Linking the Price of Agricultural Land to Use Values and Amenities

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In many areas throughout the United States, the market value of agricultural land exceeds its use value in agricultural production. This deviation is the result of many factors, including urban influence, recreation, mineral extraction, and other natural amenities. This study examines the drivers of the nonagricultural portion of cropland and pastureland values across the United States using a rich geospatial data framework linked to the USDA's June Area Survey. The analysis suggests that many natural amenities and urban pressures shape the value of US cropland and pastureland, and that development potential is the largest driver of the nonagricultural component of farmland values.

Farmland prices throughout much of the United States have exhibited an unprecedented escalation in appreciation rates in recent years, and as a result, US aggregate farmland values are now at record highs in both nominal and real terms. Farm real estate accounts for over 80% of total asset base of America's agricultural sector (Nickerson, et al., 2012). Given farmland's prominent role in the financial health of the agricultural sector, the current state of farmland price appreciation presents agricultural and applied economists with a number of important questions that will likely define future research agendas.

This study outlines some of the emerging knowledge on one important aspect of current farmland markets: linking farmland's market value to its nonagricultural use values and amenities. As a productive asset, farmland derives most of its value from the production of agricultural goods and services. However, in many areas throughout the U.S., farmland's market value exceeds its agricultural use value—in some areas agricultural use value makes up less than half of the total market value (Barnard, 2000). In addition to agricultural goods and services, farmland provides a number of ecosystem services, access to recreational amenities, and areas for urban expansion. While the majority of existing literature has addressed this disconnect in the context of urban proximity (for example, Anderson and Griffing, 2000), Kuethe, Ifft, and Morehart (2011) show that this value divergence can also be found in predominantly rural areas. Uematsu, Khanal, and Mishra. (2013) suggest that the natural amenities provided by farmland play an important role in the economic health of rural America and find evidence that farmland values, therefore, reflect the premiums associated with positive natural amenities. Bastian et al. (2002) demonstrate that in Wyoming, farmland prices reflect premiums for wildlife habitat, sport-fishing opportunities, and scenic vistas.

In addition, this difference between farmland market and implied agricultural use values may play an important role in regional economic policies. Across the U.S., agricultural land is given preferential tax treatment, in which the taxable value of the land is based on the implied agricultural use value and not the full market value (Anderson, 2012). However, a number of states have recently revised the tax treatment of agricultural properties. If the divergence between market values and agricultural use value continues to widen, while farm incomes continue to increase states and localities may look to this potential tax revenue to help ease financial difficulties. Understanding the drivers of the divergence—the non-agricultural components of farmland values—may help inform this policy debate.

This study makes an important contribution to the existing literature by developing a simple method for evaluating the portion of farmland market value not associated with the returns from agricultural production. We leverage the unique advantages provided by USDA survey data that provide accurate measures of farmland market values and agricultural returns. This yields new information on the key drivers of farmland prices.

Methodology

Most empirical studies of farmland values employ some variation of the present value model which suggests that an asset's value (e.g. farmland value) is given by the capitalized value of expected future streams of income generated by the asset. In its simplest form, the present value model is expressed:

$$(1) \qquad P_t = \sum_{i=1}^{\infty} \frac{E_t(R_{t+i})}{(1+r)^i}$$

where P_t is the value of a parcel of land at time t, R_t represents the returns to land in period t, r denotes a constant discount rate, and $E_t(.)$ is the expectations operator given the information available in time t. Expectations, however, are unobservable, and as a result, it is common to substitute a measure of observed returns, such as imputed returns or cash rents, for expected returns (see, Anderson, 2012). In this analysis we use cash rents. In this case, the present value model simplifies to:

$$(2) \qquad P_t = \frac{R^*}{r}$$

where R^* represents measurable returns to farmland—the agricultural use value.

While the present value model remains the most popular framework for analyzing farmland values, the limitations of the model are widely recognized (Ay and Latruffe, 2013). The simple present value model has been augmented to include market frictions, such as transaction costs (Just and Miranowski, 1993), or additional sources of returns, such as development to urban land use (Plantinga and Miller, 2001; Guiling et al., 2009) or government payments (Goodwin and Ortalo-Magne, 1992; Clark, et al., 1993; Weersink, et al., 1999). In an econometric framework, we can acknowledge the incomplete nature of the present value model by expressing the simplified version of the model as:

(3) $$P_t = \frac{R^*}{r} + \eta_t$$

where η_t is the portion of farmland values not attributable to agricultural returns. We refer to η_t as the nonagricultural value of farmland, with $\frac{R^*}{r}$ representing the agricultural value. Nonagricultural value can be calculated as $\eta_t = P_t - \frac{R^*}{r}$.

The primary motivation of this analysis is our empirical model which decomposes the determinants of the nonagricultural portion of farmland values as:

(4) $$ln(\eta_t) = X\beta + \varepsilon_t$$

where X is the quantifiable drivers of the nonagricultural value suggested in previous studies, such as recreational use, urban influences and natural amenities, β is a set of unknown parameters, and ε_t is the regression residual.

