Fragmentation of Agricultural Land Parcels

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Introduction

While it is certainly not a new phenomenon, fragmentation of agricultural land is a concern threatening a significant amount of farmland in the United States (Bastian et al, 2002). According to one study, urban expansion claimed 1 million acres of farmland each year between 1960 and 1990 (Heimlich et al 2001). Once this land is taken out of agricultural production and converted to other uses, restoring it to productive farmland is essentially impossible. This makes for interesting reading and represents the main focus of past studies on fragmentation. This study seeks to take fragmentation research in a new direction by looking at exurban sprawl and fragmentation of ownership. Exurban sprawl can be defined as rural residential development, which is often low density development and is scatter outside of urban areas (Theobald, 2005). This form of development coupled with premiums for smaller parcels of land is a driving force behind this study.

Fragmentation, for the purposes of this paper, is the breaking up of farmland into smaller parcels, often but not always, associated with increased residential development in the area. An example of fragmentation occurs when a farmer chooses to sell a larger tract of agricultural land off into smaller pieces; say 20 to 40 acres each. Past studies involving fragmentation have focused on land use rather than land ownership. Residential land and agricultural land located in close proximity to each other is an example of fragmentation of land use. This study looks to forge new ground by instead centering on fragmentation of ownership. This approach will look at the difference between bigger and smaller tracts of land and possibly determine if there is a preference for one over the other. Since price per acre is inversely related to parcel size (Guiling et al., 2007, Hepner, 1985), this may cause a seller to take advantage of this by selling smaller parcels rather than larger ones.

The primary objective of this study is to identify the location and magnitude of fragmentation of agricultural land parcels sold in Oklahoma. This is done with the aim of later determining why all agricultural land is not sold in small parcels. In addition to addressing where land fragmentation occurs, the study also seeks to analyze whether fragmentation has increased in frequency over time, the factors contributing to fragmentation and the effects of fragmentation on land sale prices.

The literature has few helpful studies relating to the fragmentation that is studied here. An ample amount can be found on fragmentation that is caused by residential development but that is not the focus of this study. The closest predecessor in the literature is a study by Mervish et al. (2008) that focuses on the effect of land fragmentation on the Texas cattle industry. While not entirely related to this study, another study of interest by Guiling et al. (2007) seeks to determine the effect of urban proximity on land prices. The study encompassed within this paper represents the merging of studies on land values and the fragmentation of sold parcels.

Farmers and those involved in agriculture are not the only ones who are affected or may be interested in the issues associated with fragmentation. Previous studies show an inverse relationship between parcel size and price per acre. Simply put a decrease in parcel size results in a significant increase in price per acre. This is an issue relevant to someone interested in buying a smaller parcel of land. The seller of a small parcel would benefit by knowing their parcel may receive a higher per acre price than a larger parcel with similar characteristics would. From a farmer or rancher's perspective, the more fragmented land becomes, the more costly it may become to produce on it. Indeed, should the parcel size become small enough, production would become cost prohibitive.

This study uses regression analysis and ArcGIS plotting to locate where fragmentation is occurring and to determine how the premium smaller parcels receive over larger parcels varies across space. To examine this relationship, a database containing information on Oklahoma land sales was obtained. The data was used to perform regression analysis and develop maps indicating the location and size of the parcels.

To determine to what extent parcel size has been changing over time, the first regression will be structured so that parcel size is regressed against a polynomial in time. The second regression of the study focuses on characteristics that have the greatest impact on parcel size and ultimately looks to confirm the presence of a small parcel premium. This will be achieved by regressing sales price against parcel size and other variables deemed relevant. The regression will be estimated separately for each county so as to determine how small parcel premiums vary by location.

ArcGIS plotting was used to provide a visual representation of the location of small and large parcels. It is expected that smaller parcels will be located closer to large population centers.

Data

The data for this research were collected by Farm Credit Service institutions in Oklahoma from 1971 to 2010. Farm sales transaction data includes parcel size, date of sale, legal description specified to the section, and county. The dataset is extensive and it is intended to include most agricultural land transactions that take place within the state with the exception that 1995 – 1996 and 2006 data is clearly lacking. Observations missing price information and duplicated observations were removed from the dataset. Other observations lacking a legal description were kept in the dataset because they included relevant information for regression analysis; however,

they were left out of the mapping process. About 500 observations were removed from the dataset because they were incomplete leaving almost 65,000 usable observations.

The data also included information on land classification or land use. A variety of descriptors were used to classify land as best suited for pasture, crop, timber, or other uses. Certain specific classifications were combined under one heading. A relevant example would be combining “native pasture” and “improved pasture” classifications under the more simplified term “pasture”. The final land classification categories include cropland, pasture, timber, water, waste/roads, home site and other. It should be noted that land in the Conservation Reserve Program (CRP) was classified as “other”. CRP is a voluntary program where farmers can receive annual rental payments and other benefits in exchange for allowing resource conserving cover on eligible farmland (USDA). Every effort was given to properly place specific land classifications into appropriate, more general classifications.

