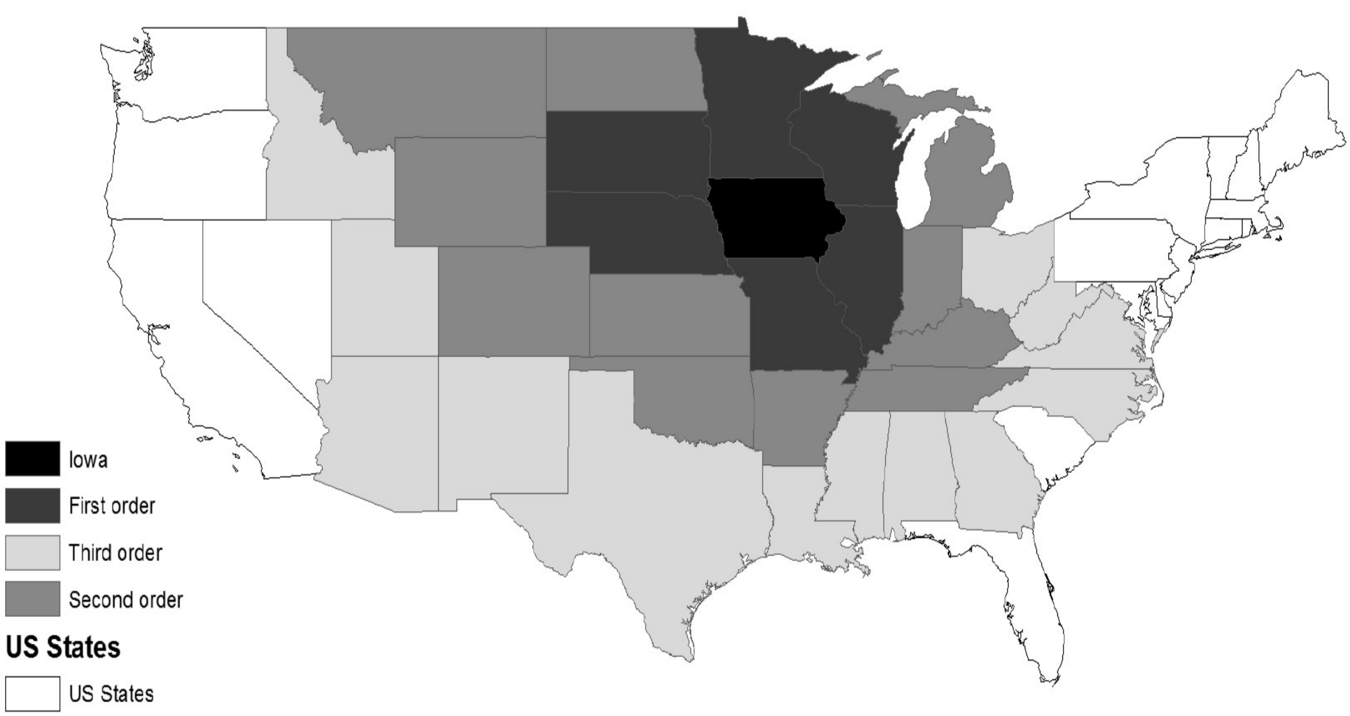

Figure 3. Spatial correlation for State-Level Farmland Values and Percentage Change First Order Queen, 1950-2014. Spatial correlation values near 0 and 1 indicate random and clustered, respectively.