In many ways, the estimation of the empirical model (4) follows the standard hedonic approach in which the value of an asset is decomposed into the individual contributions of its characteristics (Rosen, 1974). A number of studies examine the market value of agricultural lands using the hedonic price framework (for example, Huang, et al., 2006). One unique contribution of this analysis is that we limit the hedonic analysis to only the portion of the market value not explained by the agricultural use value. We estimate equation (4) separately for cropland and pastureland. It is expected that the drivers of the nonagricultural values of these distinct land types may differ (Doye and Brorsen, 2011).

Data

The estimation of our empirical model (4) requires accurate measures of both the market value of agricultural land and agricultural use value. We leverage the unique advantages of confidential data collected by the USDA's National Agricultural Statistics Servive (NASS) to identify the component of cropland and pastureland market values that is not associated with agricultural use. The June Area Survey (JAS) collects information from farmers each June on items such as acreage, land use and agricultural activities. In particular, the JAS data identifies the market value and cash rent payments of land in cropland, both irrigated and non-irrigated, and pasture, grazing or grassland. The JAS data also include information on the entire farm operation including: land uses, type of production specialty, farm real estate values and more. The agricultural land values collected by the JAS serve as the foundation of the annual NASS land value report which is considered "the gold standard for land valuation" (Zakrewicz, Brorsen, and Briggeman, 2012, pp. 70). The JAS is an area-based sample framework which ensures a geographic snapshot of agricultural land values. This feature also allows us to match JAS data to various local and field-level amenities.

The explanatory variables used in this article to model the non-agricultural determinants of farmland values fall into several categories: population and urban influence measures, recreation and natural amenities and environmental disamenities. The dependent and independent variables are described below and defined and summarized in table 1.

Nonagricultural Values

The JAS is based on a probability area frame with an annual sample of about 11,000 segments of approximately 1 square mile. Data is collected from all farmers operating within the sampled segments and segments are surveyed longitudinally over several consecutive years. We examine the cash rent and market value data reported in the JAS for 2010. The year was selected for several reasons. It is relatively recent, aligns with the 2010 Census of Population, which some of our covariates are derived from, and does not reflect the inflated housing values and rapid construction that peaked in 2007 or the immediate impacts of the economic downturn in 2008 and 2009.

As discussed previously, the dependant variable is the value of cropland or pastureland not attributable to agricultural returns as represented by capitalized cash rent payments. That is, we examine the total reported value per acre of cropland or pasture land less the capitalized cash rent value. Capitalized rents are calculated as the rental rate divided by a discount rate. The discount rate is assumed to be the 10-year treasury note rate plus an estimated risk premium of 0.04. Although JAS data is collected at the tract or farm level, our unit of observation for this study is the segment level. Hence, all data, whether representative at the tract or farm level, is aggregated and averaged using survey weights to represent the segment level. Both land values and rents must be reported for a segment for the observation to be included in our analysis. For cropland, 7,599 segments had land value reported and 5,487 had rental rates reported, for a total of 4,734 segements where nonagricultural values could be calculated. For pasture, 4,463 segments had land values reported and 2,277 had rental rates reported, for a total of 1,750 segments where nonagricultural values could be calculated. The explanatory variables included in the model are defined and summarized in table 1. A related control variable is the average tract size, which control for the impact of parcel size on nonagricultural value.

The calculation of nonagricultural values relies on a number of assumptions and caveats. First, it is assumed that rental rates fully capture agricultural use value but do not reflect amenity value. While actual expected returns are not observable, rental rates do reflect the value the market places on expected agricultural returns. Further, both land values and rental rates are collected in the same survey and, as a result, may provide a fairly precise representation of the relationship between agricultural use values and market values. Second, there are fewer rental rate observations than land value observations, as not all farmland is rented, and farmland tenure patterns vary regionally. Our models control for state and region effects which are included, in part, to capture some of this effect. Third, small farms are less likely to rent land and may not be primarily motivated by agricultural profitability. In these cases, our model may underestimate the impact of different amenities on nonagricultural value.

Population and Urban Influence Measures

The most commonly cited non-agricultural driver on farmland values is urban influence (for example, Huang, et al. 2006; Livanis, et al. 2006; Plantinga, Lubowski and Stavins 2002). Several measures of urban influence are included to capture the various ways urban areas and the associated economic activity and population can impact farmland values. The JAS respondents are directly asked what the likely use of their crop or pasture land is if sold under current market conditions. We include an indicator for the responses 'immediate development' and 'expected future development', and these variables are averaged to the segment level. The excluded categories are 'agricultural use' and 'other'. The nonagricultural values are expected to increase under development pressure. The survey responses are supplemented with a county-level index of urban-related population effects on agricultural lands based on the 2010 Census of Population—the population-interaction index (PII) published by USDA's Economic Research Service (ERS) (USDA/ERS, 2005). We also include measures of the travel time from the segment to a city with population over one million (urban area) and the travel time to a town with population of at least 2,500[1]. Farmland value is expected to be positively influenced by population measures and proximity to urban centers, although urban influence might not be positive for all landowners. For example, some landowners may prefer "solitude" or being further away from urban areas.