The interests of the research are focused on parcel sizes and land values separate from the effects of improvements. To assure acres with improvements and improved land values were not taken into account, the data, when relevant, were adjusted to exclude improvements. The acres designated “home site” or “improvements” in the original data set were subtracted from the total acres. In instances where this reduced the total acres to zero, the observation was removed from the data. A similar procedure was followed to adjust land values. If a parcel had improvements, the value of the improved land was subtracted from the total land value. This left a total price that reflected only the value of the unimproved land.

Figures 1 and 2 show the percent of land sold within certain size categories for cropland and pasture land, respectively. The purpose of these figures was to determine the possible sales trends for size categories using exponential trend lines. There are trend lines for the 0 – 40, 41 –

160, and 161 – 640 acre categories. Little to no change was found in the larger size categories so no trend line was included for those categories. Figure 1 shows the percentage of cropland sales to be decreasing in the 0 – 40 acre category while the 41 – 160 and 161 – 640 acre categories are increasing. Figure 2 for pasture sales indicates a slight increase in the percentage of sales from 0 – 40 acres, a small decline in sales of 41 – 160 acres, and a decrease in sales of parcels of 161 – 640 acres.

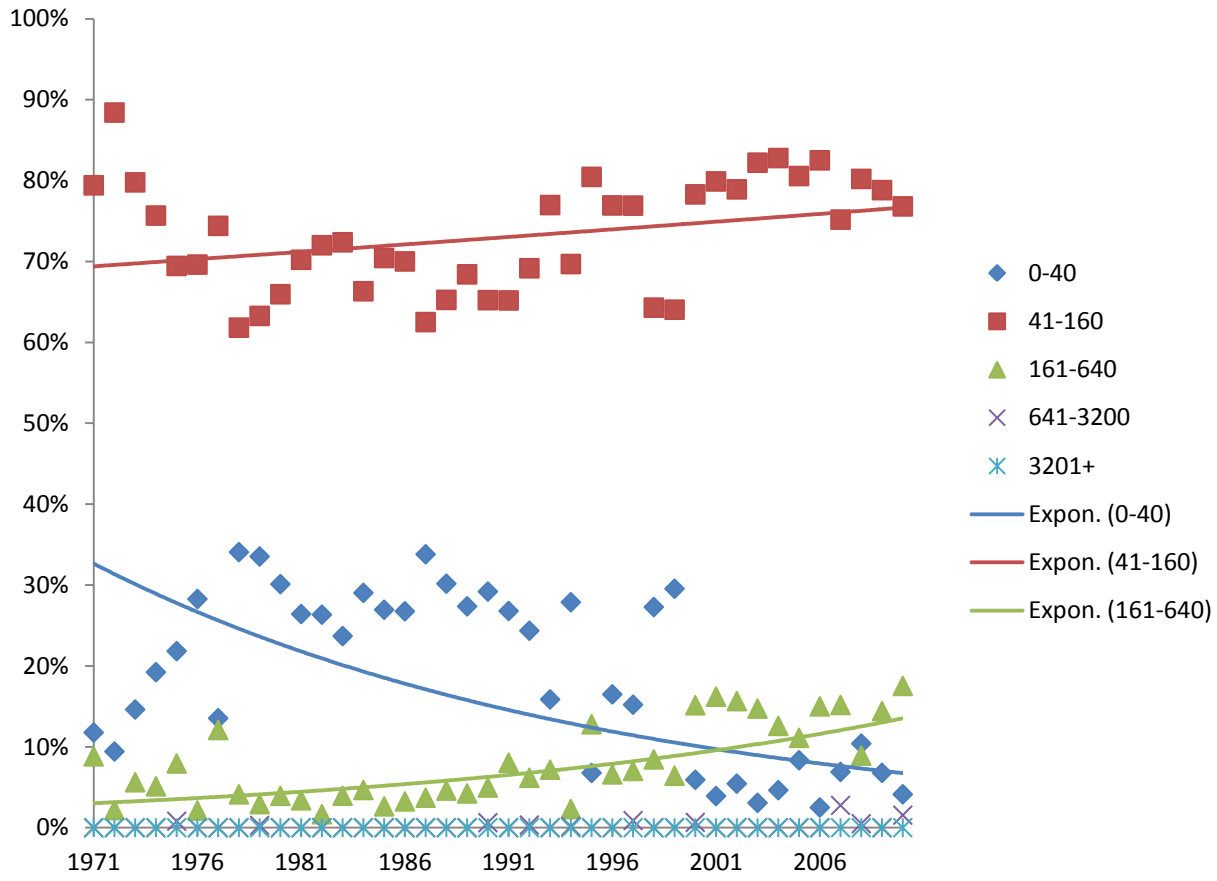

Figure 1. Percentage of cropland parcels sold in each size category from 1971 – 2010

