Trends and Determinants of Farmland Sale Prices in Western Ohio 2001 – 2010

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1. Executive Summary

Farm real estate represents the largest single investment item in a typical farmer's investment portfolio and thus understanding the determinants of farmland value is critical. A number of recent macroeconomic factors have contributed to strong increases in farmland values nationally, including historically low interest rates, increasing demand for U.S. grain exports from China, a growing biofuels market and rapid rise in key agricultural commodity prices since 2004.

While these macro trends have led to dramatic increase in average farmland values, a number of more localized factors have contributed to substantial variations in farmland values at the parcel level. Using a unique dataset of 21,342 arm’s length sales of georeferenced agricultural parcels in 50 counties in western Ohio, this report analyzes the trends and parcel-level determinants of western Ohio cropland prices from 2001-2010.

Arms-length sales are determined based on an indicator code assigned by the county or a mismatch of buyer and seller names. Land values are isolated from the total sale of land and buildings by multiplying the original sales price times the ratio of the percentage of assessed values of land over total assessed values of land and buildings.

We use these data to examine trends in land values over time and across crop reporting districts in western Ohio. In addition, we use a hedonic model to estimate marginal values of parcel attributes and location characteristics. We also examine the effects of the residential housing bust in 2007 on farmland values by examining how the so-called urban premium changed after this event. The urban premium is the total dollar value that results from a parcel’s proximity to urban areas and is measured relative to a hypothetical agricultural land parcel with no urban influence.

The analyses reveal a number of interesting findings:

- Ohio cropland prices on average remained fairly constant or even rose a bit throughout the 2000 decade. This is despite considerable downward pressure from the recent housing market bust.

- The trends in average cropland prices are different across different crop reporting districts: agriculturally important districts such as Northwest and West Central districts saw a more evident uptake in average cropland prices during the 2001-2010 period, while districts that are subject to stronger urban influences such as Southwest districts witnessed a significant decline.

- The farmland market is a very thin market compared to its residential counterpart: on average less than 2% of total farmland acreage were sold each year, and the number of parcel sales dropped significantly in 2009-2010 due to the housing market bust.

- Agricultural profitability is positively correlated with cropland prices: a 10% increase in agricultural productivity index (NCCPI) is associated on average with an additional $77.8 per acre cropland.

- Proximity to urban centers and transportation modes are also associated with an increase in cropland prices: a one-mile increase from the nearest city or the nearest highway ramp is associated with an average decline of $35.5 per acre or $2.9 per acre, respectively.

- The housing market bust resulted in a significant decline in the parcel-level urban premium: before 2007, the agricultural parcels subject to urban influence on average enjoy a $1,947 per acre urban premium, or roughly 43% of the per-acre cropland prices. However, after 2008, a sizeable reduction in the urban premium occurred: it declined to only $1,021 per acre on average, which is about 23% of the average per-acre sales price.

Based on these findings, we conclude that the local variations in farmland prices in the first decade of the 2000's were substantial and driven in large part by differences in urban proximity. Parcels closer to urban areas witnessed substantial declines in their urban premium due to the recent housing market bust. In contrast, the value of farmland in more rural areas in western Ohio increased over this time period, leading to an overall upward trend in average cropland prices in western Ohio 2001-2010.

2. Introduction

Farm real estate (land and structures) is the major asset in the farm sector balance sheet, accounting for 84% of the total value of U.S. farm assets in 2009 (Nickerson et al. 2012). As a result, changes in agricultural land values are a critical barometer of farm sector performance and the financial well-being of agricultural producers. These changes also have implications on a wide range of policy issues, including agricultural competitiveness, commodity programs, conservation payments, and farmland protection. Because of this, researchers and policymakers have long been interested in the trends in, and determinants of, farmland values. This interest has grown in recent years due to the dramatic increases in U.S. farmland values, rapid changes in agricultural commodity prices, and the boom-bust cycles in the residential land markets. These trends have raised questions about the extent to which farmland markets respond to changes in macroeconomic trends, such as commodity prices and biofuels demand, changes in farm-specific and location attributes, and changes in other land markets.

Many factors affect farmland values, including macroeconomic factors that could impact the land market as a whole, as well as local factors at a county or parcel level that cause variation in individual parcel values. Examining factors at both the macro and parcel scales is important in understanding how and why farmland values are changing (Nickerson et al. 2012), and western Ohio farmland market provides an ideal laboratory to investigate these recent changes in farmland and other markets. As part of the Corn Belt, western Ohio boasts nearly 7 million farmland acres many of which are the best prime farmland across the nation; on the other hand, almost all farmland parcels in western Ohio are subject to significant urban influences.

Using a unique dataset of 21,342 arm's length sales of georeferenced agricultural parcels in 50 counties in western Ohio, this report analyzes the trends of western Ohio cropland prices from 2001-2010, and how changes in these prices are determined by macroeconomic and more localized factors. Macroeconomic factors behind farmland values – such as interest rates, demand for corn from the biofuels market, and commodity prices – and other sector-level factors help inform whether farmland values appear to be supported by fundamental factors. A micro-level perspective reveals how farmland values vary spatially in western Ohio due to variation in parcel-level characteristics such as parcel size, soil productivity, and proximity to agricultural markets and urban centers. In this report, we examine both macro and micro aspects of western Ohio farmland values.

3. Background

3.i Brief Overview of Determinants of Farmland Prices

According to the commonly-used capitalization formula, farmland values are comprised of the net present value of economic returns to land. Formally, the model is written as

$$V_{it} = E_t \sum_s \frac{R_{is}}{(1+\delta_t)^{s-t}}, where\ s = t, t+1, \ldots \quad (1)$$

In this formulation, the value of agricultural land parcel *i* at time *t* is V_{it}, which is defined as the sum of the expected discounted annual returns to farmland, denoted as R and discounted at rate δ_t. In many regions, farmland can earn returns not just from agricultural production and government payments, but also from "non-farm" sources such as wildlife viewing, hunting and fishing or conversion to urban uses.

Annual returns are determined by both macroeconomic forces as well as more localized factors that vary across counties and by individual farmland parcels (Nickerson et al., 2012). In the next section, we focus on macroeconomic factors that influence recent U.S. farmland markets as a whole. We then summarize the key determinants of farmland values at a parcel level based on the main findings in the literature before turning to our own parcel-level analysis of farmland value in western Ohio.

3. ii Macroeconomic Factors

Since the farm crisis of mid-1980s, U.S. farmland values have increased in both nominal and real terms (Nickerson et al., 2012). Most notably, average cropland values in the Corn Belt have increased from around $4,000/acre in early 2000s to more than $6,000/acre in 2012, posing a sharp contrast with the collapse of residential real estate market in the urban land market. Much of this recent rise can be attributed to several macroeconomic factors, including: historically low interest rates, which attracted investment in agricultural land (Schnitkey and Sherrick, 2010; Nickerson et al., 2012); increasing demand for U.S. grain exports (Gloy et al., 2011); and rising demand for U.S. agricultural outputs due to a growing biofuels market (Wallander et al., 2011). This section briefly describes these macroeconomic trends.

Interest Rates

Figure 1 shows the evolution of 10-year treasury rates over time since 1960. It clearly shows that the current level of interest rates is at a historically low level. Low interest rates could have two positive effects on farmland values: first, it lowers the total cost of purchasing land for those who use debt capital, and second, low interest rates, which represent low returns on competing opportunities, makes farmland a more attractive investment alternative (Schnitkey and Sherrick, 2010).

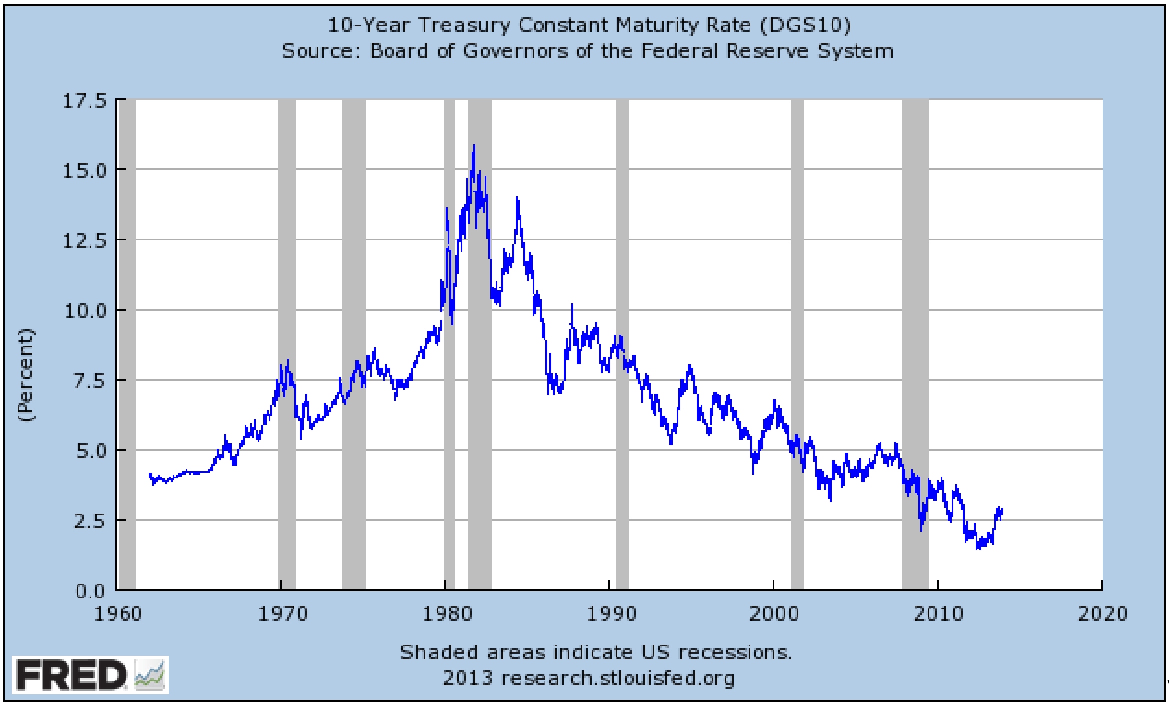

Figure 1: 10-Year Treasury Rate 1960 - 2013

Expanding Ethanol Production

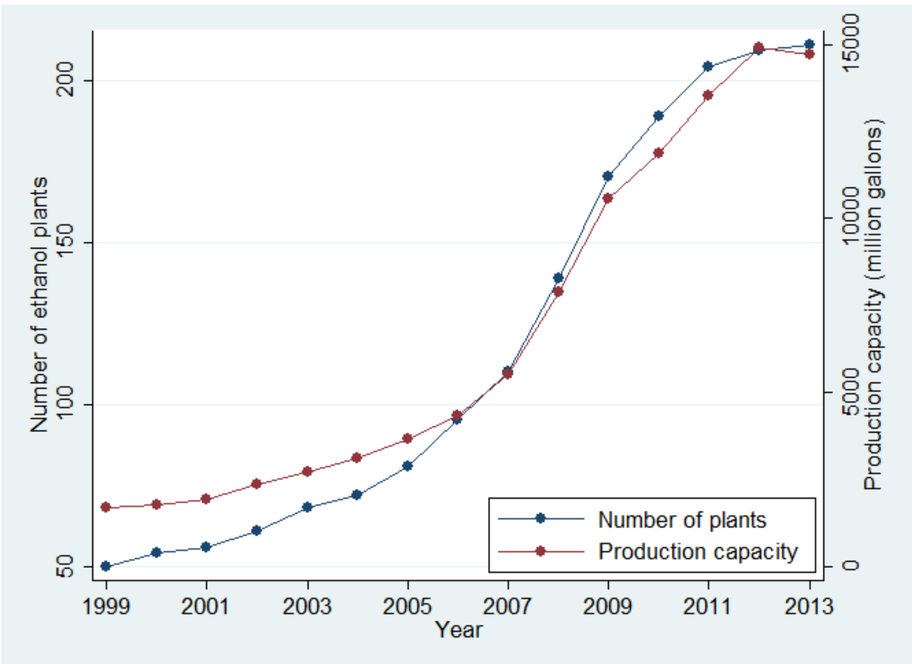

Figure 2. The number of ethanol plants and annual production capacity in the U.S. since 1999

