Watching Corn Grow: A Hedonic Study of the Iowa Landscape

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Abstract

Landscape amenities can be scarce in places with large areas of open space. Intensely farmed areas with high levels of monocropping and livestock production are akin to developed open space areas and do not provide many services in terms of landscape amenities. Open space in the form of farmland is plentiful, but parks and their services are in short supply. This issue is of particular importance for public policy because it is closely linked to the impact of externalities caused by agricultural activities and to the indirect effects of land use dynamics. This study looks at the impact of landscape amenities on rural residential property values in five counties in North Central Iowa using a hedonic pricing model based on geographic information systems. The effect of cropland, pasture, forest, and developed land as land uses surrounding the property is considered, as well as the impact of proximity to recreational areas. The study also includes the effect of other disamenities, such as livestock facilities and quarries, which can be considered part of the developed open space and are a common feature of the Iowa landscape.

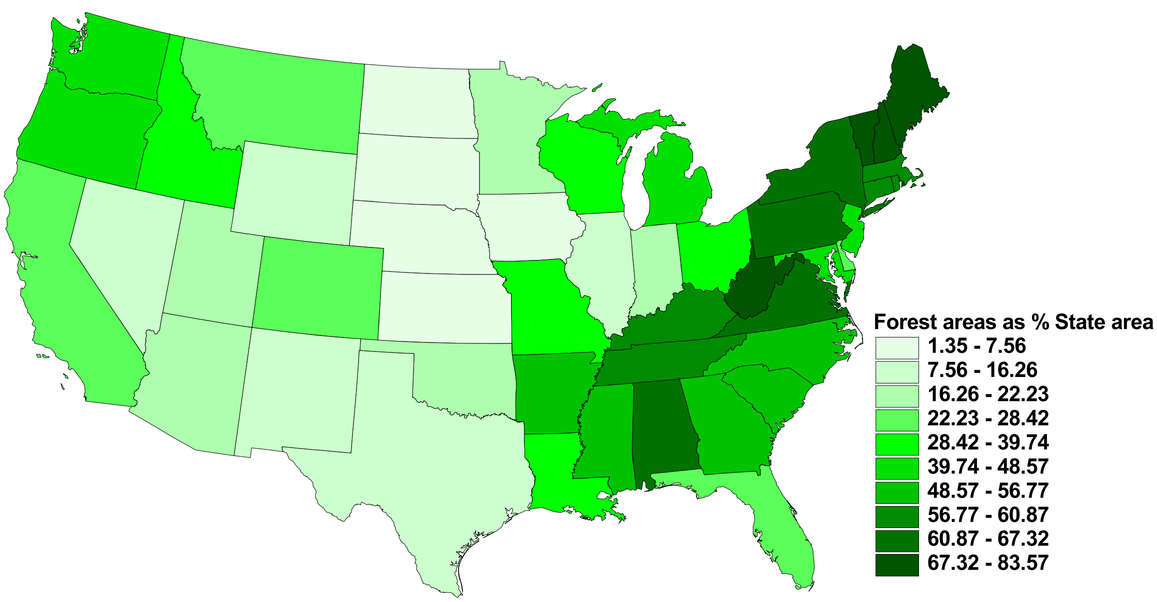
Keywords: environmental management, hedonic analysis, land use, spatial externalities.

Introduction

In recent years, economists have analyzed extensively the value of landscape amenities (e.g., Kline and Wichelns 1996, Irwin 2002, Geoghegan 2002, Ready and Abdalla 2005). In the United States, this research has focused on the Northeastern region, because of its high population density, the increase in sprawl, and the associated loss in farmland.[1] The availability of geocoded data has played a role as well. However, landscape amenities can be scarce in areas with low population density and high levels of open space. The reason is that open space is a nebulous term that groups assorted land uses such as farms, parks, and developable land. These various types of open spaces, however, provide very different services and therefore are valued differently (Irwin 2002). For example, a property surrounded by confined animal operations and farmland where corn is produced year after year is likely to have different wildlife habitats, biodiversity, and scenic views than a property surrounded by a mix of forest and ungrazed and grazed pastures.

In large parts of the Midwest, open space in the form of farmland is plentiful, but year-round green areas and parks (and their services) are in short supply. To some extent, intensely farmed areas with high levels of monocropping and confined livestock production are akin to developed open space areas and may not provide many services in terms of landscape amenities. The scarcity of landscape amenities is often intensified by the lack of green areas and parks. This is in stark contrast with the issues faced by Northeastern communities, where cropland is a small and declining area but where parks and green areas are often present. This disparity is illustrated by Figures 1 and 2. Figure 1 shows the continental United States grouped in deciles based on forested area normalized by state area.

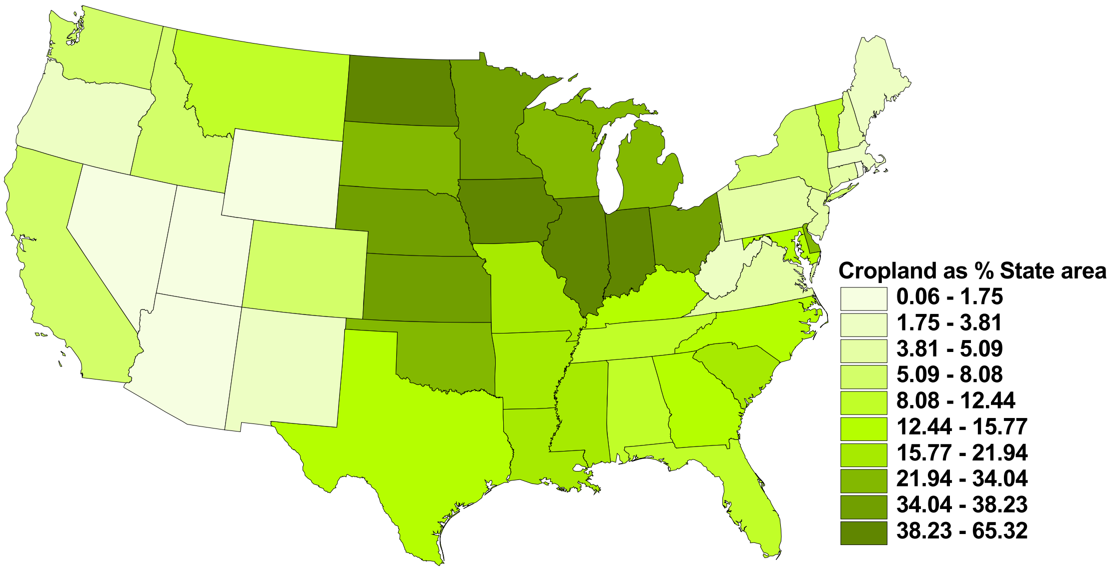
Figure 1- Forested areas in the United States by state, as a percentage of state area.