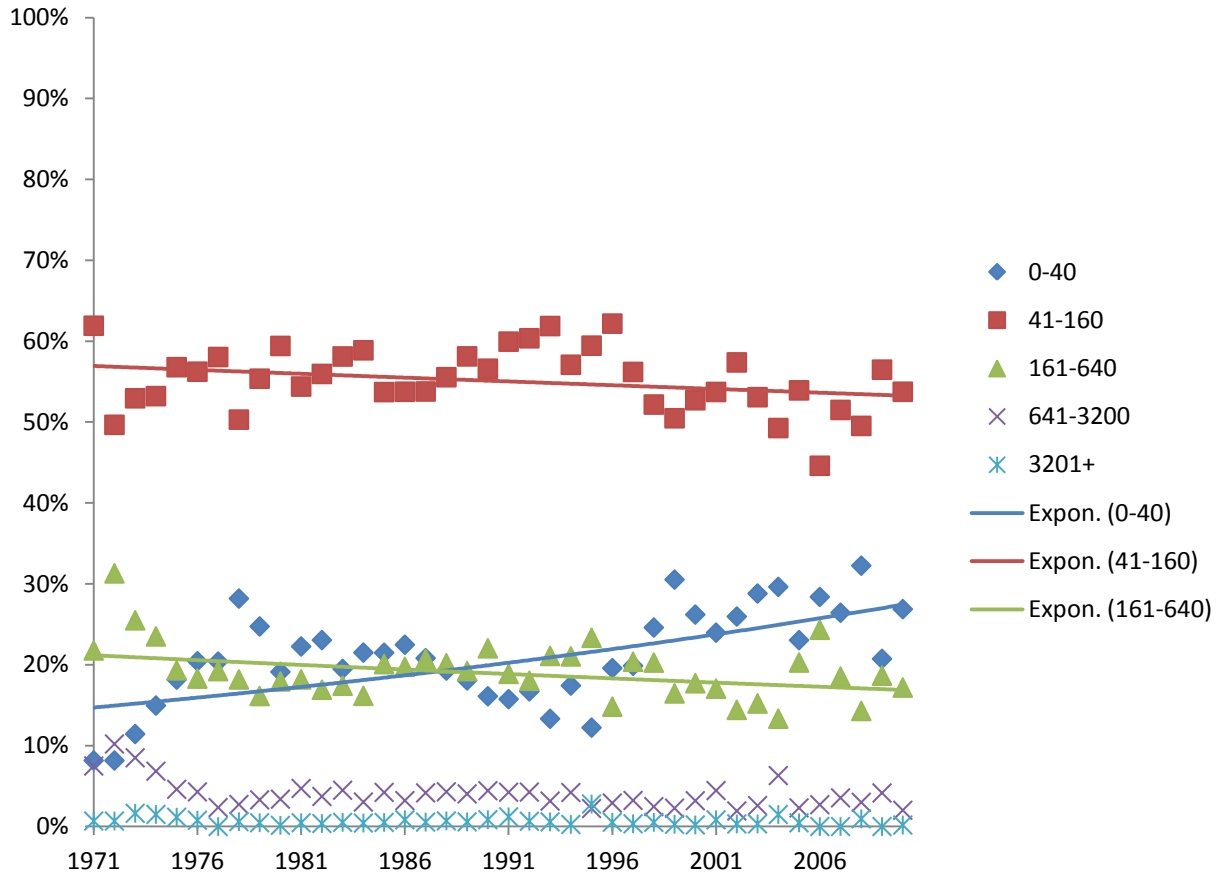

Figure 2. Percentage of pasture parcels sold in each size category from 1971 – 2010

Methods

One of the major questions driving this study is, "Where does land fragmentation occur?" During the course of research it became apparent that maps may provide a visual answer to this question. The latitude and longitude for each parcel were added to the dataset to allow mapping the parcels in ArcGIS. For each parcel, the latitude and longitude is taken from the center point of each section as specified in the legal description for each parcel. As noted above, the legal description for the parcels is specific down to the section. . Also included on the map is the location of the fourteen cities in Oklahoma as defined by the 2010 Census (U.S. Census Bureau). According to U.S. Census information from 2005, a place may be classified as a city if it has a population of

25,000 or larger (U.S. Census Bureau). They were added not only to provide relevant landmarks for the state but also as a way to visually distinguish urban areas.

The first set of maps shows the location and number of pasture parcels in the state of Oklahoma. The first map shows the location of sales and their sizes from 1971 to 1980 while the second map shows the same information from 2001 to 2010Based on these maps, it appears a larger number of smaller pasture parcels were sold from 2001 – 2010 as compared with the 1971 – 1980 time frame (Figures 3 and 4).