Ethanol has recently been embraced enthusiastically as a promising alternative renewable energy (Low and Isserman 2009). With the strong federal support represented by the Energy Policy Act of 2005 and the Energy Independence and Security Act of 2007, the number of ethanol plants saw a four-fold increase along with a dramatic increase in U.S. ethanol production, making U.S. the largest ethanol producer in the world. These federal energy policies increased demand for corn, and thus elevated corn and other agricultural commodity prices (Nickerson et al., 2012). The year of 2010 marks the first time that corn usage for ethanol production exceeds usage for feed stock. Previous studies have identified increased corn basis prices in the vicinity of an ethanol plant (McNew and Griffth, 2005), and this could translate into higher farmland values through capitalization. The increased demand, in part met by the supplies from local grain elevators, could enhance the positive impact of the proximity to grain elevators on farmland values.

Agricultural Commodity Trade and Agricultural Commodity Prices

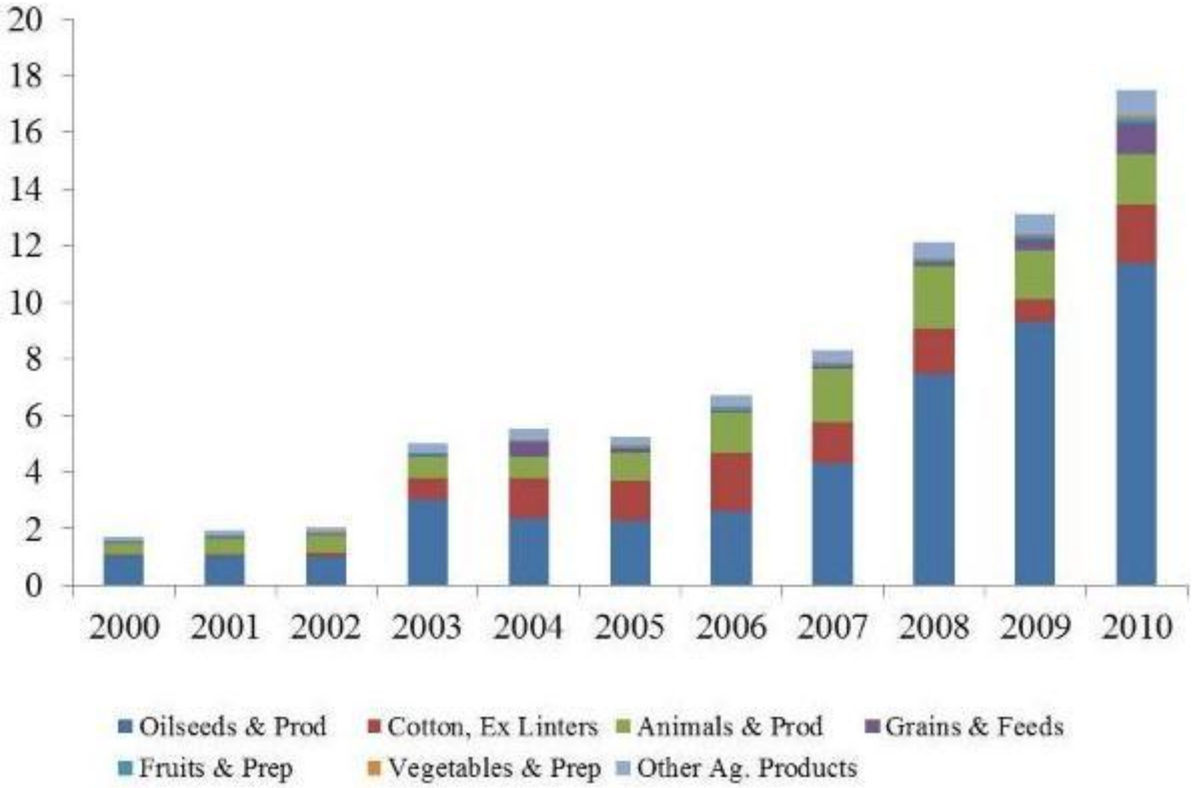

Figure 3. U.S. Agricultural Exports to China since 2000 (source: Wang et al. 2012)

With its economy growing at astonishing speed, China has become the most important importer of many agricultural commodities. First and foremost is the remarkable rise in U.S. soybean exports to China. Figure 3 shows the rapid increase of soybean exports to China especially after 2001, the year China joined the WTO. In addition, meat consumption (especially pork) has increased dramatically in China along with their living standards (see Figure 4). This rapid rise in meat consumption has also increased grain demand for livestock feeds, which is capitalized into farmland values.

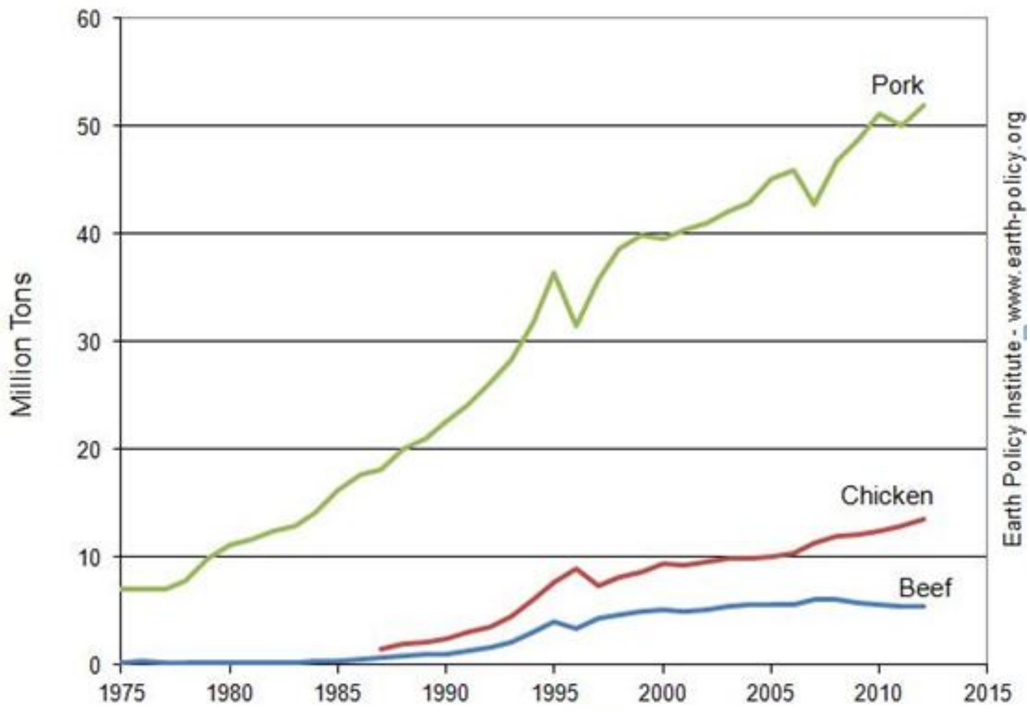

Figure 4. Meat Consumption in China 1975 – 2012 (data source: Earth Policy Institute)

The strong demand for agricultural products has given rise to recent spikes in key agricultural commodity prices since 2005 (Figure 5). These elevated commodity prices translate into higher agricultural returns, higher cash rents and higher farmland values throughout the country.

3.iii Local Factors

Numerous empirical studies have analyzed the parcel-specific determinants of farmland values (e.g. Palmquist and Danielson, 1989; Ma and Swinton, 2012; and Guiling et al. (2011), and see Nickerson et al. (2012) for an excellent review). Most applications have found a positive and significant relationship between farmland values and better soil quality (Palmquist and Danielson, 1989; Huang et al., 2006) or environmental amenities (Ma and Swinton, 2012). For example, Huang et al. (2006) shows that a one-percent increase in soil productivity rating variable would lead to a 0.68% increase in Illinois farmland prices, while Ma and Swinton (2012) find that nearby rivers increase farmland values in southern Michigan counties by 5.8% per 1000m closer to a river due to possible fishing and crop irrigation opportunities.

Principal among the nonfarm sources of returns is the expected future value increases arising from returns from future residential or commercial development for farmland in close proximity to urban areas (e.g. Hardie et al., 2001). By constructing an urban influence index of population over squared distances to nearest three cities, Shi et al. (1997) find that a one unit increase in this index will increase per acre real farmland value in West Virginia by $132.60. In addition, Guiling et al. (2009) find that the urban influence on agricultural land values extended between 20 and 50 miles away from the closest urban centers in Oklahoma.

Recent studies have also analyzed the effects of access to agricultural market channels, such as proximity to ethanol plants or grain elevators. These studies offer suggestive evidence of a declining pattern of farmland values over farm distances to grain elevators (Nickerson et al. 2012) and ethanol plants (Henderson and Gloy, 2009) in the Northern Plains. Specifically, Henderson and Gloy (2009) find that a parcel 50 miles from a plant would have a price $94 less per acre than an equivalent parcel of land next to an ethanol plant.

4. Data and methodology

Western Ohio hosts the vast majority of the state's agricultural land and provides an excellent opportunity to study the structural change in determinants of farmland values that was precipitated by the residential housing bust. Ohio was hard hit in the housing market bust and accompanying recession, as evidenced by the sharp decline of residential housing prices for its metropolitan areas in 2007 and 2008 (Lincoln Institute of Land Policy 2012). To analyze the impact of the housing market bust, we assembled a detailed database of 21,342 arm’s length agricultural land sale records for 50 western Ohio counties obtained from county assessors’ offices and from a private data vendor. The sale is deemed as arm’s length using the valid sale indicator provided by some counties, or based on a mismatch of last names of the seller and buyer. In addition, only those agricultural parcels sold between 2001 and 2010 are retained. These agricultural parcel sale records were merged with georeferenced boundaries, or were geocoded based on property addresses using ArcGIS when georeferenced parcel boundaries were not available.