[1] An exception is Bastian *et al.*, which focuses on Wyoming, but the paper deals with agricultural, not residential, properties.

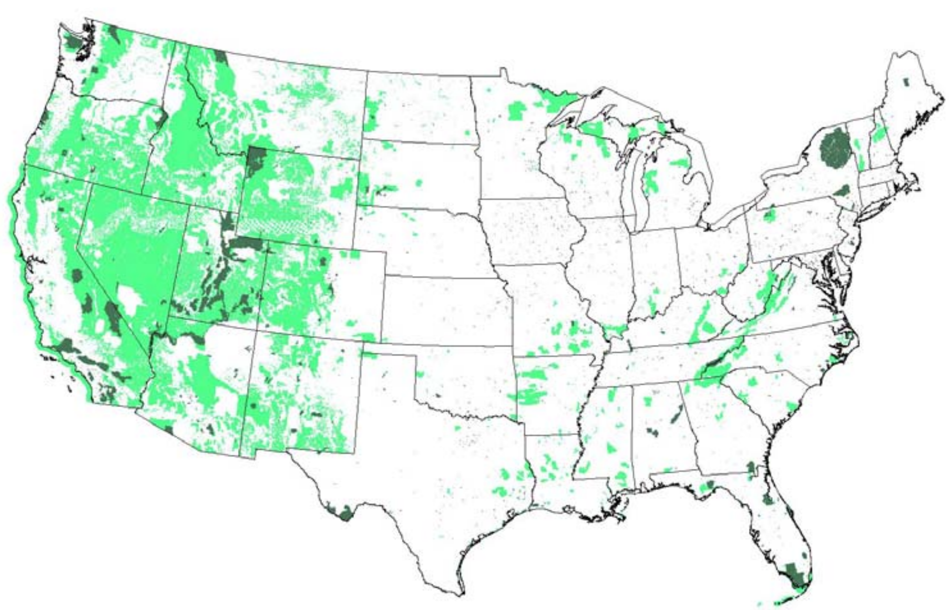
Figure 2 shows the percentage of state area in cropland in 1992. Both figures are based on the 1992 National Land Cover Characterization from the U.S. Geological Survey (USGS 2003).

Figure 2- Cropland in the United States by state, as a percentage of state area.



Aggregating at the state level can be misleading, as there are probably more differences within a state than there are across states. However, the figures illustrate the intensive nature of agriculture in the Midwest, and how it has displaced other land uses.

Figure 3 - Parks and federal green areas in the United States (ESRI 2003a,b).



The scarcity of landscape amenities is compounded by the lack of parks and public open spaces. Figure 3 shows parks (federal, state, and local) in dark green, and in light green it shows non-defense federal lands such as Bureau of Land Management lands and national forests. Large areas of the central United States have little or no green areas that can be used for recreation, and the green areas tend to be heavily fragmented.

The purpose of this paper is to study the impact of landscape amenities on property values in the Midwest, specifically in rural Central Iowa, to determine if types of open space matter. In particular, since this is a very different setting from those of previous studies, this research will help assess the value of forested open space and open space devoted to farmland. This analysis also includes the impact of confined animal operations and whether they are a significant point-source disamenity. These issues are of particular importance in the Midwest because the agricultural land uses that occupy so much of the space are heavily subsidized and are a massive source of nonpoint-source pollution. Environmental quality issues and compliance with trade agreements have been at the center of recent discussions on how agricultural support is carried out in the United States and the possibility of altering it by moving toward “green” or conservation payments. Such programs would be compliant with World Trade Organization regulations and would simultaneously decrease pollution. The current farm legislation (enacted in 2002) has already taken steps in this direction by increasing the budget of the Environmental Quality Incentives Program and by introducing the Conservation Security Program. If conservation policies increase the availability of landscape amenities, this should be considered in their assessment.

Perhaps nowhere in the United States are these issues as evident as in Iowa. According to the Iowa Department of Economic Development, the state ranks first in corn, egg, and hog production, and second in soybean and red meat production (IDED n.d.). In 2002, Geographic Information System (GIS) maps show that almost 60% of the State’s land was used to grow corn and soybeans, while less than 8% of the land was forested (IDNR 2004). State, local and private parks and nature preserves do not significantly increase the land available for recreation: overall, only 2.3 percent of the state is in conservation lands as identified by the Iowa Department of Natural Resources (IDNR)[2].

Our study area is even more intensely cropped than the state average and correspondingly has less pasture and forest than the state overall. In 2002, cropland ranged from 75% to 83% of area of the counties studied, while forests were only 1.6% to 5.55% of the area (see details in Appendix A). This because the study area is in North Central Iowa, where land tends to be more fertile than in the South and flatter (and thus more easily cropped) than in the East. These differences have changed little between 1992 and 2002, the major alteration being that, even though the area reserved for row crops in Iowa has changed little, in the study region there has been a decrease in row crop area and a corresponding increase in pasture. This is partly due to substantial increases in land set aside through the Conservation Reserve Program (CRP).[3] This study builds upon a previous work that took into account only the effect of Confined Animal Feeding Operations (CAFOs) on property values (Herriges, Secchi, and Babcock 2005).