Similar maps were made to illustrate crop sales (Figures 5 and 6). Like the pasture maps before them, they also used 1971 – 1980 and 2001 – 2010 time frames and have included the location of cities. It should be noted that fewer large parcels were sold during the later time period. Also, the maps show an increase in the number of smaller parcels sold from 2001 – 2010, particularly in the eastern half of the state where there are more pasture parcels relative to cropland parcels.

Previously cited studies indicate that agricultural land is being lost to urban or residential development. Characteristically, large tracts of land are bought up and then resold in smaller pieces that are more suited to the intended development, which suggests that as urban and residential development increases, parcel size will decrease. Thus, the first hypothesis tested in this study is that parcel size has been decreasing over time. To see how size has changed over time, parcel size will be regressed against a polynomial in time using the following model:

$$(1) \quad A_{it} = \beta_{0t} + \beta_{1t} Y_i + \beta_{2t} Y_i^2 + \varepsilon_{it}$$

where *A*, the dependent variable, is acres (parcel size), *i* represents the individual parcel, *t* represents the time period, and *Y* is the year the parcel was sold.

The second hypothesis tested in this study is based on the expectation that parcel premiums will vary with location. This idea is supported by a study by Cavailhès and Wavresky, 2003. They found the price of agricultural land is influenced not only by agricultural factors but also by factors related to urban influence as well. At a certain distance from the city, land is sold for purely its agricultural value. The closer a parcel is located near an urban boundary, the higher the premium it will achieve so as to reflect the value of future increases in rent that can be realized after the land has been converted to urban use.

Delbecq and Florax (2010) and Livanis et al (2006) found an alternative reason to explain higher land prices closer to cities. In their separate studies, they found agricultural land located closer to urban areas may be more expensive because farmers near urban areas have changed their production practices. Rather than producing traditional low-value, land-intensive crops, the producers located near urban centers have switched to high-value, labor-intensive specialty crops.

Another study by Bastian et al (2002) found agricultural land in Wyoming was more expensive when located farther away from urban areas. Farmers were thought to prefer land farther away from urban areas because they were less likely to incur urban nuisance issues and therefore placed a premium on more distant land. For those interested in buying land for recreational purposes, land located farther away from urban areas received a higher value because it has more opportunities for recreation and better scenic views.

The second model of interest in this study investigates the existence of location premiums for parcels. Specifically, is there a greater premium for smaller parcels located closer to urban areas? This is be tested by regressing price per acre against parcel size and other hedonic variables. To determine whether or not parcel premiums vary by location, the model is regressed

individually for each county in Oklahoma. It is expected that parcel premiums will vary from county to county with more urban counties having a higher premium than those located in more rural settings. The model used to test this is as follows:

$$(2) \quad lnP_{it} = \beta_{0t} + \beta_{1t}Y_i + \beta_{2t}A_i + \beta_{3t}C_i + \beta_{4t}T_i + \beta_{5t}I_i + \beta_{6t}S_i + \beta_{7t}W_i + \beta_{8t}O_i + \varepsilon_{it}$$

where the dependent variable *P* is the price per acre for an individual parcel, *i* represents the individual parcel, *t* is the time period, *Y* is the year the parcel was sold, *A* is the number of acres in the parcel, *C* is the percentage of the parcel that is cropland, *T* is the percentage of the parcel that is timber, *I* is the percent of the parcel that is irrigated land, *S* is the percent of the parcel that is devoted to a home site, *W* is the percentage of the parcel that is either considered wasted land or roadway running through the property, and *O* is the percent of parcel that falls outside of these categories. A variable indicating the percent of the parcel dedicated to pasture has been left out so as to avoid perfect colinearity among the usage variables.

Results

Figures 1 shows a decrease in the percentage of small parcel (0 – 40 acre) sales over the entirety of the dataset while Figure 2 shows an increase in the percentage of small parcel pasture sales during the same time period. These maps also show a decrease in sales near urban areas, particularly Oklahoma City. This can be seen visibly by noting the increase in white space (land lacking sales observations) around the Oklahoma City area. Southeastern Oklahoma has few land sales because much of the land in that area is owned by various timber companies.

The analysis for the effect of year on parcel size was carried out and the actual results differed from the expected results. In order to solve issues with scaling, the initial year used was

1 rather than 1971. The analysis ultimately showed there is very little effect on parcel size over time. Over the entire span of the data set, 40 years, the change in parcel size, based on this model, is only one acre.

For the second regression, the log of price per acre was regressed against parcel size, year sold, and other variables describing land use. The use of the log of price per acre allowed for effects over time to be taken into account. To avoid perfect colinearity, the usage category indicating the percent of the parcel that was dedicated to pasture use was removed from the model.