Similarly, higher incomes and housing prices also should reflect positively in land values. Included are county-level measures of median household income (USDA/ERS, 2013) and the 2nd quarter state-level nonmetropolitan housing index (Federal Housing Finance Agency, 2013). Also

1 The creation of geographical variables and other geographical analysis was completed with ESRI ArcGIS software.

included are either distance or count measures of proximity to institutional amenities – golf courses and hospitals [2]. Environmental Systems Research Institute (ESRI), the supplier of the Geographic Information System software ArcGIS, provides many data layers, including government and non-government, commercial, and Census geographies. We rely on ESRI-provided landmark and recreation datasets to provide national coverage of point locations of hospitals and golf courses (ESRI, 2013). Proximity to these features may indicate increasing amenity value for individuals. This may indirectly represent pressure for development near hospitals and golf courses. Farmland value is expected to increase with proximity or number of these institutions and features.

A related control variable is the average tract size, which controls for the impact of parcel size on the per acre nonagricultural value.

Recreation and Natural Amenities

Past studies indicate recreation and natural amenities positively influence farmland values (for example, Bastian, et al. 2002; Nickerson, et al. 2012; Pope 1985; Wasson, et al. 2013). We include the share of national, state, county and regional park land within a 10 mile buffer of the farmland tract (ESRI, 2013). While parks are generally considered an amenity due to recreation potential, the proximity to parks may indicate other influences such as restrictive zoning or the rural nature of the parcel. Therefore, the effect of park land on farmland values is unknown.

Also included are a measure of distance to nearest recreation water body (rivers and lakes) and the share of tree cover within a one mile buffer. Park and recreational water data layers were obtained from ESRI Data and Maps (ESRI 2013). Land in tree cover is derived from the National Land Cover Database 2006 (Fry et al. 2011). Values are expected to increase with proximity to recreational water. Tree cover may not be compatible with highly productive cropland or pasture land; however, because tree cover may provide both amenity and recreational opportunities we expect tree cover to positively impact nonagricultural values.

Studies have indicated that non-agricultural income sources such as hunting leases, for example, may impact farmland values (Guiling, Brorsen and Doye 2007; Henderson and Moore 2006; Pope 1985). We use the US Fish and Wildlife Service's National Hunting License Report to include the number of hunting licenses—issued to both residents and non-residents—at the state level (USFWS 2013). This measure is normalized as a per square mile measure. We expect farmland values to increase with the density of hunting licenses.

Recent years have been marked by rapid growth in domestic oil and gas production, and leasing mineral rights and the subsequent royalties provide additional returns to farmland. As a result, increased oil and gas production on a particular parcel would be expected to increase its value. We include county-level measures of oil and natural gas production. Data from oil and/or natural gas producing states were obtained on a state by state basis. Most states have production statistics available by field, county, or well, and these data were compiled at the county-level to create a database of county-level production, annually for 2000-2011. Natural gas withdrawals were not available for Illinois or Indiana and estimates were produced using geocoded wells and state total production reported to the Energy Information Agency (Weber, Low and Walsh, forthcoming).

Finally, research has suggested certain landscape and climate features provide rich natural amenities (McGranahan 1999). We control for climate using weather characteristics—average daily July maximum temperatures to reflect average day time temperatures. Thirty-year (1971-2000) normals are obtained from PRISM Climate Group[3]. We also include a measure of topography—mean slope within a 300 meter neighborhood. Topography can be a measure of a quality that people prefer – where areas with more variability in slope are more desirable.

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3 http://www.prism.oregonstate.edu/

Environmental Disamenities

The data are further supplemented with U.S. Environmental Protection Agency data on facilities and sites subject to environmental regulation. We group brownfields, large quantity generators, superfund, toxic release and other EPA sites and facilities as a simple measure to capture the disamenties associated with proximity these environmental releases. As suggested by past research (for example, Messer, et al. 2006) we expect these sites to negatively impact farmland values.

All models include fixed effects, either state or regional indicators, to capture locational heterogeneity. The regions correspond to USDA ERS farm resource regions (Heimlich, 2000).

Results

We estimate the empirical model (4) using both ordinary least squares and quantile regression following Uematsu, et al (2013). Overall, our results illustrate that various nonagricultural influences are important determinants of farmland values, and pasture values are more likely to reflect various amenities, including urban influence and development pressure. The results can be found in table 2, with results of the quantile regression presented in figures 1 and 2 and tables A1 and A2 of the Appendix. The reported coefficients can be interpreted as the percentage change in land values associated with a one unit change in the explanatory variable. Our models have strong explanatory power, with R^2 in the range of 0.97 for cropland and 0.67 for pasture. Given that the number of pasture observations is substantially smaller, we consider only three conditional quantiles (.25, .50, .75) for the quantile regression for pastureland, compared to nine quantiles (0.1, 0.2,…,0.9) for cropland.