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[2] This includes federal, state, and local public land and private preserves. See IDNR 2002a.

[3] The most dramatic increase occurred in Hamilton County, where acres increased from 2,100 in 1992 (National Resources Inventory database) to 8,704 in 2003 according to the Farm Service Agency.

Next is a brief discussion of the econometric issues relating to hedonic models, landscape amenities, and open space, followed by a description of the data used in the model. Finally, the results and conclusions are presented.

Hedonic models and landscape amenities

Hedonic analysis posits that there exists a relationship between prices and characteristics of goods and services. For example, goods such as houses are valued for various attributes, such as the number of fireplaces and the size of the lot, but also, since real estate cannot be moved, for proximity to amenities or vistas to be enjoyed from the property. Therefore, hedonic analysis provides an instrument for assessing the value of non-market goods such as landscape amenities.

The hedonic regression is a reduced-form equation whose parameters derive from the housing market equilibrium. Therefore, the assumption underlying the analysis is that the transactions used are part of a unique housing market. The parameters obtained from the regression can be used only to assess marginal changes in the attributes used in the analysis. Moreover, if such changes affect a wider population than the area's homeowners, the hedonic analysis underestimates the impacts. However, the analysis provides information on agents' preferences based on revealed rather than stated preferences and provides estimates of a part of the effects of conservation and preservation.

There are several econometric issues associated with hedonic models. When studying the impact of the value of landscape amenities on property values, the most important and problematic issue is probably the endogeneity of explanatory variables. The issue is specifically over measures of (developable) open space, because of spillover effects and missing variables. The potential for land development is influenced by the prices of surrounding properties, and it simultaneously has an effect on them. For example, if parcel *i*'s land use is residential or industrial, and this decreases the value of neighboring parcel *j* for future development, then parcel *j* is less likely to be developed. Thus, land use in parcel *i* negatively impacts the value of parcel *j*. Note that the direction of the spillover can also be reversed. For example, the landscaping and road construction associated with a new housing development could improve the value of neighboring parcels. The problem is compounded by the fact that land development tends to occur in clusters, for example, when a new subdivision is built. So the spillover effects are likely to behave in a groupwise manner. Economies of scale or the presence of a particular amenity in the neighborhood may pull toward a group of parcels being developed all together, possibly with similar characteristics. In this case, a classical ordinary least square (OLS) regression is likely to produce biased estimates. The presence of multicollinearity, on the other hand, can lead to low significance levels.

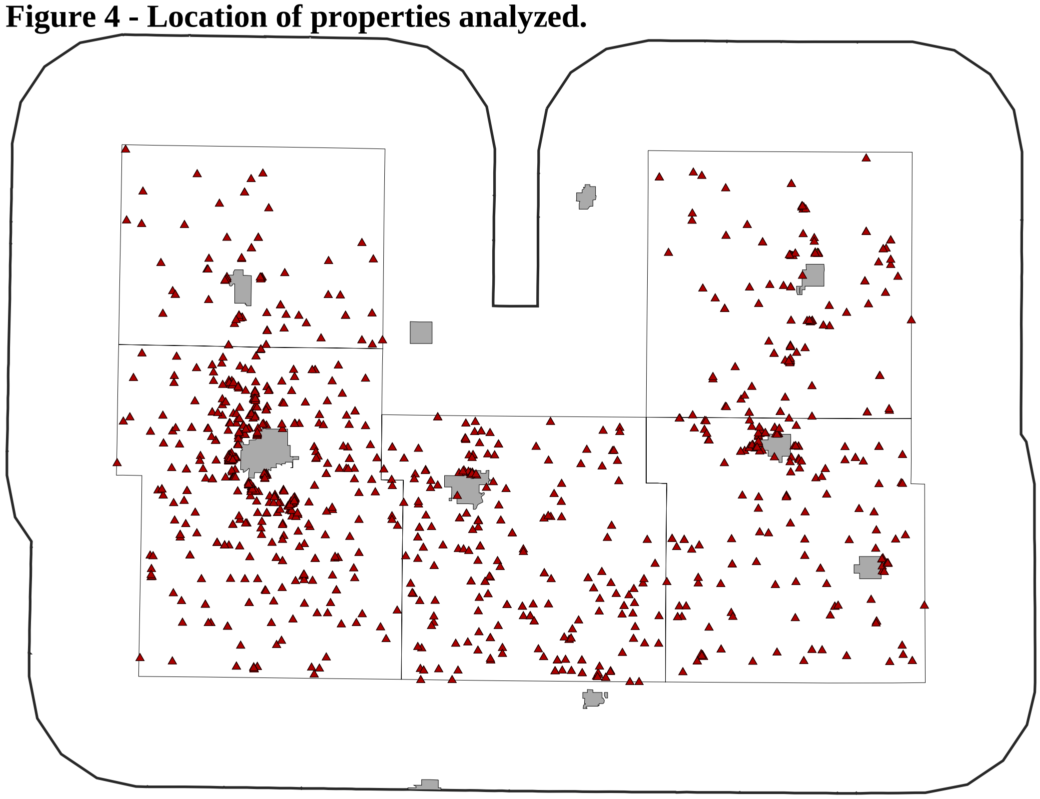
The second important issue arising in hedonic studies of open space is that of spatial error autocorrelation, which can be partly tied to the endogeneity of explanatory variables. There are two types of spatial error autocorrelation. In the first, there is correlation across space in the error terms (spatial error). This type of autocorrelation could be due to spatially correlated errors in variable measurement. In this case, OLS regression will produce inefficient but unbiased estimates. The second type of spatial error autocorrelation, spatial lag, is more serious. If the dependent variable in space, *i*, is affected by the independent variables in space, *i* and *j* (for example, because of spillover effects), then the errors will be correlated, and OLS regression will produce both biased and inefficient estimates.