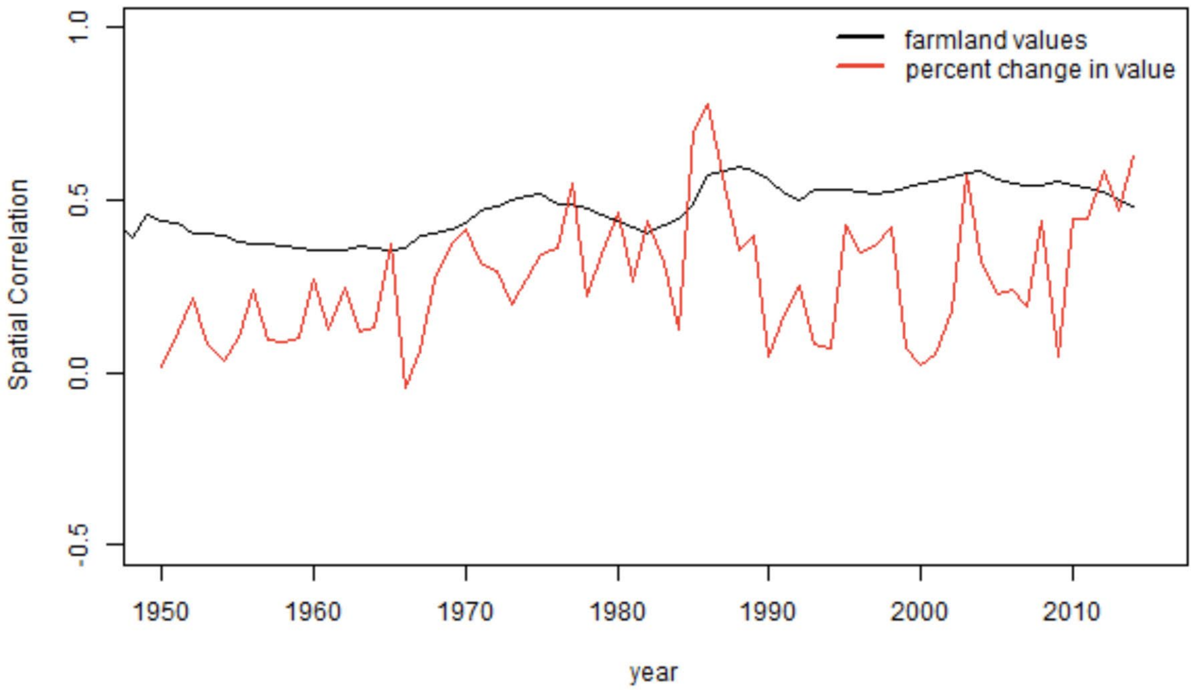

Figure 4. Spatial correlation for State-level Farmland Values and Percentage Change Second Order Queen, 1950-2014. Spatial correlation values near 0 and 1 indicate random and clustered, respectively.