There are a few key differences between the OLS and quantile regression specifications that are worth noting. The OLS regressions include state-level fixed effects to account for locational variation in omitted variables, but the limited number of observations at some quantiles requires the use of regional-level fixed effects in the quantile regressions. Some differences in the results between the OLS and quantile regression models might therefore be attributable to correlation of explanatory variables with unobserved local conditions. For example, temperature normals are not statistically significant in the OLS regression (table 1), but in our cropland quantile regression, with the more coarse regional fixed effects, both temperature and temperature squared coefficients are very large and statistically significant at the one percent level for most quantiles. While it may be that more precise measures of climate, such as the interaction of humidity and temperature, might better capture desirable climate conditions, state effects appear to absorb any mean temperature impacts as modeled in the OLS regression.

Potential for development, both intermediate and future, has the largest impact on nonagricultural values. The effect is much stronger for pastureland than for cropland, with pasture land values increasing more than 100% if future development is likely (or if 100% of the land in a segment is likely to be developed). While the net effect of immediate development on cropland is only weakly statistically significant, it is large compared to most other explanatory variables. Further, the effect of immediate or future development has larger effect and is statistically significant for the larger quantiles of cropland. Tree cover also has a strong influence on nonagricultural value, although the sign is different for cropland and pasture. High levels of nearby tree cover are associated with higher pasture nonagricultural values and lower cropland nonagricultural values. While tree cover would be expected to be a positive amenity, it may be correlated with other disamenties for cropland, such as inaccessibility to roads and heavily sloped land that is unsuitable for development.

Once development potential is taken into account, the impact of proximity to urban areas on nonagricultural values is relatively small, as measured by the PII or distance from urban areas or small town variables. However, distance to a large urban area does have a positive and statistically significant impact on pasture values. Being ten miles further from a large urban area is associated with a three percent decline in pasture nonagricultural value. Related to urban influences measures are measures of local wealth, such as median household income and the non-metropolitan housing index. These variables also have a statistically significant impact on pasture but not on cropland nonagricultural values. In the quantile regressions, these variables do have a positive and statistically significant impact on the higher-valued cropland nonagricultural values. While urban influence and wealth are consistently positive amenities for pastureland across different specifications, the results for cropland are more varied, suggesting heterogeneous impacts of urban influence. This may be due to the potential disamenities related to urban influence and wealth including congestion and noise.

Various recreational amenities are associated with higher nonagricultural values of pasture and cropland. Golf courses have a large impact on both pasture and cropland values, with an approximately 1-2 percent increase in value associated with each additional golf course within 25 miles. Distance to recreational water also has a negative (positive amenity) and statistically significant relationship with pasture nonagricultural value and for most cropland quantiles in the quantile regression analysis. While the share of nearby land in parks does not have a statistically significant impact on mean cropland or pasture values, it does have a large, positive and statistically significant impact on nonagricultural values for higher quantiles of both cropland and pasture values. Hunting licenses and other related permits have a positive and statistically significant effect for cropland and for the pasture in the quantile regression, but a smaller and negative impact on pasture values in our main regression. While this is a relatively imprecise/nonlocal measure, this result does indicate that hunting or correlated natural amenities are important determinants of farmland values.

Oil and gas production generally have a negative impact on cropland and pasture nonagricultural values. These variables represent average production per square mile at the county level, so the coefficients should be considered as the "net effect" of local production. While oil or natural gas production may provide additional income to landowners (Weber, Brown and Pender, 2013) or additional local employment and investment (Weber, 2012), the amenity value of nearby land values may decline. While the net effect in our analysis is generally a decline in nonagricultural values, in some quantiles of cropland the net effect is positive, which reflects the heterogeneity in this relationship. Although nationwide plot-level production data is not currently and may never be accessible, smaller scale regional studies may be able to take advantage of richer data to further elucidate the impact of mining and mineral production on farmland values, both from a local amenities perspective as well as a production impact.

Figures 1 and 2 illustrate the impact of our explanatory variables on different levels of cropland and pasture nonagricultural values. The confidence intervals for pasture (figure 2) are generally much larger than for cropland (figure 1), which may be related to the smaller sample size for pasture. While not directly comparable due to different quantiles being used, the impact of development pressure and various amenities on pasture nonagricultural values appears to be much more homogenous than cropland. Cropland perhaps has a wider range of nonagricultural uses than pasture, which may be reflected in nonagricultural values and their relationship with amenities. Overall, these results indicate that flexible functional forms should be used when estimating the drivers of nonagricultural values of farmland.

Conclusion

The recent apprecation in farmland values across the United States has raised a number of important questions that will likely define future research agendas for many agricultural and applied economists. This study presents emerging knowledge on an important facet of agricultural land valuation: the divergence between the market and implied agricultural use values. This study examines the nonagricultural use value of US cropland and pastureland using data collected by USDA’s June Area Survey.