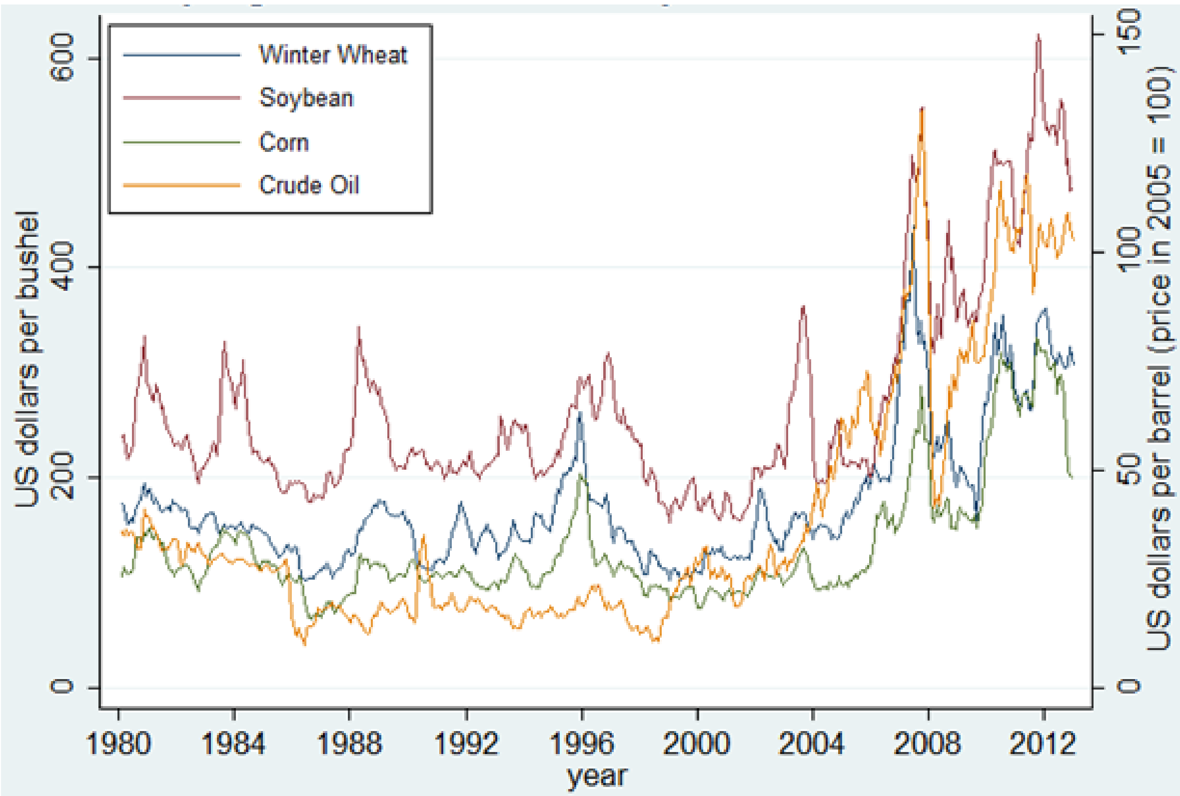

Figure 5. Key Agricultural Commodity Prices 1980-2013 (data source: IMF)

Construction of the dependent variable is a common problem in farmland value studies, given that sale prices reflect the value of both land and buildings including farm structures, residential dwellings, or both (Nickerson and Zhang 2013). Because we do not have data on the quantity and quality of buildings, we construct a sales price for farmland only to use as the dependent variable. Similar to Guiling et al. (2009) who subtracted the value of buildings from farmland sales prices, we calculate the sales price for farmland as the original sales price times the ratio of the percentage of *assessed values of land* over *total assessed values of land and buildings*. This assumes the portion of sales price attributable to land only can be approximated based on the contribution of assessed value of land to the total assessed value of land plus buildings. Outliers were identified as those observations for which estimated nominal sales prices for farmland that were above $30,000/acre or below $500/acre and were dropped from the dataset. Parcels with acres less than 5 acres are also dropped. Figure 6 shows a plot of the filtered sample consisting of 15,797 valid parcel transactions, where each green dot represents a valid agricultural parcel sold in 2001-2010.

Figure 6. Arm’s length agricultural land sales in western Ohio 2001-2010

Data on parcel attributes and location characteristics were obtained largely from the U.S. Department of Agriculture Natural Resources Conservation Service’s GeoSpatial Data Gateway (USDA GeoSpatial Data Gateway, 2012), including the Census TIGER/Line Streets, National Elevation Dataset, National Land Cover Dataset (NLCD), and Soil Survey Spatial Data (SSURGO). Additional data on locations of cities and towns in Ohio were obtained from the Ohio Department of Transportation (2012). We also used Census Block Shapefiles with 2010 Census Population and Housing Unit Counts (U.S. Census TIGER/Line, 2012) to calculate the surrounding urban population. Data on ethanol plants, grain elevators and agricultural terminal ports were obtained from the Ohio Ethanol Council (2012), the Farm Net Services (2012) and the Ohio Licensed Grain Handlers List (2012). Using these data and ArcGIS software, we were able to create the parcel attributes and location characteristics. Table 1 reports summary statistics for these variables.

	Unit	Mean	Std. Dev.	Min.	Max.
General Parcel Attributes					
Sales price per acre (with structures)	Dollars	8292.924	9172.07	500.782	59959.18
Sales price per acre (without structures)	Dollars	4743.543	4834.766	500.068	30000
Log of sales price per acre (without structures)	Dollars	8.085	0.858	6.215	10.309
Assessed land value	Dollars	76893.07	185457.2	0	9357400
Assessed improvement value	Dollars	32731.26	62238.54	0	1428250
Assessed land value % of total assessed	%	72.05%	31.11%	2.19%	100.00%
Total acres	Acres	47.835	72.437	5	2380.66
Total acres_squared		7535.06	87996.74	0.0196	5667542
Sale year	Year	2004.924	2.687456	2001	2010
Agricultural Profitability Influence Variables					
National Commodity Crops Productivity Index	Number	5764.81	1548.02	0	8800.8
Cropland % of parcel	%	55.53%	37.16%	0.00%	100.00%
Prime soil % of parcel	%	35.09%	35.82%	0.00%	100.00%
Steep slope (< 15 degrees, 15-25, 25-40, >40)	Multinomial	0.402	0.696	0	3
Distance to nearest ethanol plant	Miles	29.15	13.83	0.55	69.84
Distance to nearest grain elevator	Miles	8.32	7.12	0.03	55.27
Distance to other agricultural terminal	Miles	32.35	14.37	0.13	74.62
Forest area % of parcel	%	15.69%	26.08%	0.00%	100.00%
Wetland area % of parcel	%	0.37%	3.08%	0.00%	100.00%
Urban Influence Variables					
Distance to nearest city center with over 40,000 people	Miles	25.223	12.174	0.124	65.842
Incremental distance to second nearest city center with at least 40,000 people	Miles	14.460	13.307	0.000	64.501
Total urban population within 25 miles	Thousands	289.692	230.456	64.772	1187.381
Gravity index of three nearest cities		1117.28	33570.49	52.76	4255332
Building area % of parcel	%	3.32%	12.13%	0.00%	100.00%
Distance to nearest highway ramp	Miles	8.954	6.604	0.000	39.141
Distance to nearest railway station	Miles	3.066	1.811	0.005	11.254
Number of observations			15797		

Table 1. Summary statistics of agricultural land sales in western Ohio 2001- 2010

Most of the variables in Table 1 are self-explanatory; however, some explanations are in order. First, the variable *National Commodity Crops Productivity Index (NCCPI)* is an index value from the National Soil Information System (NASIS). Specifically, the index is based on natural relationships of soil, landscape, and climate factors and assigns productivity ratings for dry-land commodity crops. Most desirable characteristics lead to larger values of *NCCPI* (see Dobos et al. (2008) for details). The *percentage of prime farmland* variable is based on the suitability of soils for most kinds of field crops: for each parcel, the percentage measure of land area in prime soil is calculated. The *incremental distance to second nearest city center* variable is measured as the difference between the distance from the parcel to the nearest city center and to the second nearest city center. Following Shi et al. (1997), the *gravity index of three nearest city centers* variable calculated as the weighted average of population divided by distance squared for the nearest three cities.

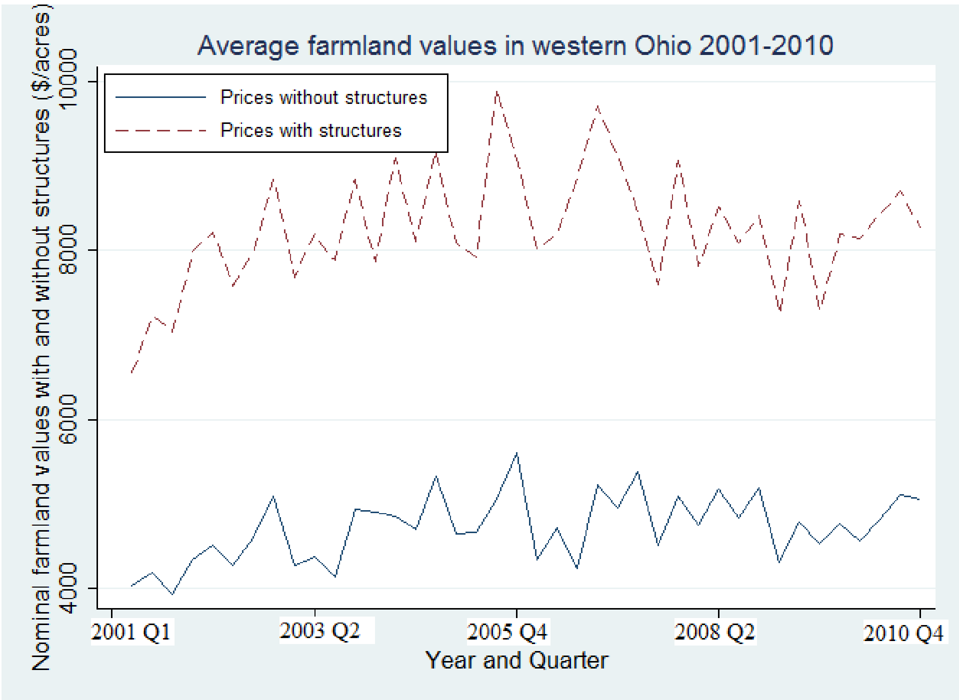

Figure 7. Average farmland prices with and without structures in western Ohio 2001-2010

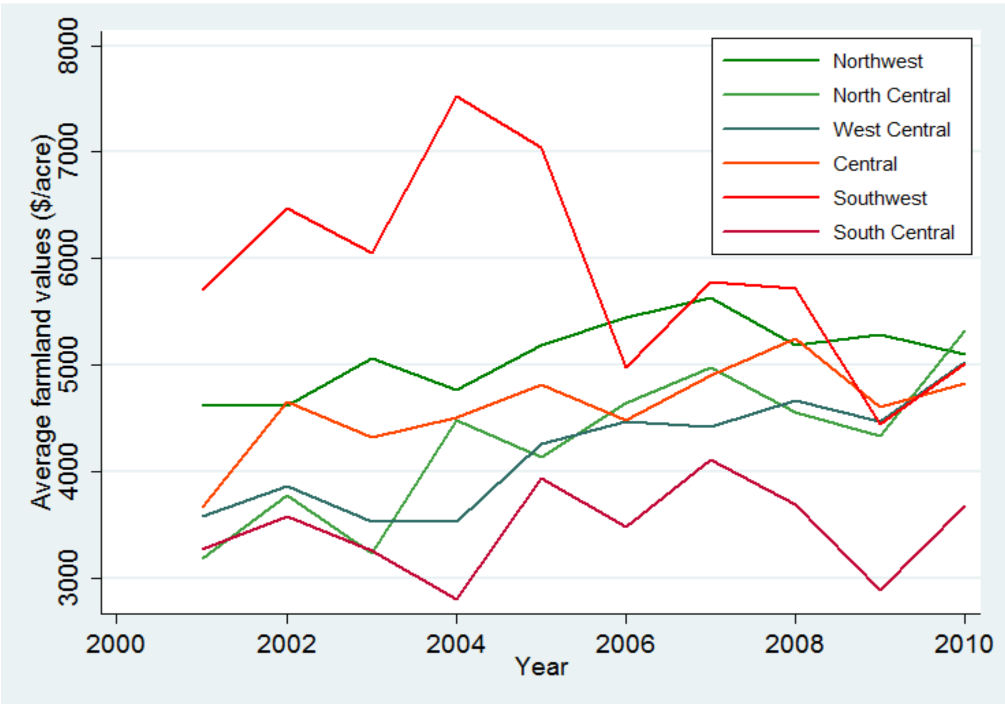

Figure 8. Average farmland prices without structures by crop reporting district 2001-2010