To correct for spatial dependence, the approach in the literature has been to use instrumental variables (IVs), truly exogenous explanatory variables correlated with the endogenous variables (Irwin 2002). IVs are used in the first stage of a two-stage estimation process to obtain predicted values for the endogenous values that are then used in the second-stage hedonic estimation.

Data

The property sale dataset includes rural residential property sales that took place between 1992 and 2002 in five counties in North Central Iowa: Franklin, Hamilton, Hardin, Humboldt, and Webster. As noted earlier, the dataset has been used in a previous paper focusing on the distance to livestock facilities. It consists of owner-occupied homes sold via arms-length transactions; that is, the properties were offered on the open market for a reasonable period of time, and the sale price was the result of negotiation between a willing seller and a willing buyer with no coercion or advantage taken by either party. The raw data was obtained from each county assessor's office. The initial number of sales available for analysis was 1,290. The properties sold ranged from old farmhouses that retain very little of the surrounding land to new subdivisions on the edge of town. As Figure 4 shows, a disproportionate number of sales (578) were within a 10-mile radius of Fort Dodge, the largest city in the study area, at around 25,000 inhabitants.

Figure 4 - Location of properties analyzed.



The larger towns are in gray; house sales are red triangles.

Parcels with more than 10 acres were excluded to avoid the inclusion of primarily agricultural properties. Properties whose sale prices were less than 50% of the assessed values and/or sold for less than $5,000 were also excluded. In total, 1,145 sales were available for the analysis.

Table 1 details the physical attributes of the houses and parcels used and their neighborhood characteristics. The sales price was adjusted to 2002 prices using the Consumer Price Index owners' equivalent rent of primary residence for Midwest Size class D areas. The distance to the closest town was calculated with the PCMILER program.

Table 1 - Physical attributes of the houses and parcels.

Variable	Units	Variable name	Mean	SD	Minimum	Maximum
2002 adjusted price	dollars	PRICE02	94,728.49	62,651.46	5,550.14	535,911.75
Lot size	acres	LOT	2.38	2.22	0.05	10.00
Age	years	AGE	52.57	32.59	0.00	142.00
Living area (w/o additions)	square feet	LAWA	1,172.70	502.65	224.00	5,112.00
Area of additions	square feet	ADD	175.65	273.15	0.00	1,642.00
Air conditioned	0/1	AC	0.62	0.48	0.00	1.00
Number of bathrooms	number	BATHS	1.58	0.68	0.50	6.00
Number of decks or porches	number	EP_OP_DK	1.61	0.98	0.00	5.00
Number of fireplaces	number	FIRE	0.40	0.54	0.00	3.00
Attached garage dummy	0/1	ATTD	0.45	0.50	0.00	1.00
Distance to closest town w/ > 2,500 pop.	miles	DIST_TO	9.87	5.77	0.60	35.20
Median income by township	dollars/ family	MEDY	47,037.21	5,642.59	32,368.00	63,063.00

The other variables used in this analysis belong to two general categories: the landscape surrounding each property, including the broad land uses adjacent to the house (cropland, pasture, forest, developed) and the distance to the closest park; and the "point source" disamenities around the parcel, ranging from the livestock facilities in close proximity to each home to waste water treatment plants and landfills. Table 2 details the first group of variables. A 400-meter buffer was chosen, consistent with the existing literature, because it reasonably represents the area that can be viewed from the property. In the case of parks, the percentage of park area within a one-mile radius was also included, because it reflects distances that can be traveled on foot for short outings.

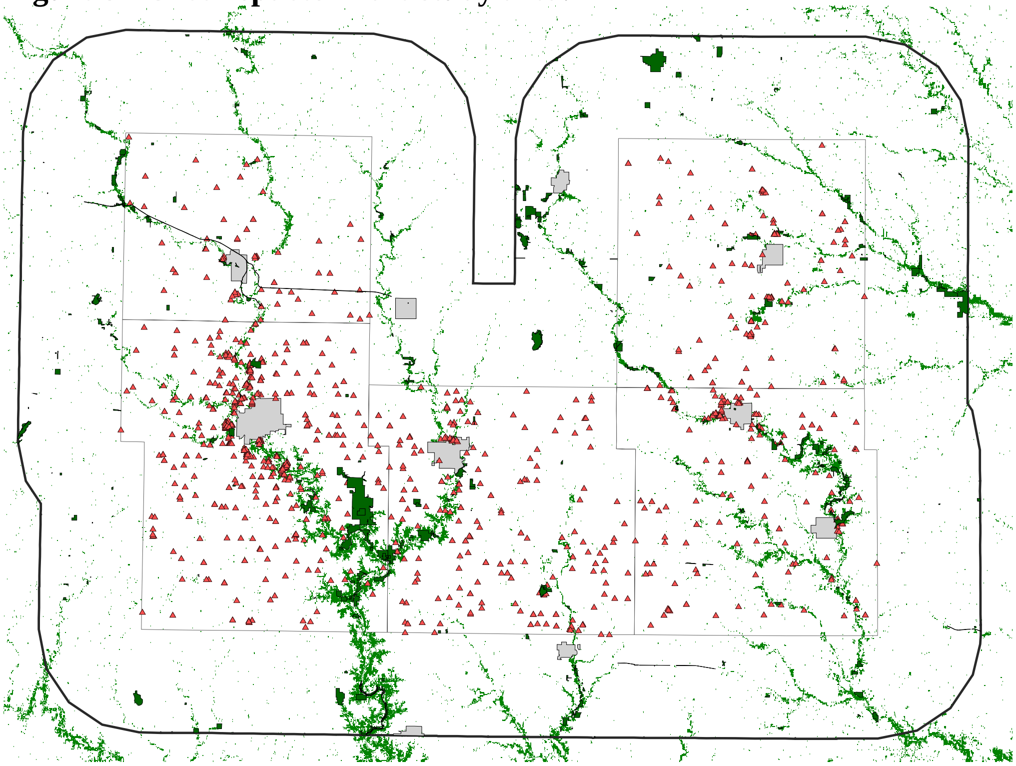
Table 2 - Landscape surrounding the properties.