The analysis suggests that many natural amenities and urban pressures shape the nonagricultural value of US cropland and pastureland, yet development potential is a key driver of the nonagricultural component of farmland values. Overall pasture values are more likely to be inflated based on nonagricultural influences. These findings explain discrepancies between pasture and cropland values that have been observed in recent years; local amentities explain why pasture values are higher in some areas than cropland values despite the lower implied agricultural use value of pastureland.

The emerging knowledge provided by this study is derived from data that are national in scope. While geospatial data availability will likely expand in the future and this analysis can be further enhanced, some data will only be accessible or relevant for more limited geographic areas. Future research may build on the foundation outlined here by using more detailed data on local amenities in a restricted geographic area. Future research may also further explore the relationship between "nearby amenities" vs on-site amenities, such as hunting on a specific property versus ample nearby hunting areas.

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Tables and Figures

Table 1. Summary Statistics

	Cropland		Pasture	
	Mean	Std. Dev.	Mean	Std. Dev.
Nonagricultural Value	1710.31	4154.16	2012.28	3307.97
Agricultural Value	1148.58	1409.34	301.18	368.99
Tract size	112.08	105.24	66.44	78.74
Immediate Development Potential	0.03	0.12	0.04	0.13
Future Development Potential	0.04	0.14	0.05	0.14
Population intensity index	21.28	29.12	15.83	24.62
Travel time urban area	235.74	170.28	277.21	186.97
Travel time to small town	36.14	32.05	48.35	42.43
Slope (mean)	4.53	6.14	6.33	7.52
Distance to recreational water	9.04	8.24	10.48	9.22
Ave. max. temp. (July)	87.30	4.88	89.55	4.87
Ave. max. temp. squared (July)	7644.80	866.39	8042.41	858.08
Tree cover	0.16	0.22	0.16	0.22
Land in Parks	0.01	0.07	0.02	0.09

Distance to nearest hospital	11.16	6.37	13.25	8.84
Golf courses	12.19	14.37	7.58	10.13
EPA sites	14.69	21.82	8.45	15.16
Oil production	0.26	1.39	0.53	1.75
Natural gas production	4.01	30.63	13.57	61.82
Median household income ($1000)	43.53	9.35	41.83	9.30
Hunting and fishing licenses	16.01	12.31	9.75	8.40
Nonmetro. housing index	181.28	27.32	182.90	14.57