5. Trends in Farmland Prices Across Space and Over Time

4.i Average Farmland Prices

Crop Reporting District	period	Obs	<15 miles	Obs	15-30 miles	Obs	>30 miles
		Miles to nearest city center					
1: Northwest	2001-2006	545	6420.03	1072	4968.519	1126	4387.053
	2007-2008	176	6651.78	332	5489.929	242	4904.378
	2009-2010	83	7112.098	167	5041.909	217	4928.426
2: North Central	2001-2006	123	4605.92	340	3567.014	828	4213.896
	2007-2008	23	2697.405	100	4032.025	288	5660.035
	2009-2010	5	2581.306	47	4759.389	123	4860.688
3: West Central	2001-2006	534	4589.603	885	4067.37	691	3676.739
	2007-2008	243	5054.883	257	4436.923	204	4529.339
	2009-2010	174	4959.544	187	4532.839	211	5077.237
4: Central	2001-2006	883	5177.538	1585	4676.053	611	3705.86
	2007-2008	225	5446.471	469	5764.061	150	3758.366
	2009-2010	106	6211.458	230	4784.748	111	3780.76
5: Southwest	2001-2006	1810	7018.666	225	3812.451		
	2007-2008	312	6201.85	54	4608.179		
	2009-2010	178	5513.759	55	4178.035		
6: South Central	2001-2006	163	3438.768	371	3530.841	176	3332.034
	2007-2008	37	3779.083	68	3891.373	41	4309.449
	2009-2010	25	3057.874	86	3239.203	37	4270.222

Table 2. Average farmland prices by crop reporting district and miles to nearest city center

Figure 7 shows the evolution of average farmland prices with and without structures by quarter from 2001 to 2010. The red dashed line is the nominal average farmland prices per acre with structures from the original dataset, which we refer to as farm real estate values. The blue line denotes the nominal prices with the value of buildings stripped using in the LAND_RATIO variable illustrated in the previous section. We refer to this as cropland prices throughout the paper unless otherwise noted. This red dashed line in the figure reveals that the farm real estate values experienced a modest increase in the early 2000s from around $7,000/acre in 2001 to more than $9,000/acre in 2006, and then declined gradually to around $8,000/acre in the late 2000s. The decline is noticeable; however its size is much smaller than the decline of urban residential housing values – according to Standard & Poor’s Case-Shiller repeat sales price index shown in Figure 9, residential property values in major metropolitan areas have declined by approximately 40% between 2007 and the end of 2008. The estimated cropland prices shown in a blue line reveals an even flatter trend throughout the 2000s decade compared to the farmland real estate values. It suggests that the rise and fall in farm real estate values results more from the value of the buildings and the urban premium than other determinants that affect only cropland prices.

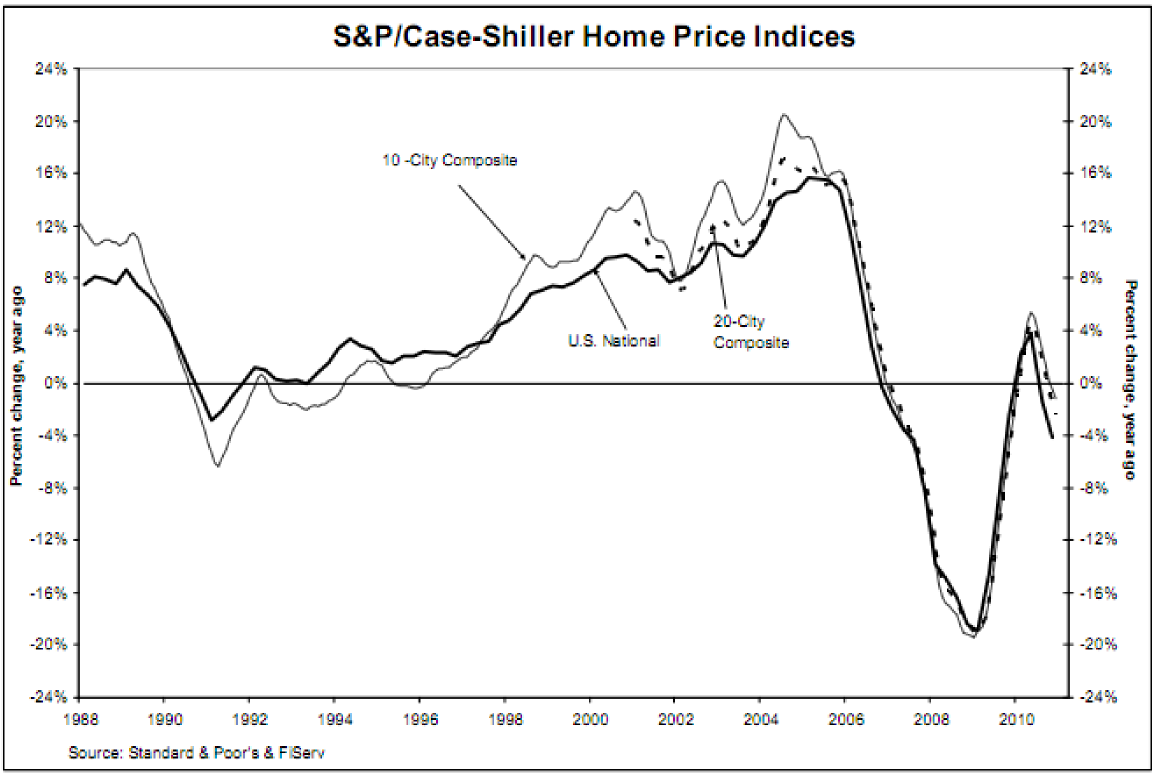

Figure 9. Evolution of the residential housing values in large metropolitan areas in the US 1988-2010

A breakdown of cropland prices by different crop reporting districts in Figure 8 illustrates this point more clearly. Farmland parcels in the *Southwest* district are subject to strong urban influences from the Cincinnati metropolitan area; while farmland parcels in the *Northwest*, *West Central*, and *North Central* districts are more rural and therefore agricultural returns will exert more of an influence. These two groups exhibit contrasting trends: farmland prices in the *Southwest* district are much higher than other agricultural districts before 2006, and saw dramatic decline after 2007. This district is the only region where average farmland prices sharply declined due to the housing market bust. Farmland prices in the other three agricultural districts increased steadily over the 2000s decade, particularly in the *West Central*, and *North Central* districts. These latter trends are more analogous to the trends of NASS survey of farmland values.

Table 2 illustrates the relationship of average farmland prices by distance to nearest city center for each of the districts. In general the closer the farmland parcels to the nearest city center, the higher the average farmland prices. In *Northwest*, *Southwest*, and *Central* districts, farmland within

15 miles from nearest city center on average sells more than $1,000/acre more than farmland beyond 30 miles from the city center. However, a similar relationship is not apparent in the raw data for the three other cities.

Crop reporting district	Acre class	Obs	2001-2006	Obs	2007-2008	Obs	2009-2010
1: Northwest	5-20 acres	847	7479.979	215	7404.756	135	7586.851
	20 acres or more	1650	2836.194	455	3530.579	297	3754.066
2: North Central	5-20 acres	396	4665.578	101	5511.387	50	5964.896
	20 acres or more	758	2776.15	260	3873.542	117	4123.101
3: West Central	5-20 acres	499	5570.158	145	5741.128	97	6255.101
	20 acres or more	1483	2995.041	514	3835.363	441	4201.056
4: Central	5-20 acres	1045	5445.723	245	6493.735	114	6254.802
	20 acres or more	1812	3327.567	526	3876.924	297	3627.675
5: Southwest	5-20 acres	878	7450.938	151	7061.742	58	5104.677
	20 acres or more	909	4395.896	185	4013.496	153	3928.793
6: South Central	5-20 acres	196	4593.986	39	6025.9	27	3905.97
	20 acres or more	486	2648.967	99	2831.996	117	3135.062

Table 3. Average farmland prices by crop reporting district and soil quality

Table 3 summarizes the average farmland prices by crop reporting district and farmland parcel size. We break the farmland parcels into two distinct groups by size: one group has more than 20 acres and the other has only 5-20 acres. These two groups face very different demand: the smaller parcels less than 20 acres could be used as hobby farms and home sites, and thus are subject to more competitive and possible speculative bidding which drives up prices way beyond its cropland values; the bigger parcels, on the other hand, are mainly used for agricultural production and thus are more driven by agricultural commodity trends. Table 3 reveals that the smaller parcels have much higher average prices than parcels over 20 acres, and this is consistent across all crop reporting districts. Table 3 also confirms that smaller parcels are subject to speculative demand as hobby farms, and thus the number of sales and average cropland prices declined precipitously after the housing market bust, especially in the *Southwest* district. Cropland prices for parcels greater than 20 acres saw a significant increase over the 2000 decade, especially in the districts dominated by agriculture such as *Northwest* and *West Central* districts, which results from rises in agricultural commodity prices and farm net returns.

5.ii Surface Map of Parcel-level Farmland Prices

As shown in Figure 6, our data consists only of arm's length farmland parcels sold from 2001 to 2010, and as a result not spatially contiguous. We use spatial interpolation methods to spatially interpolate the farmland prices on other farmland parcels. Specifically, we use kriging to optimally predict the farmland prices on unsold farmland parcels separately for 2001-2006, 2007-2008, and 2009-2010. Kriging makes inferences on unobserved values, takes into account the covariance structure as a function of distance and obtains best linear unbiased predictor (Anselin, 2004). A comparison of Figures 10(a) – (c) shows that farmland prices are higher around metropolitan areas. The trends of farmland values in various metropolitan areas are different: cropland prices for parcels close to Toledo, OH stayed fairly high and steady throughout the 2000 decade, while cropland prices for parcels in the Cincinnati metropolitan area experienced a significant decline from 2001-2006 to 2007-2008. These contrasting trends are analogous to what is revealed in Figure 8: parcels in the Toledo metropolitan area are mostly rural and mainly used for agricultural production, and they also fall within the *Northwest* crop reporting district which enjoyed the rise in agricultural commodity prices and farm net returns. In contrast, farmland parcels in the Cincinnati area or the *Southwest* district are subject to much stronger urban influence and thus are more influenced by the rise and fall in the residential housing market revealed in Figure 9.