Description	Units	Var. name	Mean	SD	Minimum	Maximum
% Park within 1,600-meter radius	percent	PARK1600	2.06	4.72	0.00	27.01
% Park within 400-meter radius	percent	PARK400	1.90	8.46	0.00	58.84
Distance to nearest park	miles	DIS_PARK	1.88	1.42	0.00	6.56
% Forest within 400-meter radius at year of sale	percent	FOR400	9.75	12.69	0.00	68.90
% Developed within 400-meter radius at year of sale	percent	URB400	7.05	8.99	0.00	49.83
% Pasture within 400-meter radius at year of sale	percent	PAS400	25.34	15.32	1.54	68.76
% Cropland within 400-meter radius at year of sale	percent	CROP400	54.45	30.41	0.00	97.70

It is important to note that even though some parcels have very little cropland around them, this is because of the proximity of either forest or pasture rather than proximity of developed areas. In fact, the minimum percentage of open space as the sum of cropland, forest, and pasture is over almost 42%. Moreover, there is a very strong negative correlation between the forested areas and cropland (-0.744) and between pastures and cropland (-0.820).

There are around 300 parks in the study area. It is difficult to give a precise number because it depends on how one defines a park. In the dataset, river accesses are listed separately, and so are state preserves and wildlife areas, even though they may have the same name. Overall, they cover almost 33,000 acres. The parks tend to be small, averaging around 74 acres. Mostly, they belong to county conservation boards and the IDNR. Only six of them are in private holdings. This is important to note because in other parts of the country, privately owned conservation land and easements play a much larger role in open space preservation. Figure 5 shows the parks and forests in the study area in 2002. Overall, there are 171.49 square miles of forest (i.e., 109,748 acres). This is out of an area of 6,038 square miles (or 3,864,331 acres), that is, the study area is 0.85% park and 2.84% forest. Of the properties analyzed, 418 houses had a park within one mile, and 132 had a park within the 400-meter radius.

Figure 5 - Green spaces in the study area.



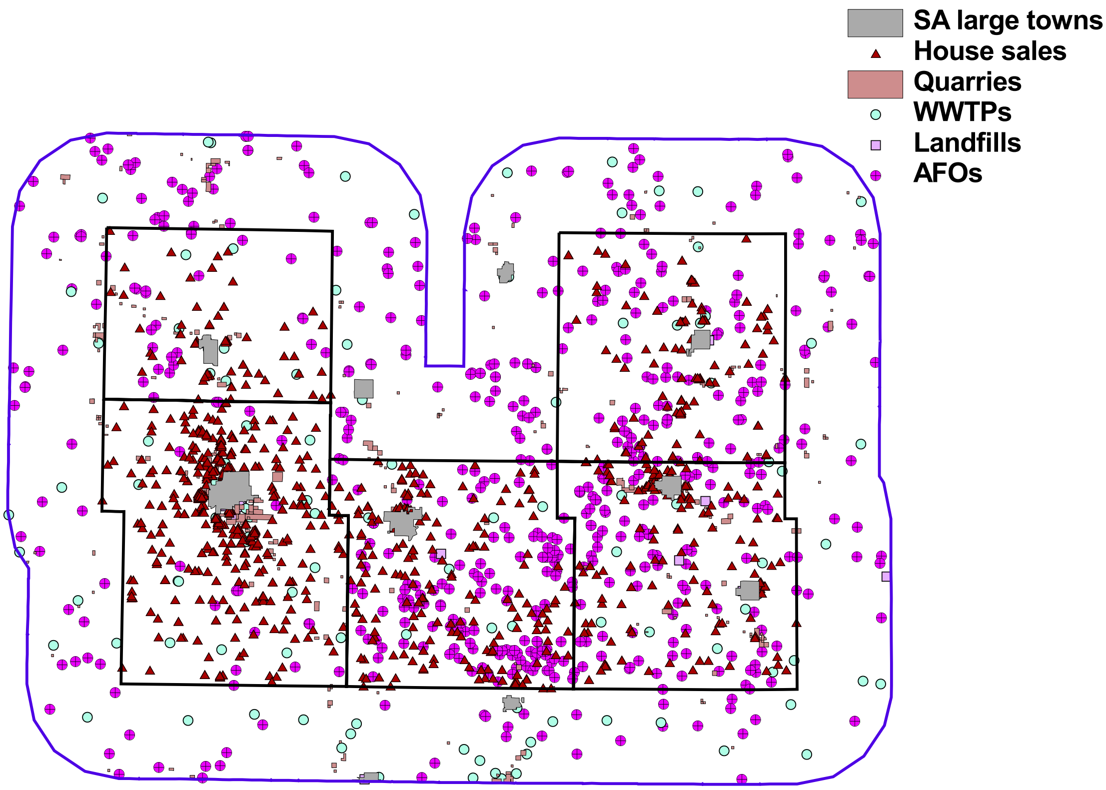
The green areas outlined in black are the parks; the others are the forests.