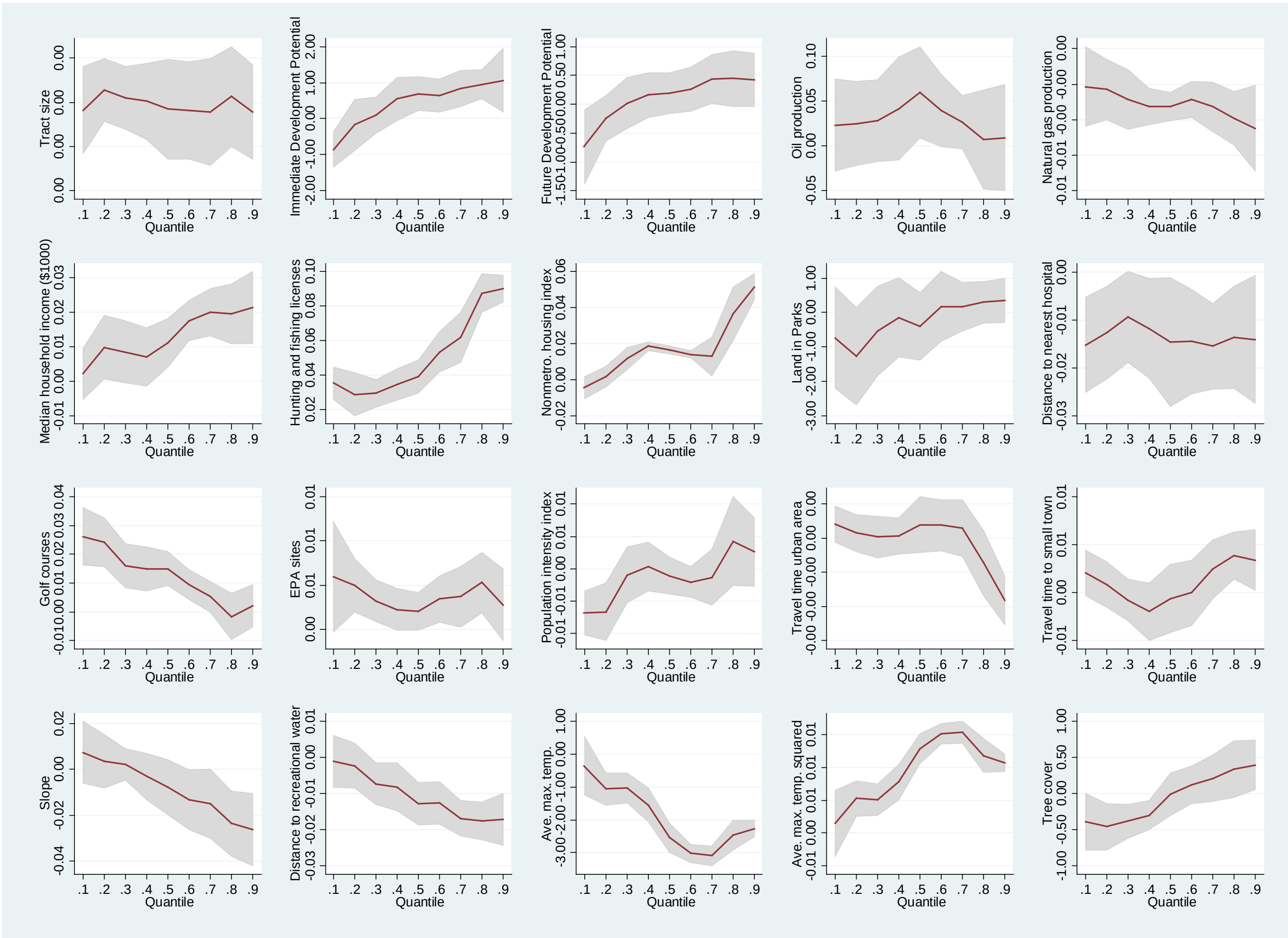
Table 2. OLS Regression Results

	Ln Nonagricultural Value	
	Cropland	Pasture
Tract size	0.001***	-0.001***
	(0.000)	(0.000)
Immediate Development Potential	0.364*	1.105***
	(0.184)	(0.153)
Future Development Potential	0.012	0.941***
	(0.158)	(0.173)
Population intensity index	-0.005	-0.001
	(0.004)	(0.002)
Travel time urban area	0.000	-0.003***
	(0.001)	(0.001)
Travel time to small town	0.001	-0.001
	(0.001)	(0.001)
Slope (mean)	0.006*	-0.006
	(0.003)	(0.004)
Distance to recreational water	0.000	-0.006**
	(0.002)	(0.002)
Ave. max. temp. (July)	0.260	-0.078
	(0.258)	(0.200)
Ave. max. temp. square (July)	-0.001	0.000
	(0.001)	(0.001)
Tree cover	-0.806***	0.332**
	(0.116)	(0.153)
Land in Parks	0.054	0.510
	(0.292)	(0.316)
Distance to nearest hospital	-0.007**	-0.012**
	(0.003)	(0.005)
Golf courses	0.015***	0.011**
	(0.005)	(0.004)
EPA sites	0.002	0.001
	(0.001)	(0.004)
Oil production	-0.021**	-0.018**
	(0.008)	(0.008)
Natural gas production	-0.002***	0.000
	(0.000)	(0.000)
Median household income ($1000)	0.005	0.012***
	(0.005)	(0.004)
Hunting and fishing licenses	0.013***	-0.009*
	(0.003)	(0.005)
Nonmetro. housing index	0.002	0.002***

	(0.001)	(0.001)
Observations	4659	1717
R^2	0.975	0.673

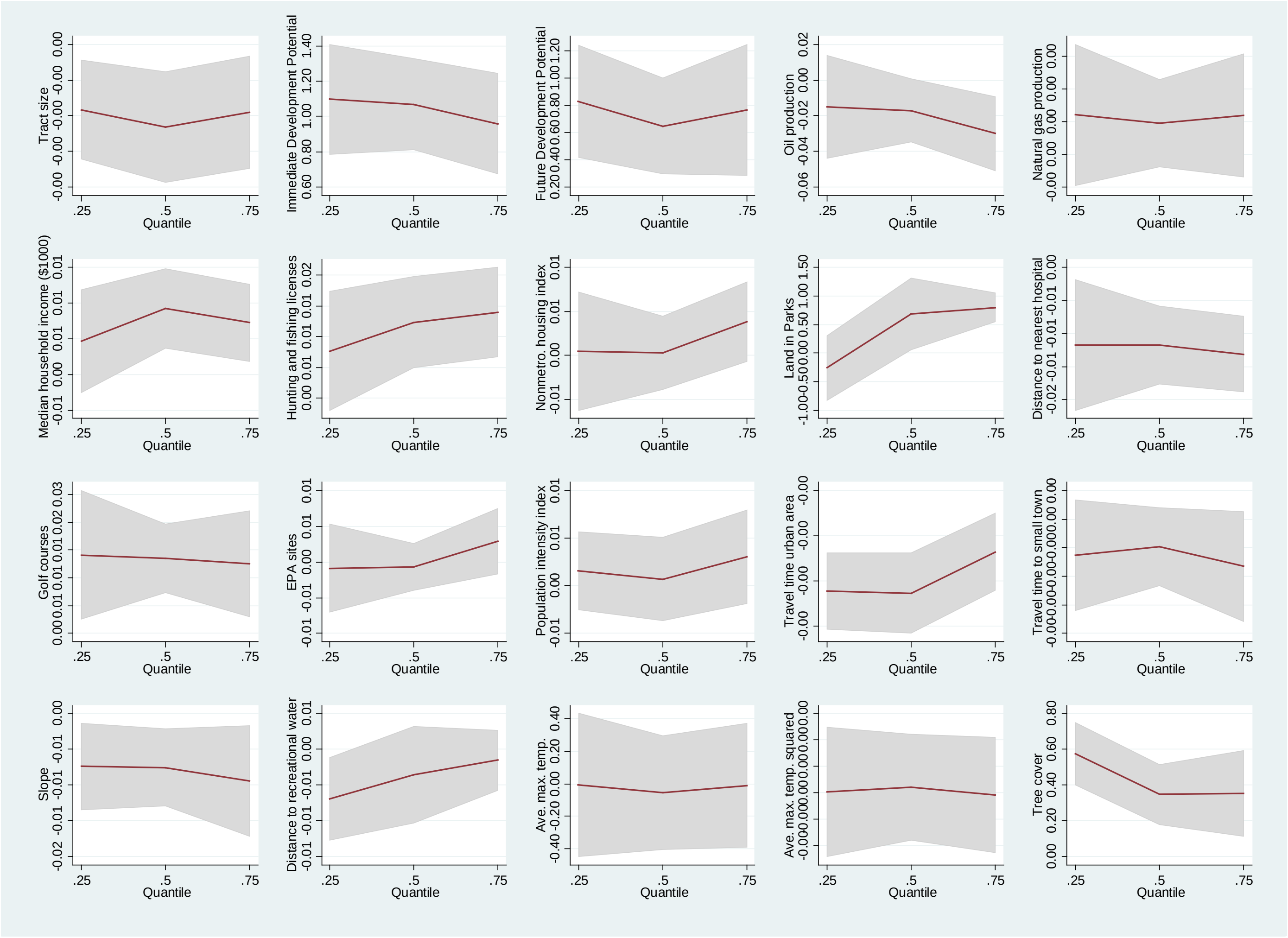
Note: Standards errors are reported in parenthesis and are robust to correlation at the state level; state fixed effects are also included in the regression; *Ten percent level of significance, **five percent level of significance, ***one percent level of significance