5.iii Average Parcel Size

We summarize the average parcel size by the sale year and quarter in figure and find that the average parcel size in western Ohio increased from 45 acres in 2001 to 55 acres in 2010. Table 4 also reveals that there is substantial variation in the average farmland parcel size by crop reporting districts. On average, farmland parcels in that Northwest and West Central districts where the majority of prime farmland resides have a larger acreage than parcels located in Southwest district which are subject to much stronger urban influence from the Cincinnati metropolitan areas. It is also evident that the average size of farmland parcels sold in the Northwest increased dramatically from the early 2000s to the late 2000s, suggesting more sales in late 2000s are of larger prime farmland designated for agricultural production. The Delaware and Madison counties do stand out as anomalies with relatively high parcel size.

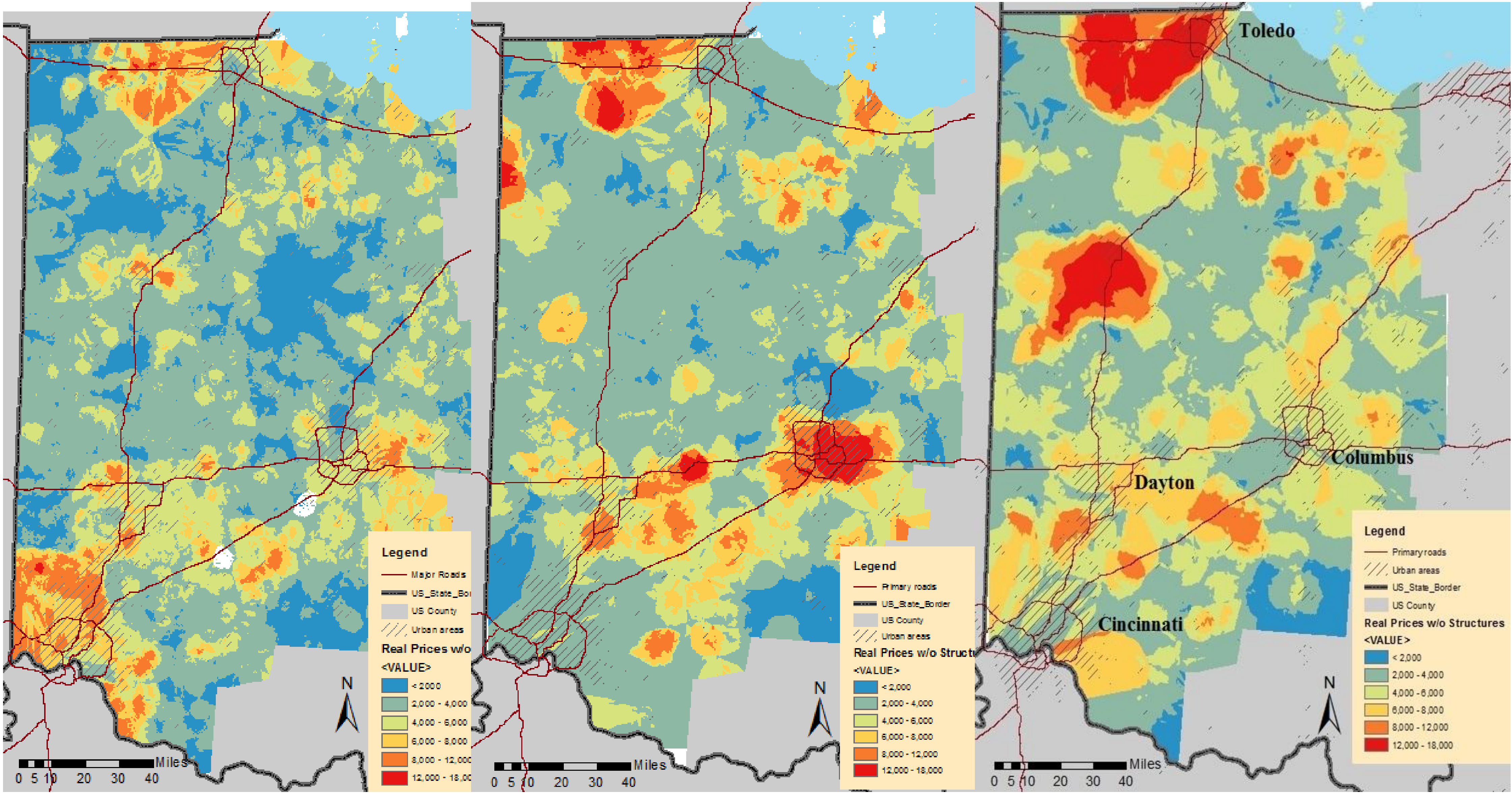

Figure 10 (a, b, c): Surface map of parcel-level farmland prices using kriging in 2001-2006, 2007-2008, and 2009-2010

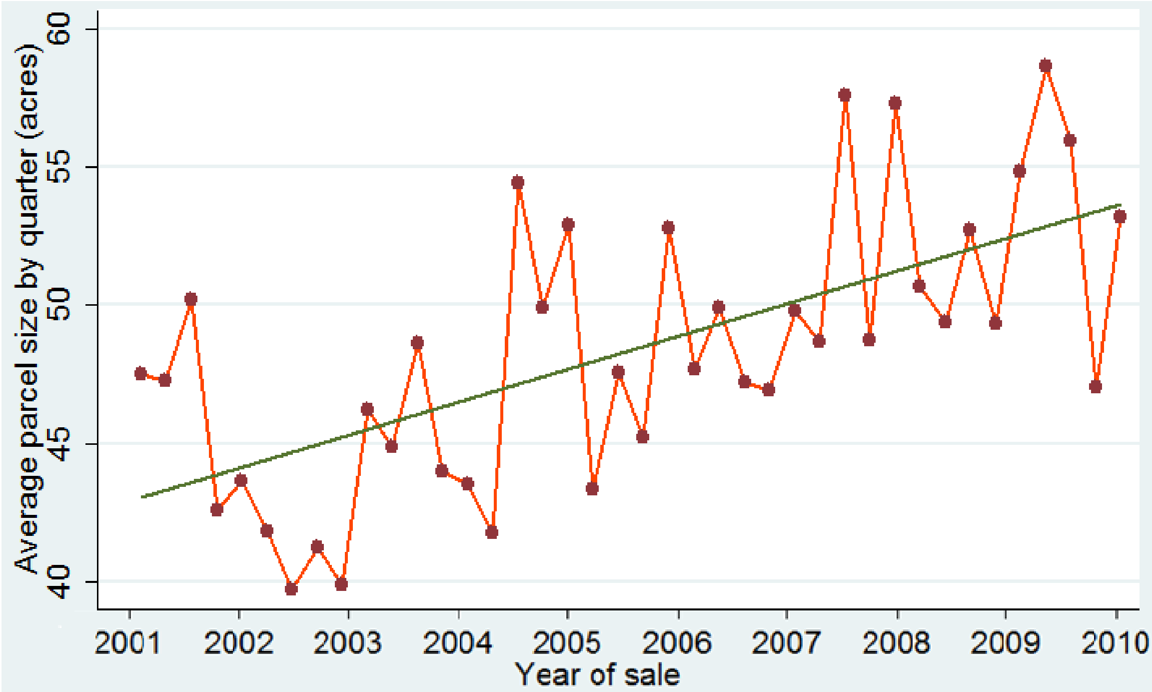

Figure 11. Average parcel size by year and quarter

District	county	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
1: Northwest	Allen	43.4	44.7	36.9	34.7	31.2					
	Defiance	33.0	48.1	38.7	30.8	62.2	60.0	153.9	72.7	37.7	80.0
	Fulton	31.7	23.0	22.2	31.2	24.9	20.5	31.7	37.4	23.8	39.1
	Hancock	35.0	22.0	38.9	42.0	36.9	24.8	42.0	29.0	41.6	40.0
	Henry	34.0	13.8	21.8	37.3	45.7	30.0	23.0	24.9	21.9	43.5
	Lucas	24.0	29.9	22.1	29.0	26.0	35.4	26.2	27.6	28.6	34.6
	Paulding	52.4	41.9	50.8	52.6	50.6	76.7	64.6	57.5	43.9	75.2
	Putnam	37.0	45.3	34.2	47.1	20.6	26.8	43.0	34.0	71.0	47.5
	Senaca	40.2	38.5	40.2	43.3	42.1	39.6	33.4	45.0	52.0	42.9
	Van Wert					58.2	76.3	51.6	35.3	60.2	52.5
	Williams	49.2	48.0	43.7	44.9	40.6	40.4	40.9	35.7	43.3	51.3
	Wood	61.8	52.9	56.6	50.5	63.5	60.3	50.7	66.9	53.8	
2. North Central	Crawford	37.9	27.4	32.5	49.3	33.5	36.5	41.1	47.7	44.9	48.5
	Erie	37.8	52.4	16.2	60.3	31.6	35.0	53.2	42.2	39.2	40.4
	Huron	31.0	35.2	27.7	41.7	26.5	49.3	29.0	42.2	63.6	40.9
	Ottawa	33.5	24.3								
	Richland	43.5	39.9	40.9	35.3	32.9	38.1	32.7	44.2	45.0	
	Sandusky	49.2	50.8	51.1	59.0	90.4	67.8	62.1	66.4	55.8	
	Wyandot	47.3	24.8	41.6	39.0	48.1	54.9	49.5	30.7	59.5	85.2
3: West Central	Auglaize	45.4	50.6	52.7	55.0	59.2	48.4	42.7	32.8	47.9	54.2
	Champaign	54.2	62.3	55.1	42.2	47.3	59.2	50.2	58.6	40.0	57.9
	Clark	41.7	28.9	48.4	43.4	30.4	43.0	29.3	46.3	52.4	43.3
	Darke	65.0	54.1	59.3	59.3	57.2	54.7	67.6	59.3	64.9	59.9

	Hardin	80.9	93.6	96.5	98.1	78.0	73.6	92.9	112.3	91.5	77.3
	Logan	32.5	38.0	44.2	62.7	48.7	46.1	56.5	55.9	47.4	38.5
	Mercer	42.2	42.9	47.7	56.2	57.9	57.5	50.6	61.4	46.6	56.4
	Miami	78.1	79.5	60.7	82.0	52.4	46.9	74.1	56.6	63.6	
	Shelby	40.1	31.9	39.3	33.9	30.6	31.6	33.0	43.1	51.6	32.3
	Delaware	480.2	246.4	419.0	644.6	371.3	473.5	322.6	196.2		
	Fairfield	33.8	34.7	40.0	32.8	30.2	26.8	40.5	50.0	28.3	
	Fayette	48.4	53.5	67.7	54.8	29.5	58.3	49.5	57.4	47.2	61.3
	Franklin	68.8	68.2	59.0	67.5	33.9	79.0	57.2	33.3		
	Knox	30.9	30.0	35.8	25.2	34.5	36.6	26.4	30.5	35.9	
4: Central	Licking	46.5	45.3	44.7	47.5	48.0	52.4	46.7	72.5	41.5	60.2
	Madison	170.5	42.1	44.8	59.3	63.9	51.6	79.9	126.6	162.9	113.9
	Marion	42.4	24.5	26.4	87.1	23.0	42.9	55.5	66.4	32.3	38.2
	Morrow	46.6	52.0	63.3	48.4	44.6	51.4	65.3	48.6	65.7	47.5
	Pickaway	45.3	48.8	60.9	41.7	46.3	49.4	50.6	25.0	48.5	70.3
	Ross	67.9	43.6	59.9	21.9	63.5	65.3	48.5	55.5	48.4	70.3
	Union	36.0	41.9	33.5	40.1	37.9	37.6	41.9	35.8	35.7	28.8
	Butler	30.4	18.7	26.7	31.5	40.2					
	Clermont	55.4	36.8	37.3	19.8	29.9					
	Clinton	34.9	52.4	53.1	34.8	38.0	35.5	26.6	74.3	70.8	38.4
5: Southwest	Greene	19.8	23.8	55.0	24.4	30.4	25.2	40.1	26.2	25.1	
	Hamilton	9.3	15.2	21.8	19.6	32.5	20.4	33.3	35.0	44.6	87.6
	Montgomery	27.5	30.3	34.4	32.5	32.4	33.4	29.4	36.0	42.4	41.7
	Preble	41.7	37.4	41.8	29.6	31.7	38.2	44.3	39.3	42.3	54.5
	Warren	24.0	28.4	38.0	31.3	30.9	41.5	26.4	50.9	40.8	51.6
6: South Central	Brown	44.7	44.9	39.8	50.0	50.4	47.1	45.0	45.2	73.8	57.5
	Highland	48.9	41.5	56.0	42.2	51.4	48.8	63.1	45.2	59.6	62.6

Table 4. Average parcel size by county and year

5.iv Number of Parcel Sales by county

A summary of number of parcel sales by crop reporting district, county and sale year is shown in table 5. On average, almost all counties experienced a sharp decline in the number of farmland sales after the housing market bust, for example, the average number of sales in Fulton County dropped from 80 before 2007 to 20 in 2009-2010. However, regional variations are also evident and it appears that farmland parcels in districts under stronger urban influence such as Southwest district experienced in a greater decline in number of sales than that in districts dominated by agriculture such as West Central district.