Of most interest to this study is the parameter estimates for "Acres" that was derived from this regression. Since the regression was run separately for the 77 counties in Oklahoma, it provided an opportunity to determine whether or not there is a difference in sales price that can be attributed to a parcel's location. To determine which counties are classified as rural and which are classified as urban, Rural-urban Continuum Codes from the Economic Research Service (2004) were relied upon to make the distinction. Rural-urban Continuum Codes range from 1 to 9 with 1 signifying a county in metro areas with a population of 1 million or more. A Rural-urban continuum code of 9 represents a county that is completely rural with an urban population of 2,500 or less and is not adjacent to a metro area (Economic Research Service).

The regression analysis shows the counties with the larger or less negative coefficients for the variable "Acres" are those counties where one can expect to receive higher prices for their parcels. It should be noted that the sign for the "Acres" coefficient is negative for all 77 counties. The difference in the "Acres" coefficient among counties is indicative of the presence or lack thereof of a location premium for smaller parcels. A larger coefficient will mean there is a larger premium while smaller number means little or no premiums exists in that county. A map

indicating the coefficient for each county follows in Figure 7. Counties with lighter shading receive larger premiums for smaller parcels. Of particular interest is that of the ten counties with the smallest coefficients, eight of those either are metro areas or are adjacent to metro areas. Since the coefficients are significant this would indicate there is a premium on price per acre that can be attributed to a parcel's location. Smaller parcels located in or near urban areas can expect to achieve a higher per acre price than those that are located farther away from metro areas according to Rural-urban Continuum Codes. It is expected at some distance from an urban area a parcel may be valued for solely its agricultural use. Thus, these results can explain why most land is not sold in small parcels.

Conclusion

The focus of this study was to determine whether fragmentation has been increasing over time and whether or not a location premium exists for smaller parcels. This was accomplished by estimating two different models. The first model regressed a polynomial in time to determine whether or not fragmentation has been increasing over time. While it was hypothesized that parcel size was decreasing, this was not found to be the case. Over the 40 years of data, parcel size was found to only have decreased by one acre.

The purpose of the second model was to verify whether or not a location premium exists for small parcels. This model was regressed individually for each of the 77 Oklahoma counties. It was found that a location premium does exist for smaller parcels with parcels in urban counties more likely to receive a premium than those located in more rural counties.

Future research in this area may choose to focus on premiums as they relate to land use. It may be possible that cropland receives a premium over pasture land or vice versa. It may even be

possible that location premiums exist between the eastern and western half of the state where agricultural production practices are more livestock or crop-based, respectively.

Despite what casual observation seems to suggest, there is little evidence to suggest fragmentation has been increasing over time. However, this study found evidence to support a location premium for smaller parcels. For those looking to purchase a piece of land, these findings may affect the location and size of their purchase. This study confirms that fragmentation has an effect on land prices and further research should be done to fully understand its impact on agricultural land.

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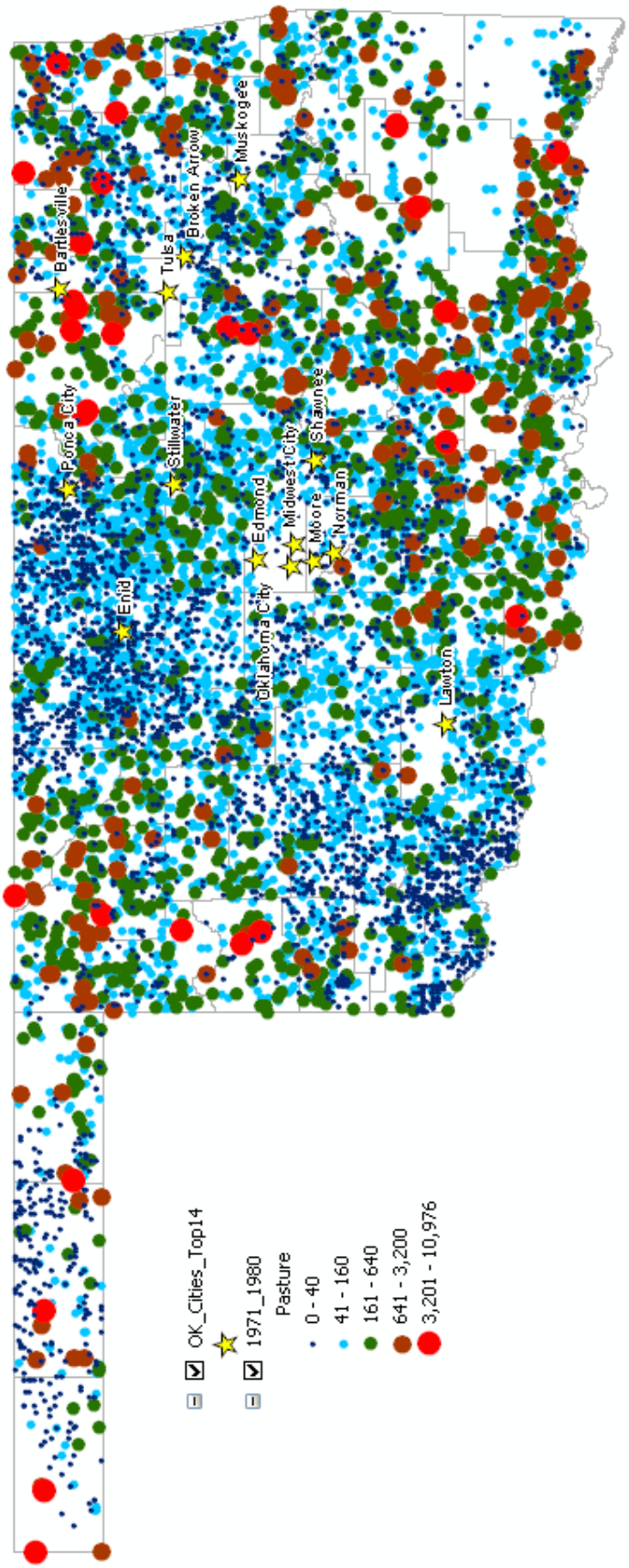