Figure 1. Quantile Regression Coefficients – Cropland



Note: 95% Confidence intervals are shaded grey and calculated using a bootstrap procedure with 500 repetitions

Figure 2. Quantile Regression Coefficients – Pasture



Note: 95% Confidence intervals are shaded grey and calculated using a bootstrap procedure with 500 repetitions

Appendix

Table A1. Quantile Regression Results – Cropland

	Ln Nonagricultural Value - Cropland								
	q10	q20	q30	q40	q50	q60	q70	q80	q90
Tract size	0.001***	0.001***	0.001***	0.001***	0.001***	0.001***	0.001***	0.001***	0.001***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Immediate Development Potential	-0.639**	-0.179	0.308	0.483***	0.469***	0.625***	0.780***	0.986***	1.235***
	(0.304)	(0.271)	(0.228)	(0.128)	(0.149)	(0.165)	(0.139)	(0.154)	(0.231)
Future Development Potential	-0.649*	-0.215	0.152	0.210*	0.271**	0.303**	0.410***	0.317**	0.581***
	(0.350)	(0.211)	(0.148)	(0.125)	(0.132)	(0.120)	(0.131)	(0.132)	(0.199)
Population intensity index	-0.004	-0.003	0.003*	0.003**	0.004***	0.006***	0.007***	0.002	0.001
	(0.002)	(0.002)	(0.002)	(0.001)	(0.001)	(0.001)	(0.002)	(0.002)	(0.002)
Travel time urban area	0.001***	0.002***	0.001***	0.001***	0.002***	0.002***	0.002***	0.001***	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Travel time to small town	0.001	0.000	-0.000	0.000	0.001	0.001	0.002	0.002**	0.001
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Slope	0.017***	0.012***	0.005*	0.002	0.001	-0.002	-0.007**	-0.006**	-0.005*
	(0.005)	(0.004)	(0.003)	(0.002)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
Distance to recreational water	-0.004	-0.006*	-0.008***	-0.009***	-0.012***	-0.014***	-0.016***	-0.012***	-0.009***
	(0.003)	(0.003)	(0.002)	(0.002)	(0.002)	(0.002)	(0.003)	(0.002)	(0.002)
Ave. max. temp.	-0.083	-0.529**	-0.478***	-0.483***	-0.611***	-1.066***	-1.351***	-0.774***	-0.513***
	(0.390)	(0.234)	(0.149)	(0.134)	(0.160)	(0.187)	(0.250)	(0.139)	(0.130)
Ave. max.	0.000	0.003**	0.002***	0.002***	0.003***	0.005***	0.007***	0.004***	0.003***