Iowa counties have very different levels of digitized information. In the study area, only one had digitized and geo-referenced parcel information. Therefore, two state level GIS datasets on land use were used. The first dataset details the land use in 1992 and is based on the Iowa Gap Analysis Program project. The second dataset has information for 2002 and is derived from satellite imagery collected between May 2002 and May 2003 and developed by the IDNR. Since the set of land uses was not the same for the two databases, and since both of them, but particularly the GAP database, were excessively detailed for this study, we aggregated the categories of land use down to six: water, wetlands, forests, pasture, row crops, and developed/barren land. Appendix B shows the details of the procedure. Since there is a gap of 10 years between the two land uses that corresponds to the 10 years during which the properties used in the study were sold, linear interpolation was used to infer the land use around the parcels at the year of sale.

The last group of variables, detailed in Table 3 and illustrated in Figure 6, consists of the "point source" disamenities around the parcels. The information comes from the IDNR GIS Library (IDNR 1998, 2000, 2003).

As Figure 6 shows, surface mines and quarries, a potential disamenity source typical of a developed open space, are very common in the Iowa landscape. Gypsum, sand, and gravel represent Iowa's largest mineral industries, and there are almost 2,000 quarries and pits in the state. In our study area, there are 274 surface mines. However, 94 of them were closed by 1992, while 37 closed between 1992 and 2001. Moreover, 40 new mines were registered between 1992 and 2001. We surmise that the effect of an open surface mine is likely different from that of a closed one. Since we know the date of closure of the mine and the date of its registration, the dataset was corrected to reflect open mines at the time of the sale for each house. The impact of the open surface mines is likely very localized: having one next to the property can mar the view, and the noise of machinery and trucks can be highly disturbing. Therefore, we use the number of quarries within a 400-meter radius as a variable. Besides the quarries, there are 24 landfills and 124 Waste Water Treatment Plants (WWTP) in the area.

Figure 6 - Disamenities surrounding the properties.



Information about the CAFOs database is detailed in Herriges, Secchi, and Babcock. The dataset contains information only on large operations that needed to file a manure management permit with the state. The great majority of the facilities are hog operations. As in the previous work, in the regression, the variables used will be the distance to the closest CAFO, number of CAFOs within 3 and 10 miles and then interaction terms. The interaction terms size*distance (CROSS1) capture the impact of the size of the operation, while the interaction terms with the south and northwest depict the effect of being downwind of a livestock facility in the summer (when the wind is mostly from the south) or fall (northwestern winds). A positive coefficient indicates that for homes downwind of a confinement operation, an increase in the distance to the CAFO is associated with a higher property value.

Table 3 - Disamenities surrounding the properties.

Description	Units		Mean	SD	Min.	Max.
Distance nearest CAFO	miles	AFODIS1	2.80	1.75	0.01	6.79
Size nearest CAFO	'000s lbs.	AFO1LW	480.62	296.91	160.00	2600.00
=1 if nearest CAFO is south; else = 0	0/1	SO	0.23	0.42	0.00	1.00
=1 if nearest CAFO is northwest; else = 0	0/1	NW	0.30	0.46	0.00	1.00
# CAFO in 3 mile radius	number	AFO3C	2.36	3.20	0.00	27.00
# CAFO in 10 mile radius	number	AFO10C	27.07	24.98	2.00	102.00
# open quarries within 400 meter	number	NOQRR400	0.02	0.13	0.00	2.00
Distance nearest quarry	miles	DISOQRR	2.87	2.30	0.00	11.72
Distance nearest WWTP	miles	DISWWTP	2.40	1.50	0.06	8.33
Distance nearest landfill	miles	DISLDFLL	6.09	3.99	0.47	20.01

Results

As we noted before, the hedonic regression is a reduced form equation, and therefore economic theory provides no guidance on the functional form to use. In practice, linear, semilog, and log-log functions have been used. Each has potential drawbacks and advantages. The linear functional form does not allow for interactions between the independent variables, while the logarithmic form does. The logarithmic forms can also be superior in dealing with heteroskedasticity issues. However, the coefficients of the logarithmic form can be difficult in terms of prediction and interpretation, since unbiased regression coefficients in units of log price will be biased when transformed back to price. We tried four different specifications of the functional form, as detailed in Table 4. In terms of notation, X is the vector of house characteristics; N is the vector of census neighborhood characteristics, D is the vector of distances to amenities or disamenities and their characteristics and L is a vector of landscape neighborhood characteristics. The linear form for prices and distance is the one with the highest fit, and therefore it is the one for which the results are presented.

Table 4 - Choice of functional form.

Functional Form	Adjusted R^2
$P_i = c + \alpha' X_i + \beta' N_i + \gamma' D_i + \delta' L_i$	0.6754
$P_i = c + \alpha' X_i + \beta' N_i + \gamma' D_i^{-1} + \delta' L_i$	0.6604
$\ln(P_i) = c + \alpha' X_i + \beta' N_i + \gamma' D_i + \delta' L_i$	0.5826
$\ln(P_i) = c + \alpha' X_i + \beta' N_i + \gamma' \ln(D_i) + \delta' L_i$	0.5736
$P_i = c + \alpha' X_i + \beta' N_i + \gamma' \ln(D_i) + \delta' L_i$	0.6673

Since the water and wetlands account for very little space around the properties, the forest, pasture, cropland, and developed land sums up to around one. Therefore, to avoid perfect collinearity, cropland was excluded, and the coefficients on the other land uses can be interpreted as the change in value of the property for a 1% increase in that land use and corresponding reduction of cropland.

Table 5 details the results of the OLS estimation. The coefficients relating to the structural characteristics of the house have the expected signs and are all statistically significant. Proximity to a larger town and location in townships with higher median income levels are also significant.

This specification produces substantially stronger results in terms of the negative impacts of CAFOs than in the previous study, possibly because the noise level has been reduced. The distance to the closest animal operation is significant, and so is the interaction term with the northwest, indicating that an increase in the distance to the facility is linked with a higher property value, if a house is downwind of a CAFO in the fall.