Figure 3. Pasture sales, 1971 – 1980

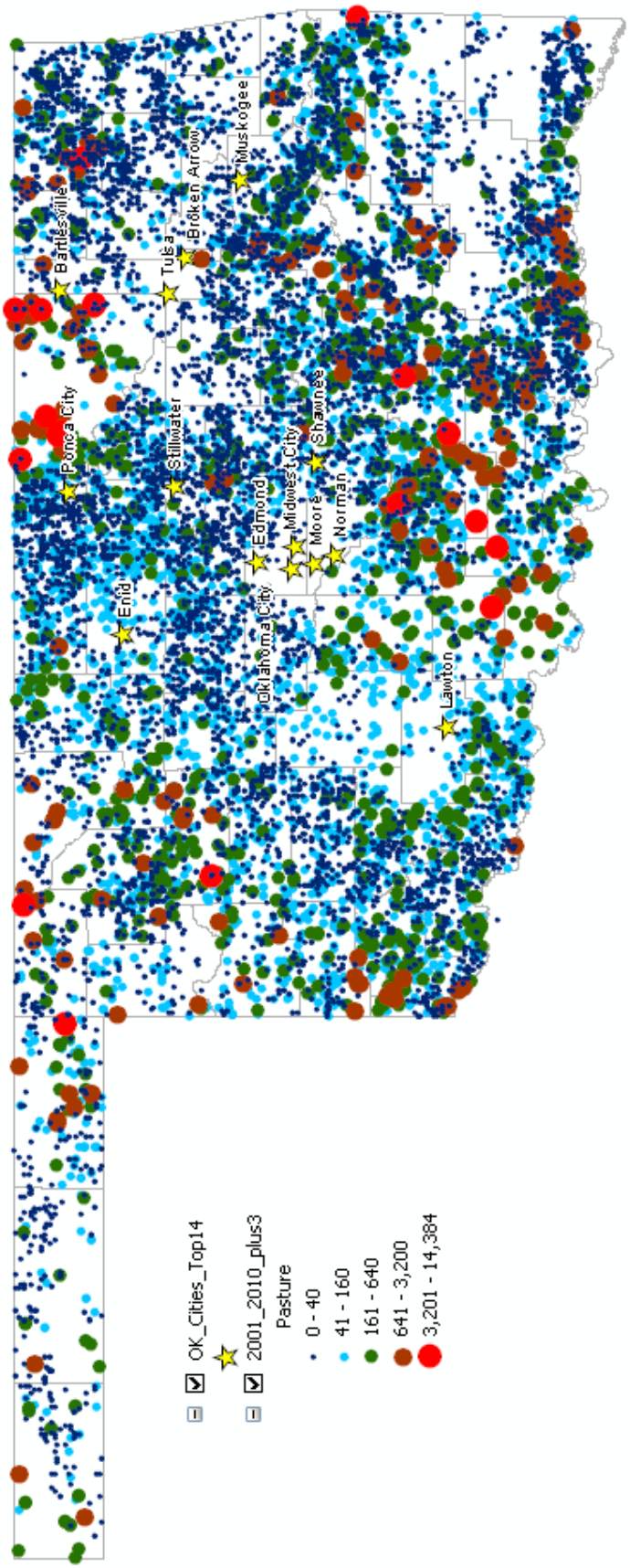

Figure 4. Pasture sales, 2001 – 2010