temp. squared									
	(0.002)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Tree cover	-0.645***	-0.827***	-0.888***	-0.785***	-0.758***	-0.648***	-0.619***	-0.556***	-0.472***
	(0.206)	(0.144)	(0.112)	(0.107)	(0.096)	(0.085)	(0.098)	(0.086)	(0.109)
Land in Parks	-0.917	-0.700	-0.255	0.185	0.053	0.170	0.224	0.338*	0.591**
	(0.650)	(0.519)	(0.455)	(0.268)	(0.188)	(0.202)	(0.201)	(0.188)	(0.255)
Distance to nearest hospital	-0.013***	-0.008**	-0.002	-0.002	-0.001	0.000	0.002	-0.003	-0.003
	(0.005)	(0.004)	(0.003)	(0.003)	(0.003)	(0.004)	(0.004)	(0.004)	(0.004)
Golf courses	0.020***	0.016***	0.008***	0.005***	0.002	-0.001	-0.002	0.004*	0.004
	(0.004)	(0.004)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.003)
EPA sites	0.005**	0.004***	0.003***	0.003***	0.003***	0.002***	0.003***	0.002*	0.003*
	(0.002)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)
Oil production	0.017	0.037	0.030	0.060*	0.095**	0.108***	0.041**	0.004	-0.026**
	(0.029)	(0.025)	(0.029)	(0.036)	(0.038)	(0.030)	(0.020)	(0.009)	(0.012)
Natural gas production	-0.001	-0.002**	-0.002***	-0.003***	-0.003***	-0.003***	-0.003***	-0.002***	-0.002*
	(0.001)	(0.001)	(0.000)	(0.000)	(0.000)	(0.001)	(0.001)	(0.001)	(0.001)
Median household income ($1000)	0.003	0.014***	0.013***	0.015***	0.016***	0.017***	0.016***	0.015***	0.016***
	(0.004)	(0.004)	(0.002)	(0.002)	(0.002)	(0.002)	(0.003)	(0.002)	(0.003)
Hunting and fishing licenses	0.017***	0.014***	0.014***	0.012***	0.010***	0.011***	0.015***	0.015***	0.012***
	(0.005)	(0.003)	(0.002)	(0.002)	(0.002)	(0.002)	(0.003)	(0.002)	(0.003)
Nonmetro. housing index	-0.004	-0.000	0.000	0.001	0.001	0.003**	0.009***	0.008***	0.006**
	(0.003)	(0.002)	(0.001)	(0.001)	(0.001)	(0.001)	(0.003)	(0.002)	(0.003)
Observations	4659	4659	4659	4659	4659	4659	4659	4659	4659
Psuedo-R^2	0.422	0.513	0.611	0.671	0.667	0.629	0.586	0.561	0.542

Note: In the parentheses under QR estimates are bootstrapped standard errors obtained through 500 bootstrap replications; *Ten percent level of significant, **five percent level of significance, ***one percent level of significant; regional fixed effects are also included in the regression

Table A2. Quantile Regression Results – Pasture

	Ln Nonagricultural Value - Pasture		
	q25	q50	q75
Tract size	-0.001***	-0.001***	-0.001***
	(0.000)	(0.000)	(0.000)
Immediate Development Potential	0.989***	1.045***	0.955***
	(0.181)	(0.140)	(0.164)
Future Development Potential	0.690***	0.634***	0.828***
	(0.201)	(0.169)	(0.279)
Population intensity index	0.003	0.001	0.003
	(0.002)	(0.002)	(0.002)
Travel time urban area	-0.002***	-0.003***	-0.002***
	(0.000)	(0.000)	(0.000)
Travel time to small town	-0.002*	-0.001	-0.001
	(0.001)	(0.001)	(0.001)
Slope	-0.008**	-0.006**	-0.009***
	(0.004)	(0.003)	(0.003)
Distance to recreational water	-0.002	-0.004*	-0.001
	(0.003)	(0.002)	(0.002)
Ave. max. temp.	0.037	-0.020	-0.011
	(0.299)	(0.196)	(0.231)
Ave. max. temp. squared	-0.000	0.000	-0.000
	(0.002)	(0.001)	(0.001)
Tree cover	0.514***	0.344***	0.368***
	(0.118)	(0.114)	(0.119)
Land in Parks	-0.218	0.706**	0.772***
	(0.386)	(0.313)	(0.237)

Distance to nearest hospital	-0.011**	-0.008***	-0.013***
	(0.004)	(0.003)	(0.003)
Golf courses	0.013***	0.014***	0.012**
	(0.005)	(0.004)	(0.005)
EPA sites	0.000	0.001	0.003
	(0.003)	(0.002)	(0.003)
Oil production	-0.019	-0.020*	-0.033***
	(0.014)	(0.011)	(0.010)
Natural gas production	0.000	0.001*	0.001
	(0.000)	(0.000)	(0.000)
Median household income ($1000)	0.006	0.010***	0.008***
	(0.004)	(0.002)	(0.003)
Hunting and fishing licenses	0.010**	0.011***	0.014***
	(0.005)	(0.004)	(0.004)
Nonmetro. housing index	-0.001	0.003	0.005**
	(0.003)	(0.002)	(0.002)
Observations	1717	1717	1717
Psuedo-R^2	0.465	0.467	0.435

Note: In the parentheses under QR estimates are bootstrapped standard errors obtained through 500 bootstrap replications; *Ten percent level of significance, **five percent level of significance, ***one percent level of significance; regional fixed effects are also included in the regression