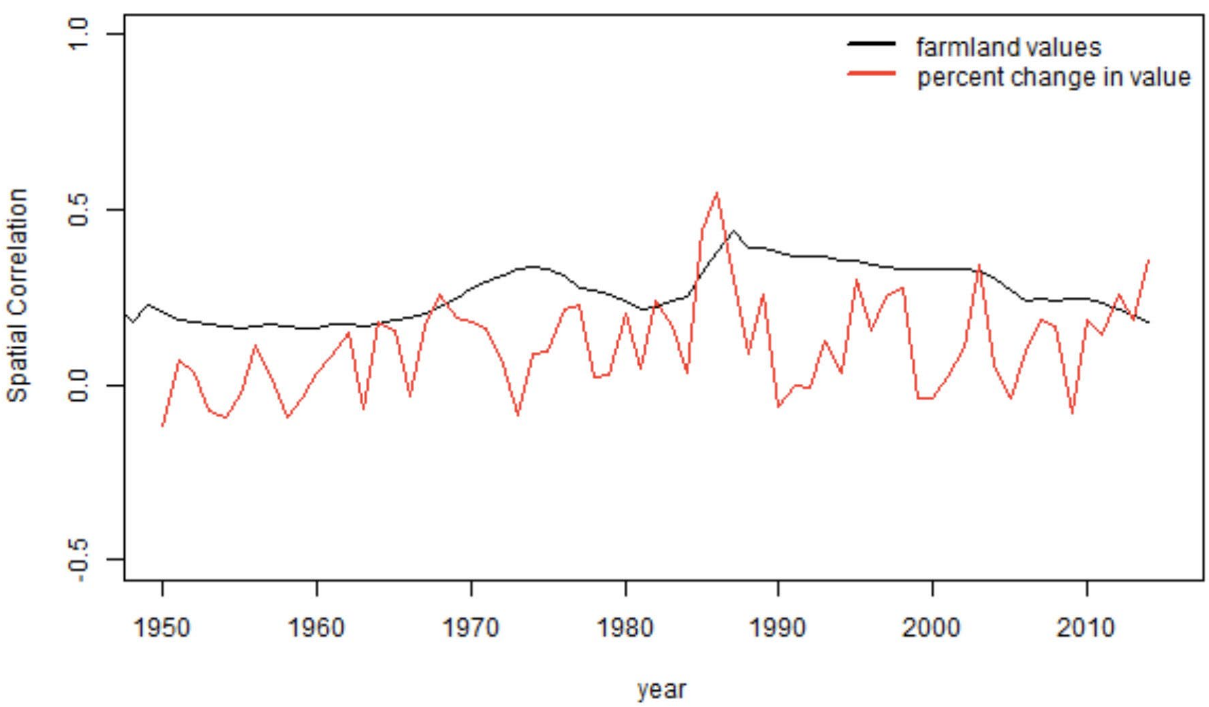

Figure 5. Spatial correlation for State-level Farmland Values and Percentage Change Third Order Queen, 1950-2014. Spatial correlation values near 0 and 1 indicate random and clustered, respectively.

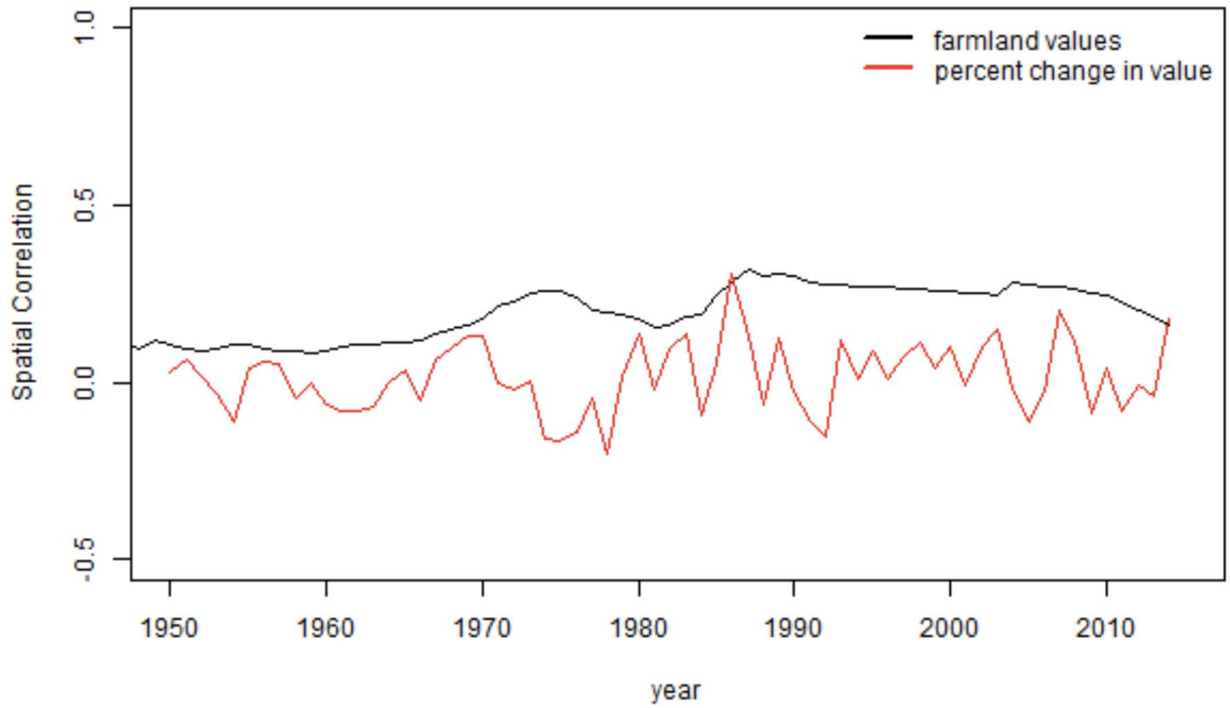

Figure 6. Spatial correlation for State-level Farmland Values Comparing First, Second, and Third Order Contiguity. Spatial correlation values near 0 and 1indicate random and clustered, respectively.