The presence of landfills is another significant point-source disamenity, while the presence of wastewater treatment plants is not. This could be because the dataset contains disparate operations, ranging from sewage treatment plants for the towns in the area to industrial wastewater discharge treatment facilities. Two variables were constructed for quarries: the number of quarries open within a 400-meter radius, and distance to quarries. The first one is significant while the second is not. The reason is probably that quarries, unlike CAFOs, are a more localized source of disutility for property owners. As expected, proximity to a park is a positive amenity, and so is the percentage of forested land surrounding the property.

Table 5 - OLS regression results.

Variable	Estimated Coefficient	Standard Error	t-statistic	P-value
C	-56839.3	13553	-4.19385	[.000]
LOT	3815.95	574.264	6.64494	[.000]
AGE	-270.796	48.6769	-5.56313	[.000]
LAWA	29.7858	2.94904	10.1002	[.000]
ADD	26.2517	4.61872	5.68377	[.000]
AC	14443.7	2493.88	5.79167	[.000]
BATHS	31487.9	2290.13	13.7494	[.000]
EP_OP_DK	5423.49	1173.45	4.62183	[.000]
FIRE	12274.9	2253.12	5.44798	[.000]
ATTD	7829.06	2566.55	3.05042	[.002]
MEDY	0.674951	0.207037	3.26004	[.001]
DIST_TO	-934.381	286.052	-3.26648	[.001]
AFODIS1	4725.26	1435.71	3.29124	[.001]
CROSS1	-2.30303	2.12927	-1.08161	[.280]
CROSS1SO	-328.068	819.916	-0.40013	[.689]
CROSS1NW	2366.14	874.473	2.70578	[.007]
AFO3C	1030.91	585.798	1.75984	[.079]
AFO10C	183.468	78.3182	2.3426	[.019]
DISOQRR	-530.434	700.187	-0.75756	[.449]
NOQRR400	-20569.3	8289.23	-2.48145	[.013]
DISWWTP	-395.075	981.757	-0.40242	[.687]
DISLDFLL	1466.53	446.09	3.28753	[.001]
PARK1600	-322.14	371.656	-0.86677	[.386]
PARK400	95.662	184.914	0.517331	[.605]
DIS_PARK	-2608.29	1064.44	-2.4504	[.014]
FOR400	208.892	105.137	1.98685	[.047]
URB400	-278.859	165.444	-1.68552	[.092]
PAS400	-59.6909	98.3311	-0.60704	[.544]

Instrumental variables were obtained from Iowa's Soil Properties and Interpretation Database from the Iowa Cooperative Soil Survey and from the IDNR's Natural Resources GIS Library coverage of highways and incorporated cities for the state (IDNR 2002b,c). They are as follows.

1. The corn suitability rating (CSR). The CSR gives a relative ranking of all soils mapped in the state of Iowa based on their potential to be utilized for intensive row crop production and are based on long-term averages. Ratings range from 100 for soils that have no physical limitations, occur on minimal slopes, and can be continuously row cropped to as low as 5 for soils with severe limitations for row crops.
2. Average slope information, expressed in percentages as the number of feet of fall per 100 feet of horizontal distance.

3. Linear distance to the closest town, irrespective of the town size (there are 112 towns in the study area).
4. Linear distance to the closest highway.

Generally speaking, any truly exogenous variable can be used as an instrumental variable, but the efficiency of the estimation improves as the correlation between endogenous variables and instruments increases. As Table 6 shows, there is a strong positive correlation between the CSR index and the land being cropped, while the correlation is strongly negative for forest and pasture. The reason is that prime agricultural land in Central Iowa tends to be heavily farmed.

Table 6 - Correlation between endogenous variables and instruments.

	Forest	Pasture	Urban	Crop
CSR	-0.747	-0.572	-0.055	0.711
Slope	0.831	0.461	0.130	-0.692
Distance to closest town	0.342	-0.232	-0.232	0.367
Distance to highway	-0.264	-0.305	-0.304	0.382

As expected, these correlations are reversed in the case of slope, and slopey land has some positive correlation to being developed. This is probably because development in this area is mostly for residential purposes, and slopey and forested lands have attractive characteristics for this use. Finally, developed open space, as expected, has a negative correlation to the linear distance to the nearest town and to the nearest highway.

The results of the IVs estimation, given in Table 7, are quite similar to those of the OLS procedure. The coefficients for the structural characteristics of the house have the expected signs and are all statistically significant at the 1% level, except for the lot size, which is statistically significant at the 5% level. Proximity to a larger town is still significant, while median income in the township is not.

The coefficient for distance to a CAFO is still significant and negative. The coefficients for number of CAFOs in the 3- and 10-mile radius are significant as well, at the 10% and 5% levels, respectively. The fact that their signs are positive probably indicates that the presence of livestock enterprises has positive impacts on the local rural economy. The presence of open quarries within a 400-meter radius is still a significant disamenity.

The proximity of a park and having forested areas close by are still positive amenities.

For the average house in the sample, which sold for $94,728, and the average distance to a CAFO, which is 2.8 miles, these results suggest that increasing the distance of the CAFO by a mile increases the house's value by over $6,000. Similarly, the average number of CAFOs in a 10-mile radius is 27. Increasing that number to 28 would increase the house's value by $208. In terms of amenities, the average distance to a park is 1.88 miles. Decreasing that distance by a mile would increase the house's value by over

$2,350. The average forested area around the house is 10%, and increasing that percentage to 11% would increase the value of the house by $446.

Table 7 - Instrument variables regression results.