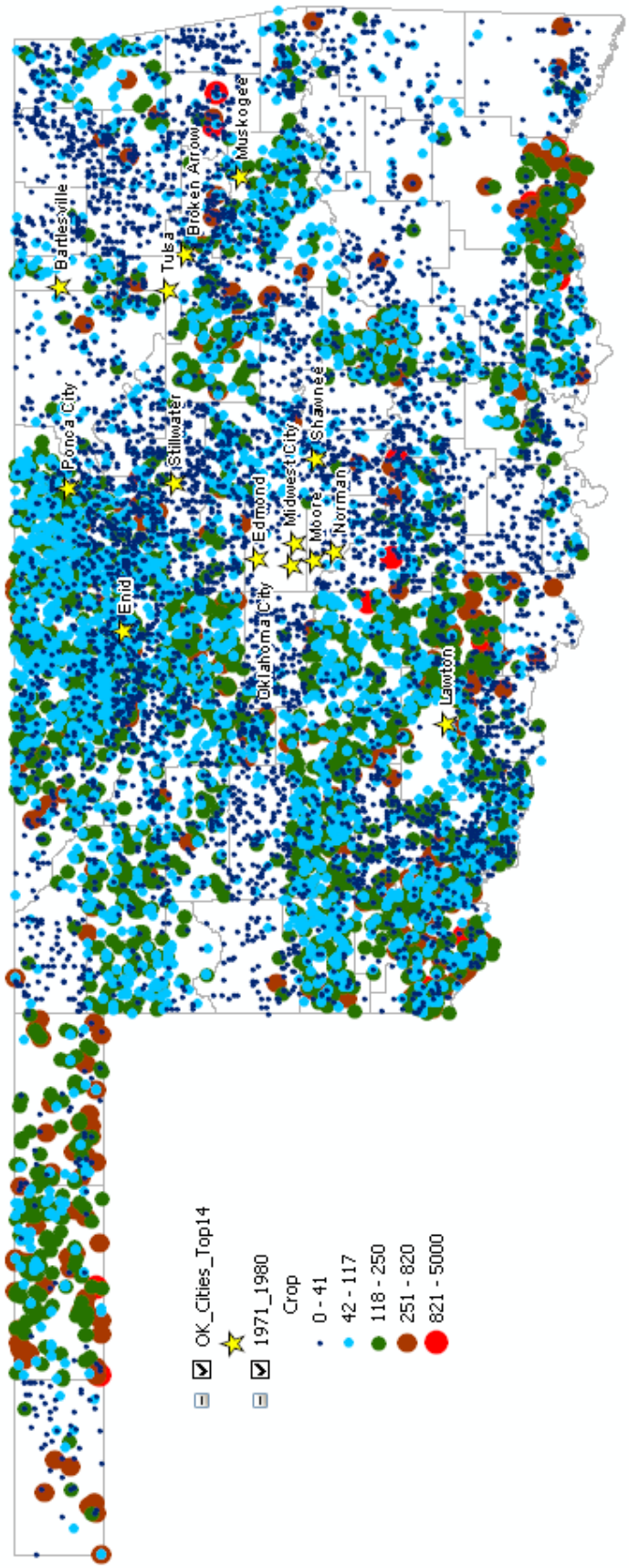

Figure 5. Crop sales, 1971 – 1980

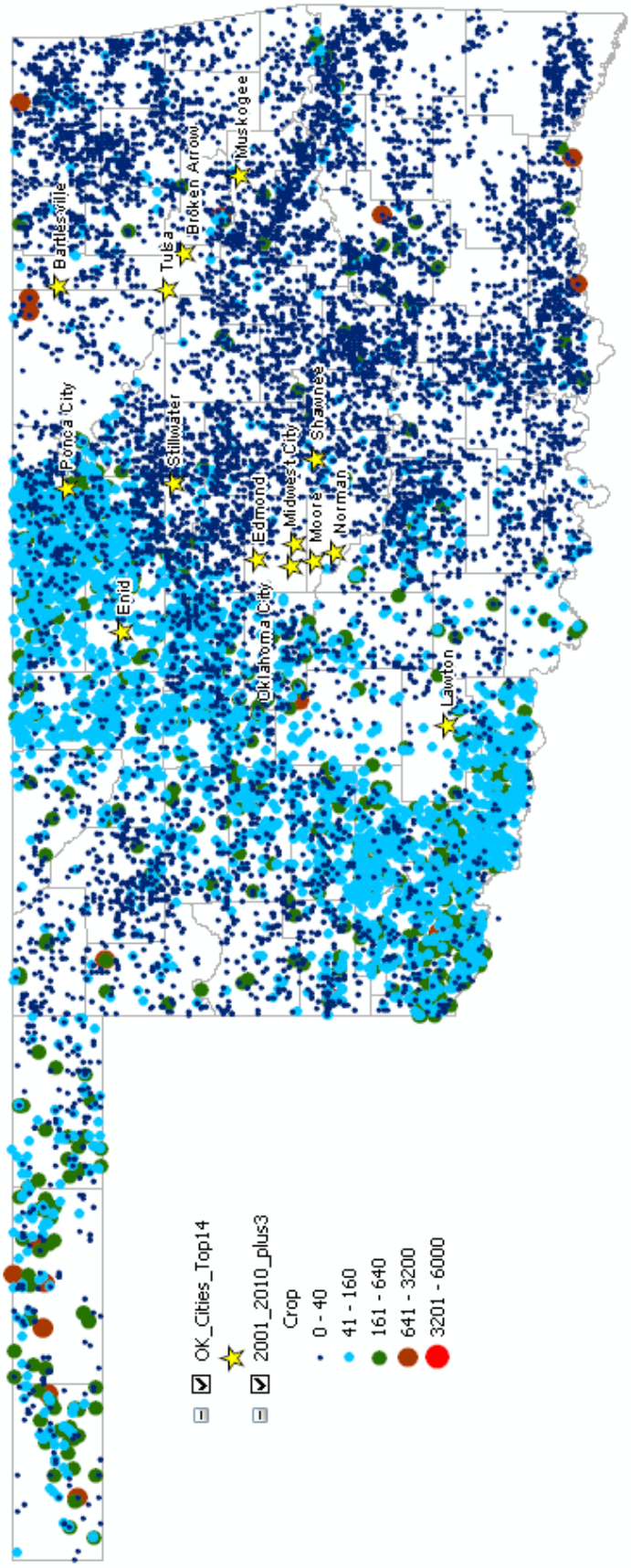