District	county	Total	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
1: Northwest	Allen	258	38	42	43	121	14					
	Williams	287	40	26	42	35	38	19	24	22	21	20
	Fulton	691	81	84	95	90	83	89	65	57	27	20
	Lucas	206	26	25	26	21	25	21	17	11	15	19
	Defiance	169	17	25	29	43	20	15	4	8	4	4
	Henry	116	12	13	15	6	15	11	16	10	7	11
	Wood	593	53	52	65	60	83	58	83	113	26	
	Paulding	322	42	33	35	45	24	32	36	27	23	25
	Putnam	96	7	11	9	13	11	8	10	13	5	9
	Hancock	199	10	16	19	19	20	22	18	24	22	29
	Van Wert	69					3	10	13	14	10	19
2: North Central	Sandusky	371	65	54	56	33	34	14	55	43	17	
	Ottawa	78	46	32								
	Erie	141	16	21	13	9	14	13	17	15	12	11
	Senaca	954	107	92	105	127	105	102	92	73	82	69
	Huron	299	43	26	40	22	34	29	20	24	24	37
	Wyandot	39	8	2	4	5	7	3	3	2	2	3
	Crawford	250	25	23	26	29	24	30	30	20	17	26
	Richland	699	54	59	72	118	76	112	98	84	26	
3: West Central	Mercer	408	36	38	35	47	44	42	35	43	37	51
	Auglaize	252	34	36	23	24	17	22	20	25	23	28
	Hardin	375	39	39	35	37	36	50	31	35	35	38
	Darke	624	45	58	57	53	59	61	73	81	62	75
	Shelby	302	37	29	35	33	32	35	29	28	17	27
	Logan	447	43	55	57	53	54	49	52	41	24	19
	Miami	248	17	16	22	32	28	25	48	26	34	
	Champaign	263	32	31	31	29	25	26	20	26	22	21
	Clark	467	47	49	63	52	56	50	44	47	29	30
4: Central	Marion	138	19	17	23	10	4	15	10	8	19	13
	Morrow	371	40	34	35	54	32	49	26	38	32	31
	Knox	968	87	105	134	127	128	143	96	110	38	
	Union	330	42	33	37	42	38	31	41	14	22	30
	Delaware	158	9	11	12	25	32	20	14	35		
	Licking	493	59	65	64	72	60	42	46	26	27	32
	Madison	232	39	22	26	31	23	24	20	18	9	20
	Franklin	71	6	9	10	7	5	4	8	22		
	Fairfield	625	70	65	80	95	80	87	85	59	4	
	Fayette	323	42	64	40	33	24	26	23	22	20	29
	Pickaway	290	32	27	28	25	30	37	38	20	16	37
	Ross	371	29	26	37	33	56	57	32	33	30	38
5: Southwest	Preble	437	54	54	64	48	54	46	22	31	32	32
	Montgomery	526	65	67	68	87	58	38	43	36	25	39

	Greene	343	29	27	34	49	38	36	56	63	11	
	Butler	369	86	80	83	61	59					
	Warren	253	41	22	31	29	38	20	25	16	12	19
	Clinton	326	39	23	45	42	30	33	29	29	29	27
	Hamilton	60	5	6	7	10	7	2	6	10	2	5
	Clermont	320	43	49	49	163	16					
6: South Central	Highland	560	64	70	80	48	54	63	47	37	34	63
	Brown	444	67	56	61	58	47	42	32	30	20	31

Table 5. Number of agricultural land sales in western Ohio 2001-2010 by county and year

5. v Agricultural Turnover Ratio

The agricultural land turnover ratio is calculated by dividing the average total number of acres sold in 2001-2010 by total cropland acres in this particular county. Table 6 and Figure 12 show that on average, less than 2% of total farmland acreage were sold in each year, confirming previous literature's finding that agricultural land market is much thinner than its residential counterpart. Not surprisingly, counties in the metropolitan area such as Delaware County have a higher agricultural turnover ratio than other rural counties. However, that is not true of all metropolitan counties. For example, both Clermont and Brown counties, located in the Cincinnati metropolitan area, had turnover rates right around one percent.

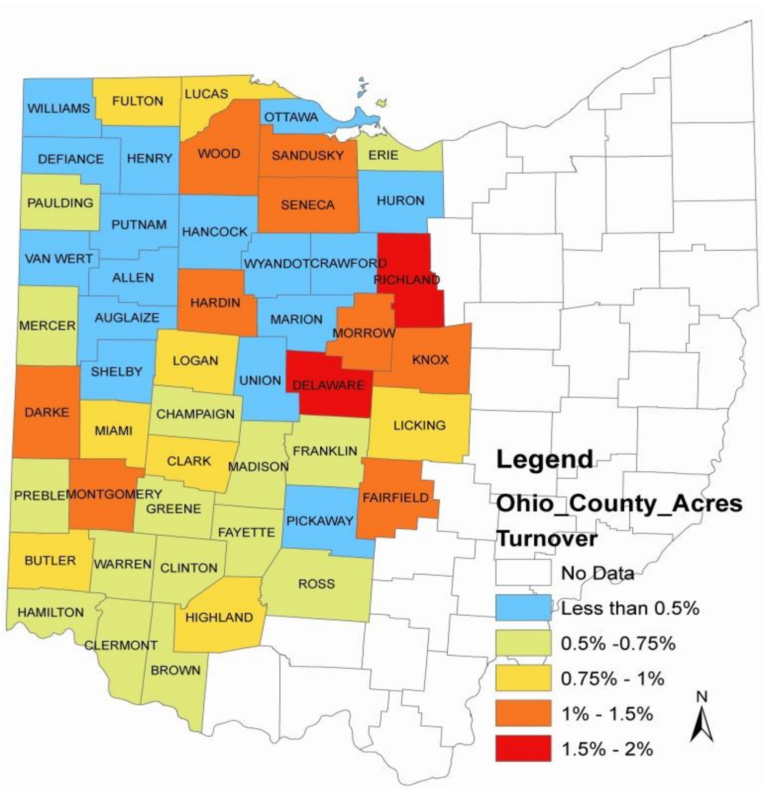

Figure 12. Agricultural land turnover ratio in percentage by county

Crop Reporting District	County	Acres Sold 2001-2010	Acres Sold Per Year	Cropland Acres In the county	Turnover (%)
CENTRAL	DELAWARE	23305	2330.5	122444	1.903
	FAIRFIELD	20548.9	2054.89	140666	1.461
	FAYETTE	15564.6	1556.46	197629	0.788
	FRANKLIN	3631.58	363.158	50618	0.717
	KNOX	27288.4	2728.84	142905	1.910
	LICKING	19546.6	1954.66	169136	1.156
	MADISON	17473.5	1747.35	225382	0.775
	MARION	4135.38	413.538	189598	0.218
	MORROW	17224.3	1722.43	134935	1.276
	PICKAWAY	11925.4	1192.54	257059	0.464
	ROSS	12259.7	1225.97	152574	0.804
	UNION	8633.29	863.329	197888	0.436
NORTH CENTRAL	CRAWFORD	6617.83	661.783	200751	0.330
	ERIE	4737.66	473.766	75261	0.629
	HURON	9474.09	947.409	189541	0.500
	OTTAWA	2202.73	220.273	107052	0.206
	RICHLAND	23955.7	2395.57	110222	2.173
	SANDUSKY	17826.2	1782.61	167236	1.066
	SENECA	36834.2	3683.42	241699	1.524
	WYANDOT	1639.73	163.973	202008	0.081
NORTHWEST	ALLEN	7466.05	746.605	170421	0.438
	DEFIANCE	6693.08	669.308	202932	0.330
	FULTON	17021.8	1702.18	171973	0.990
	HANCOCK	5751.23	575.123	228555	0.252
	HENRY	2772.05	277.206	218797	0.127
	LUCAS	5096.78	509.678	59085	0.863
	PAULDING	13757.4	1375.74	236605	0.581
	PUTNAM	2650.88	265.088	283594	0.093
	VAN WERT	2464.32	246.432	235927	0.104
	WILLIAMS	9603.35	960.335	179095	0.536
	WOOD	28269.9	2826.99	259716	1.088
SOUTH CENTRAL	BROWN	17017.1	1701.71	173184	0.983
	HIGHLAND	24479.8	2447.98	203208	1.205
SOUTHWEST	BUTLER	10067	1006.7	96442	1.044
	CLERMONT	7343.91	734.391	75839	0.968
	CLINTON	12518.5	1251.85	195889	0.639
	GREENE	10229.1	1022.91	142281	0.719
	HAMILTON	1379.77	137.977	12268	1.125
	MONTGOMERY	15547	1554.7	97463	1.595
	PREBLE	12299.1	1229.91	204033	0.603
	WARREN	6965.91	696.591	71975	0.968

	AUGLAIZE	9563.68	956.368	192248	0.497
	CHAMPAIGN	11893.5	1189.35	177052	0.672
	CLARK	16266.5	1626.66	153465	1.060
	DARKE	34756.7	3475.67	319890	1.087
WEST CENTRAL	HARDIN	25956.9	2595.69	230547	1.126
	LOGAN	17752.1	1775.21	168822	1.052
	MERCER	18994.8	1899.48	265784	0.715
	MIAMI	14519.9	1451.99	179034	0.811
	SHELBY	7717.32	771.732	192808	0.400

Table 6. Agricultural land turnover ratio by county

6. Hedonic Analysis of Farmland Prices

Hedonic models are a revealed preference method based on the notion that the price of a good or parcel in the marketplace is a function of its attributes and characteristics. With Rosen's (1974) seminal work as a backdrop, the hedonic price method has become the workhorse model in the studies of real estate or land values (e.g. Palmquist 1989), and the determinants of farmland values. Numerous applications of hedonic models applied to farmland markets have examined the marginal value of both farm and non-farm characteristics of farmland, including soil erodibility (Palmquist and Danielson 1989), urban proximity (e.g. Shi et al. 1997), wildlife recreational opportunities (e.g. Henderson and Moore 2006), zoning (e.g. Chicoine 1981), and farmland protection easements (e.g. Nickerson and Lynch 2001). The farmland returns R_{it} in equation (1) can be approximated by a linear combination of parcel attributes and location characteristics. Hedonic models are commonly specified in log-linear form, which is defined as

$$\log(V_{it}) = \beta_0 + \beta_A{}'\boldsymbol{A_{it}} + \beta_U{}'\boldsymbol{U_{it}} + \theta_j + \tau_t + \varepsilon_{it}, \qquad (2)$$

where τ_t is time fixed effects which captures the temporal variations in returns and discount factor; θ_j is a spatial fixed effect, which captures unobserved variations across crop reporting districts; and ε_{it} is the remaining normally distributed error term; and the agricultural land values V_{it} are approximated by cropland prices. $\boldsymbol{A_{it}}$ denotes the the parcel-specific variables affecting agricultural productivity and $\boldsymbol{U_{it}}$ are location-specific urban influence variables. The regression coefficients are represented by β_0, β_A, and β_U and are estimated by regressing the cropland price per acre on the set of parcel characteristics $\boldsymbol{A_{it}}$ and $\boldsymbol{U_{it}}$ and the spatial and time fixed effects τ_t and θ_j.