Variable	Coefficient	Standard Error	t-statistic	P-value
C	-28,965.90	30133.4	-0.96126	[.336]
LOT	2,584.85	1147.39	2.25281	[.024]
AGE	-278.559	53.398	-5.21666	[.000]
LAWA	28.59	3.27835	8.72084	[.000]
ADD	24.0495	5.30063	4.53711	[.000]
AC	14315.6	2565.81	5.57937	[.000]
BATHS	30788.1	2366.88	13.0079	[.000]
EP_OP_DK	5315.52	1211.55	4.38735	[.000]
FIRE	11127.4	2416.7	4.60438	[.000]
ATTD	7855.49	2705.42	2.90362	[.004]
MEDY	0.449022	0.303915	1.47746	[.140]
DIST_TO	-979.144	302.416	-3.23774	[.001]
AFODIS1	6122.55	2169.31	2.82235	[.005]
CROSS1	-3.39098	2.26338	-1.49819	[.134]
CROSS1SO	-814.273	1031.36	-0.78952	[.430]
CROSS1NW	1094.27	1382.18	0.791703	[.429]
AFO3C	1146.62	640.557	1.79004	[.073]
AFO10C	208.421	84.0394	2.48004	[.013]
DISOQRR	-648.137	767.183	-0.84483	[.398]
NOQRR400	-20760.7	8575.82	-2.42085	[.015]
DISWWTP	-1434.31	1620.67	-0.88501	[.376]
DISLDFLL	1087.69	592.407	1.83605	[.066]
PARK1600	-582.75	469.512	-1.24118	[.215]
PARK400	33.7532	244.068	0.138294	[.890]
DIS_PARK	-2354.26	1196.36	-1.96785	[.049]
FOR400	445.922	196.266	2.27202	[.023]
URB400	-1291.29	937.78	-1.37697	[.169]
PAS400	-131.755	343.367	-0.38372	[.701]

Conclusions

Even though the land use cover information and general landscape information available for the State of Iowa is coarse compared with the data in more urbanized parts of the country, our model clearly shows that landscape amenities have value for rural residents. Our results suggest that conservation policy should take into account the preferences of rural residents not engaged in farming. In particular, the farming community and policymakers tend to have a strong opposition to increasing land set aside from production for conservation purposes, ranging from land enrolled in the

Conservation Reserve Program to restored native prairies, as they fear depopulation of rural areas. This study indicates that it may be possible to make rural areas more attractive to live in.

This option should be considered carefully, in light of two other important drivers of change in the current landscape of the Corn Belt. The first one is the continuing trend toward larger farm sizes, and the second is the nonpoint-source pollution problems created both locally and regionally by large-scale confined animal production and monoculture agriculture. These two issues together will likely result in an agricultural production system that can only support a dwindling population. The possibility of producing biofuels and other products from perennial vegetation is currently receiving a great deal of attention in the Midwest. When such technologies become viable, they are likely to alter the landscape significantly. However, in the meantime, the pressure to produce more corn for ethanol is apt to decrease further the diversity of the rural landscape. In particular, there are strong economic pressures not to reenroll land into the Conservation Reserve Program and to put marginal areas into crop production.

This study also suggests that the siting of point disamenities such as CAFOs and landfills has implications for residential properties. While the siting of landfills away from residential areas and potentially developable land is a relatively straightforward interpretation of our results, the issue of CAFO siting is more complex. The reason is that while CAFOs are a point disamenity, they also appear to have a positive impact on the local rural economy. Thus, CAFO siting decisions have to weigh two conflicting forces.

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Appendix A – Percentage of land use in 1992 and 2002 for the counties studied.

1992						
	Water	Wetland	Forest	Pasture	Row crops	Dev.d
Humboldt	0.7	1.8	1.1	8.1	87.7	0.6
Franklin	0.1	1.2	1.8	16.0	78.8	2.1
Webster	0.7	0.8	6.4	8.7	80.8	2.5
Hamilton	0.6	0.5	3.4	8.2	85.3	2.0
Hardin	0.7	1.2	3.5	14.6	78.3	1.7
Iowa	1.1	2.0	7.4	27.8	59.9	1.8
2002						
	Water	Wetland	Forest	Pasture	Row crops	Dev.d
Humboldt	0.5	0.3	1.6	12.5	83.5	1.5
Franklin	0.2	0.2	1.9	14.5	80.8	2.4
Webster	0.8	0.5	5.5	13.2	77.7	2.3
Hamilton	0.4	0.2	2.7	13.6	80.3	2.8
Hardin	0.4	0.4	4.3	16.9	74.9	3.1
Iowa	0.9	0.7	7.7	28.3	59.3	3.1

Sources: IDNR 2001 and 2004.

Appendix B – Land use aggregations.

Aggregation for comparison	Category in 2002	Category in 1992
Water	Water	Open Water
Wetlands	Wetland	Temp. Flooded Wetland
	Bottomland	Seasonally Flooded Wetland
		Semi-permanent Flooded Wetland
		Saturated Wetland
		Permanently Flooded Wetland
		Seasonally Flooded Forested Wetland
		Seasonally Flooded Shrubland
		Semi-permanently Flooded Shrubland
		Temp. Flooded Forested Wetland
		Temp. Flooded Shrubland
		Saturated Shrubland
Forests	Coniferous Forest	Eastern Red Cedar Forest
		Pine Forest
		Evergreen Forest
		Eastern Red Cedar Woodland
	Deciduous Forest	Upland Deciduous Forest
		Mixed Evergreen/Deciduous Forest
		Upland Deciduous Woodland
		Mixed Evergreen/Deciduous Woodland
		Upland Shrub
Pasture/Grass	Ungrazed Grass	Warm Season Grass/Perennial Forb
	Grazed Grass	Cool Season Grass
	CRP Grassland	Grassland with Sparse Trees
	Alfalfa	
Row Crops	Corn	Cropland
	Soybeans	
	Other Row Crop	
Developed	Roads	Sparsely Vegetated/Barren
	Commercial	Artificial/Low Vegetation
	Residential	Artificial/High Vegetation
	Barren	Barren/Mixed Vegetation