Figure 6. Crop sales, 2001 – 2010

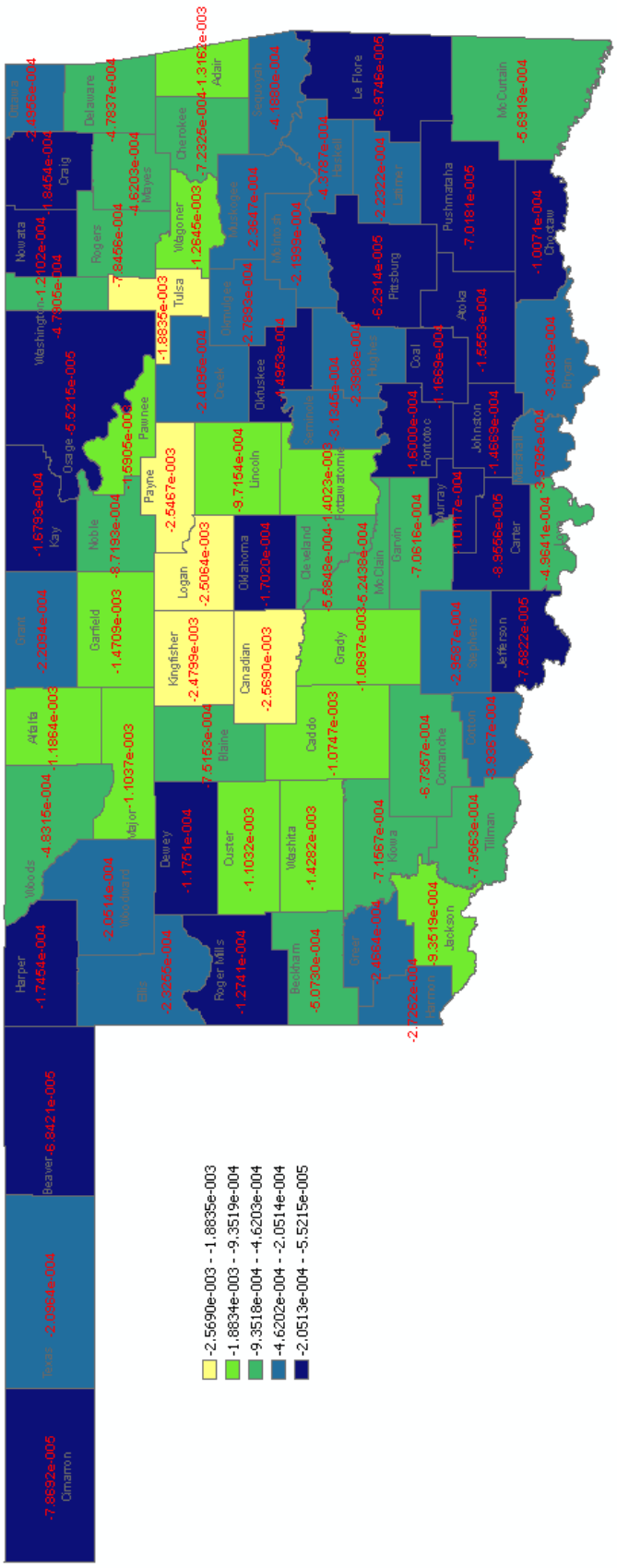

Figure 7. County parameter estimates for "Acres"