	Unit	Mean	Coef	Std Err.	Marginal Value
Agricultural Profitability Influence Variables					
NCCPI	Number	5764.81	4.11E-05***	0.0000	$77.844
Prime soil % of parcel[1]	%	35.09%	0.0285	0.0184	$0.925
Steep slope	Multinomial	0.402	-0.0096	0.0104	($203.107)
Distance to nearest ethanol plant	Miles	29.15	0.0052***	0.0006	$16.927
Distance to nearest grain elevator	Miles	8.32	-0.0049***	0.0014	($15.870)
Distance to other agricultural terminal	Miles	32.35	-0.0065***	0.0006	($21.035)
Forest area % of parcel	%	15.69%	0.0306	0.0276	$0.994
Wetland area % of parcel	%	0.37%	-0.4423**	0.1872	($14.329)
Urban Influence Variables					
Distance to nearest city center	Miles	25.223	-0.0110***	0.0009	($35.518)
Incremental distance to 2nd nearest city center	Miles	14.460	-0.0067***	0.0007	($21.680)
Total urban population within 25 miles	Thousands	289.692	1.66E-04***	0.0000	$0.539
Gravity index of three nearest cities[2]		1117.28	7.29E-08	0.0000	$0.026
Building area % of parcel[1]	%	3.32%	0.1240***	0.0482	$4.028
Distance to highway ramp	Miles	8.954	-0.0009	0.0013	($2.921)
Distance to railway station	Miles	3.066	0.0031	0.0032	($10.049)
General Parcel Attributes					
Assessed land value % of total assessed[1]	%	72.05%	0.8563***	0.0199	$27.921
Total acres	Acres	47.835	-0.0064***	0.0001	($19.725)
Total acres_squared		7535.06	3.2E-06***	0.0000	
Time Effects					
Year 2002			0.0908***	0.0239	$308.600
Year 2003			0.1133***	0.0234	$389.502
Year 2004			0.1818***	0.0230	$647.312
Year 2005			0.2448***	0.0241	$900.529
Year 2006			0.2606***	0.0246	$966.576
Year 2007			0.3217***	0.0250	$1,232.035
Year 2008			0.3205***	0.0253	$1,226.664
Year 2009			0.3138***	0.0291	$1,196.792
Year 2010			0.3514***	0.0289	$1,367.049
District Effects					
District-Northwest			0.0185	0.0265	$60.623
District-West Central			-0.1153***	0.0275	($353.572)
District-Central			-0.0765***	0.0262	($239.111)
District-Southwest			-0.0077	0.0308	($24.904)
District-South Central			0.0373	0.0468	$123.389
Constant			7.7615***	0.0598	
Number of observations	15, 797				
Adjusted R-squared	0.2502				

Table 7. Estimated coefficients and marginal implicit prices from simple hedonic analysis

These estimates can be used to construct a so-called implicit price associated with each of the parcel characteristics. The implicit price is equivalent to the marginal value of a characteristic and can be interpreted as the increase in cropland price from a small increase in that characteristic, holding all other characteristics constant.

6. i Estimated Implicit Prices

Table 7 reports these estimated marginal values from this regression model. We only report the marginal effects for brevity. Considering first the variables associated with agricultural productivity, we find that a 10% increase in the agricultural productivity index NCCPI is associated on average with an additional $77.80 cropland price per acre whereas a 10% increase in the percentage of prime soil is associated with an average increase of $9.30 per acre. Steeper slopes are found to decrease the value of cropland – specifically, we find that a switch from non-steep-sloped land parcel to a parcel with steep slope (> 15 degrees) will on average lead to an $200 reduction on cropland prices. A one mile increase from grain elevators and agricultural terminals is found to decrease cropland prices by an average of $15.80 and $20 respectively. On the other hand, a one-mile increase from ethanol plants is found to be positively correlated with cropland prices, suggesting a rural effect. Given the likelihood of unobserved variables that may be influencing this result, we note that this is a correlation and not necessarily the causal effect. Finally, a one-percent increase in the amount of wetlands on a parcel is associated with an average decrease of $14.30.

Turning to some of the other results, we note that distance from urban centers is associated with a decline in cropland prices. Specifically, a one-mile increase from the nearest city is associated with an average decline of $35.50 per acre and a similar distance from the second nearest city with an average decline of $21.70. Increased distances from transportation nodes are also found to decrease cropland prices: a one-mile increase from the nearest highway ramp and nearest railway station is associated with average declines in cropland prices per acre of $2.90 and $10.00respectively.

The time effects reveal macroeconomic trends that affect all parcels equally and reveal a steady increase in average cropland prices over time. Relative to the year of 2001, farmland parcels sold after 2006 sell for more than $1,000/acre higher. These statistically significant and increasing marginal effects on the year fixed effects clearly confirm Figure 8. Finally, we note that some districts are associated with a net positive effect on cropland prices while others are associated with a net negative effect. These reflect unobserved factors that affect cropland prices and that vary across districts, but that are not explicitly captured in our regression model.

6.ii Effects of the Housing Market Bust on the Urban Premium

Zhang and Nickerson (2013) further use these data and model to explore the influence of urban proximity by examining the change in farmland parcels' urban premium before and after the housing market bust. The appendix below provides a more detailed summary of their methods. We summarize their main results here.

The so-called urban premium quantifies for each parcel the total dollar value resulting from being located closer to urban areas relative to a hypothetical agricultural land parcel with no urban influence. This urban premium measure consists of four distinct parts: value derived from being closer to the nearest city with at least 40,000 people than the reference parcel, additional value derived from being within proximity to the second nearest city, the positive effects resulting from surrounding urban population, and the value derived from total weighted population of the three nearest cities captured in a gravity population index. With these measures, we are able to identify the parcel-level structural change in the influence of urban premium before and after the housing market bust. To construct this metric, the coefficients from a modified version of the original hedonic model (equation (2)) are used:

$$\log(V_{it}) = \beta_0 + \beta_A{}' A_{it} + \beta_{U\_boom}{}' U_{it} + \beta_{U\_bust}{}' U_{it} * Post\_2008 + \tau_t + \theta_j + \varepsilon_{it}, \qquad (3)$$

As before, A_{it} denotes the the parcel-specific variables affecting agricultural productivity; U_{it} are location-specific urban influence variables; $\tau_t$is a time fixed effect and θ_j is a spatial fixed effect, defined here at the census tract level; and β_0, $\beta_A$and β_U are regression coefficients that are estimated. In addition, $Post\_2008$ is a binary indicator variable that equals 1 if the parcel sold after the housing market bust and 0 otherwise. Therefore, the estimate of β_{U_bust} reveals the effect of the urban influence variables on cropland values after the bust. In this model, four key urban influence variables are used in U_{it}: *distance to the nearest city center*, *additional distance to the second nearest city center*, *surrounding urban population within 25 miles*, and *a gravity index of population in three nearest cities* defined in section 2.iii. The coefficients associated with their interaction terms

β_{U_bust} indicate the significance and magnitude of the structural break in the effects of urban influence after the housing market bust.

Table 8 reports the estimates of urban premium before and after the housing bust using the results from the hedonic model. Note that the urban premium on average accounts for more than 40% of the cropland prices, confirming previous findings that urban influence is the most important non-farm factor in shaping farmland values in areas facing urbanization pressures. The biggest of these contributors is *the distance to nearest city center*, whose effect is almost twice as big as that of *incremental distance to second nearest city center*. The magnitude of the effect of distance before 2007 is a 0.88% increase in surrounding farmland values for each one-mile reduction in distance to nearest city center, and is comparable to the findings of previous studies (Ma and Swinton 2012). All else equal, the positive benefit per acre resulting from being closer to the nearest city declined from a significant effect of $30.92 per mile before 2007 to an insignificant $12.97 per mile effect after the housing market bust, an almost 60 percent reduction. In other words, due to the housing market bust, the single largest source of urban influence became insignificant in shaping surrounding farmland values, at least in the immediate short run. The decline is universal across parcels that are located within 10 miles from the boundary of urbanized areas or that are farther away. In addition, the effects of multiple urban centers are no longer significant after 2007. In 2009 and 2010, the only urban influence variable that is still significant is the surrounding urban population.

	Whole sample		**<10 miles**		**10-20 miles**		**30-60 miles**	
	Boom	**Bust**	**Boom**	**Bust**	**Boom**	**Bust**	**Boom**	**Bust**
Total Urban Premium	**$1947**	**$1021**	**$2993**	**$1670**	**$2258**	**$1350**	**$1158**	**$669**
	($1086)	($579)	($1493)	($739)	($1006)	($635)	($465)	($281)
1) miles to nearest city center	$1374	$571	$2185	$951	$1631	$741	$721	$351
	($727)	($279)	($865)	($312)	($600)	($252)	($322)	($140)
2) incremental distance to second nearest city center	$284	$85	$255	$75	$268	$70	$308	$104
	($199)	($54)	($294)	($61)	($217)	($61)	($122)	($45)
3) surrounding urban population	$231	$368	$390	$662	$294	$541	$112	$215
	($231)	($320)	($328)	($404)	($246)	($399)	($95)	($140)
4) gravity index	$59	-$2	$165	-$17	$66	-$2	$17	-$1
	($93)	($39)	($183)	($133)	($66)	($2)	($12)	($1)
Number of observations	9079	1517	1293	128	2854	406	2044	478

Table 8. Comparison of urban premiums before and after the housing market bust

The four main urban influence variables are included in the construction of the urban premium even if their coefficients are statistically insignificant. From Table 8 and Figure 12, we observe that, before 2007 relative to the reference parcel not subject to urban influence, the agricultural parcels subject to urban influence on average enjoy a $1,947 per acre urban premium, or roughly 43% of the per-acre cropland prices. However, after 2008, a sizeable reduction in the urban premium occurred: it declined to only $1,021 per acre on average, which is about 23% of the average per-acre sales price.

We also find that, as expected, the urban premium is on average higher for parcels in closer proximity to urban centers (Table 8), and the impact of the residential housing market bust varied with urban proximity: the difference in the size of the urban premium for parcels within 10 miles of the nearest city center was around $1,835 greater than that for parcels at least 30 miles away from urban centers before 2007, on average, and this difference shrank to about $1,001 after the housing market bust. In other words, the housing market bust has a greater impact on parcels closer to urban centers than those farther away, and resulted in some convergence of the size of the urban premium between these two groups.

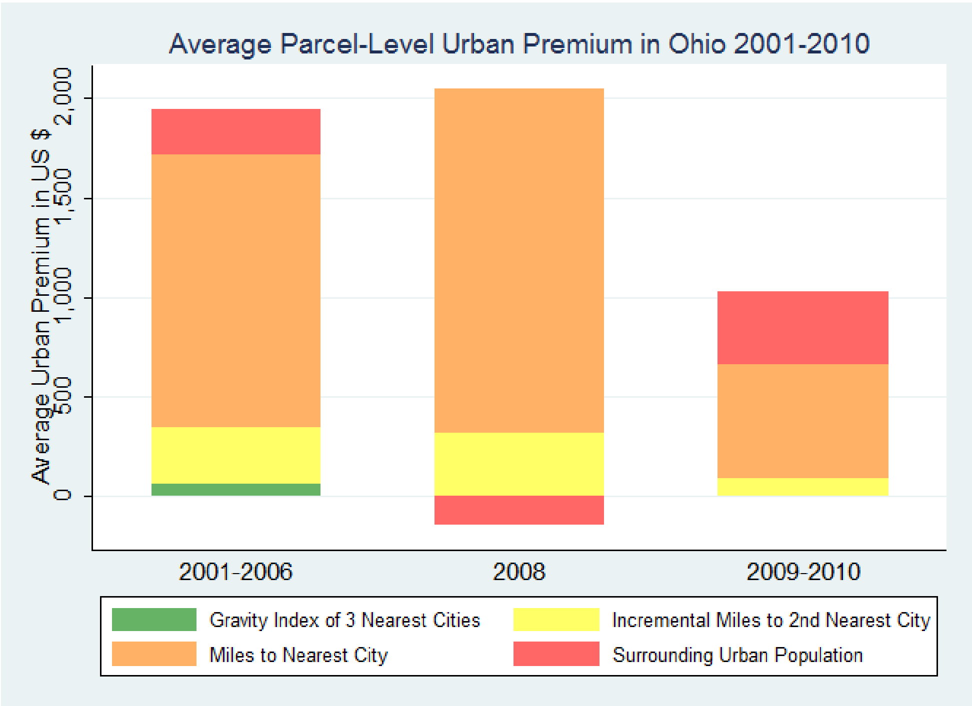

Figure 12. Average parcel-level urban premium in Western Ohio from 2001-2010

A map of estimated urban premiums based on the regression is included in Figure 13. Prior to 2007 the urban premium, with an average of $1,947 per acre, ranges from $145 per acre for parcels that are more than 50 miles away from the nearest city center to almost $8,000 per acre for parcels within urbanized areas. This rich spatial heterogeneity of the urban premium suggests that even in Ohio where almost all parcels are subject to some degree of urban influence, the actual magnitude of the value of the urban influence varies substantially across space. The spatial distribution is intuitive: the urban premium is much higher in areas in close proximity to urban areas.

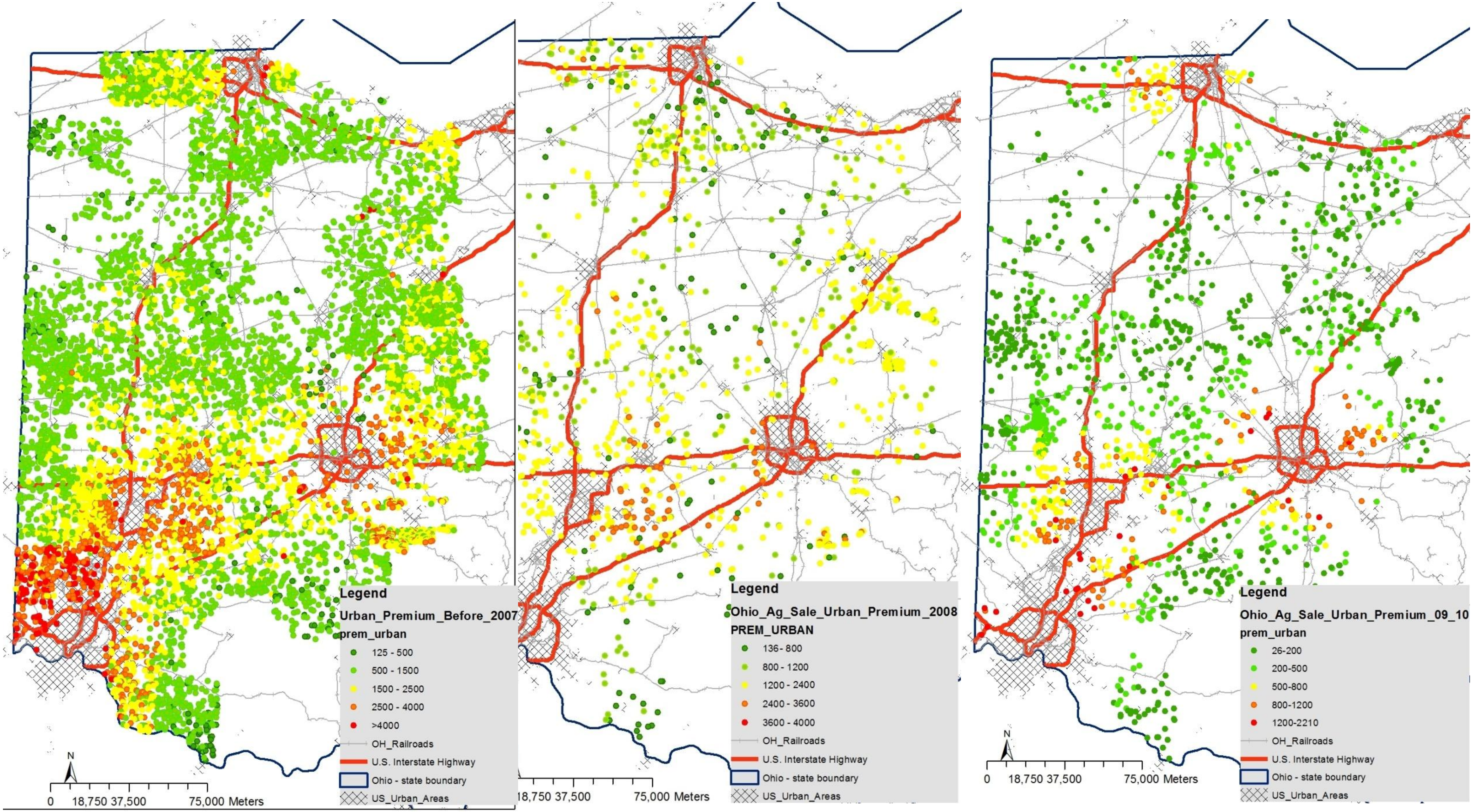

Figure 13 (a,b,c). Spatial distribution of parcel-level urban premium 2001-2010

7. Conclusion

Valued at $1.85 trillion in 2010, farm real estate accounted for 85% of total U.S. farm assets (USDA-ERS 2012); it also represents the largest single investment item in a typical farmer's investment portfolio. The continued significance of farmland values to both the farm sector and to many farm households means that understanding the key trends and determinants of farmland prices will remain of perennial interest. In this bulletin, using a unique dataset of arm's length farmland parcel transactions, we have sought to describe and explain the trends in cropland prices in western Ohio from 2001 to 2010.

Similar to other Midwestern states, farmland values in western Ohio, especially in the areas dominated by agriculture such as *Northwest* and *West Central* districts, saw a steady increase over the 2000 decade. Much of this increase can be attributed to historically low interest rates, rising demand for agricultural commodities for exports and biofuels production, which leads to rapid increases in agricultural commodity prices and farm net returns. On the other hand, farmland parcels close to urban areas faced significant downward pressure due to the recent housing market bust: our analysis show that on average, the urban premium – value resulting from being closer to urban areas – dropped from $1,947 per acre before 2007 to only $1,021 per acre after the housing market bust in 2009-2010. This decline is most evident in districts subject to strong urban influence such as *Southwest* district.

In sum, despite the significant declines in the urban option value for parcels closer to urban areas due to the recent housing market bust, the increases in the farmland values in more rural areas in western Ohio more than compensated this decline, leading to an upward trend in average cropland prices in western Ohio 2001-2010.

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8. Appendix: Methodology for constructing the urban premium

The main specification uses 2001 to 2006 as the pre (boom) period, and 2009 to 2010 as the post (bust) period. The pre- and post- periods were determined based on changes in the residential housing price indexes in Cleveland and Cincinnati metropolitan areas. These indexes exhibited rapid declines through the end of 2008, and a relative leveling off in 2009 and 2010 (Lincoln Institute of Land Policy 2012). The years 2007 and 2008 are treated as a transition period and therefore dropped from the analysis.

Zhang and Nickerson estimate the hedonic model specified in equation (4) and use the results to calculate the urban premium associated with each farmland parcel before and after the housing bust. The parcel level urban premium is calculated as the difference between the predicted prices using actual distance and population variables U_{it} for one parcel and the predicted prices using distance and population variables $\overline{U}$ of the reference parcel with no urban influence:

$$\widehat{\log(P_{it})} = \widehat{\beta_0} + \widehat{\beta_A}' A_{it} + \beta_{\widehat{U\_boom}}' U_{it} + \beta_{\widehat{U\_boom}}' U_{it} * D_{t\_bust} + \widehat{\tau_t} + \widehat{\theta_j} \quad (5)$$

$$\log\dddot{(P_{it})} = \widehat{\beta_0} + \widehat{\beta_A}' A_{it} + \beta_{\widehat{U\_boom}}' \overline{U} + \beta_{\widehat{U\_boom}}' \overline{U} * D_{t\_bust} + \widehat{\tau_t} + \widehat{\theta_j} \quad (6)$$

$$\text{urban premium} = \exp\left(\log\left(P_{it}(\widehat{U_{it})}\right) + \widehat{\sigma_\epsilon^2}/2\right) - \exp\left(\log(\dddot{P_{it}}(\overline{U})) + \widehat{\sigma_\epsilon^2}/2\right) \quad (7)$$

Guiling et al. (2009) has estimated the extent of urban influence using parcel level data in Oklahoma, and found that for a city with around 50,000 residents, the urban influence on farmland prices extends 45 miles from the city center. Semiparametric regressions using our data in Ohio reveal that the effects of urban influence become negligible around 60 miles away from the nearest city center, and the effects of the incremental distance to the second nearest city center are no longer evident beyond 40 miles. As a result, the distance and population variables for the reference parcel in this study are 60 miles for the distance to nearest city, 40 miles for the incremental distance to the second nearest city, and zero for surrounding urban population and gravity index. Using this definition, our measure of the urban premium is constructed relative to the hypothetical, rural parcel whose urban influence variables are denoted as $\overline{U}$. In our study region of Ohio, this metric is always positive for all the agricultural parcels.