Modeling and Analyzing the Property Price Impact of Proximity to Greenways in Knox County

By: Esnayde Mejia

Abstract

Located right outside of the Smoky Mountains, Knox County is home to some of the most robust natural habitats in the state. Knox County has capitalized on that through the creation of a greenways and trails system that provides 112.5 miles of paved and unpaved trails for citizens to enjoy. It includes scenic routes through mountains, waterways, and the urban landscape making it attractive to those seeking an active lifestyle and a connection to nature. The creation of the greenways and trail system in Knox County, therefore, provides a pricing advantage for the houses that are located in proximity to these features. The challenge comes in assessing the true value that these greenways bring to properties in their proximity. This is because proximity to greenways is not the only feature that impacts price. We have to also account for externalities and characteristics which at times are not easily observable nor quantifiable. For my analysis, I used greenway and trail data, geocoded addresses for the county, and census tract level data to create a buffer to show the proximity of properties to the greenway and trail system in Knox County. In order to account for housing characteristics I used data for condition, total living area, number of bedrooms, lower level, number of full and half baths, heating, roofing material, stories, and exterior wall material. Next, I compiled census data to be able to location characteristics including the total education, associate's degrees, bachelor's degrees master's degrees, doctorate degrees, professional school, median household income, total population, percent Black or African American, and percent Asian population. Finally to control for changes, such as inflation, over time I included yearly and quarterly data for the properties.

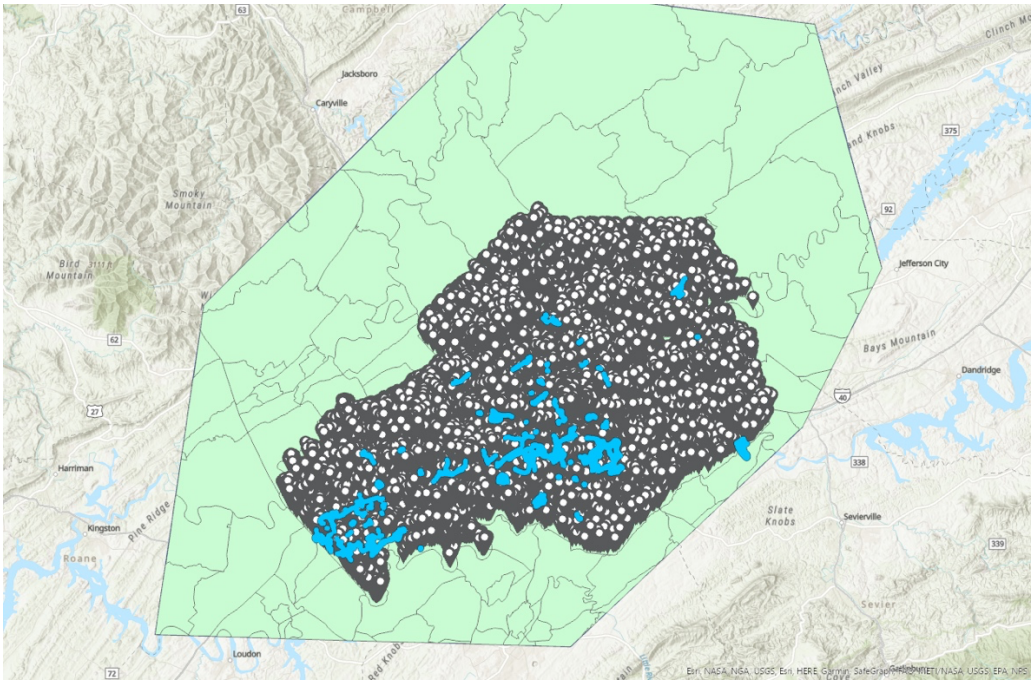
Introduction

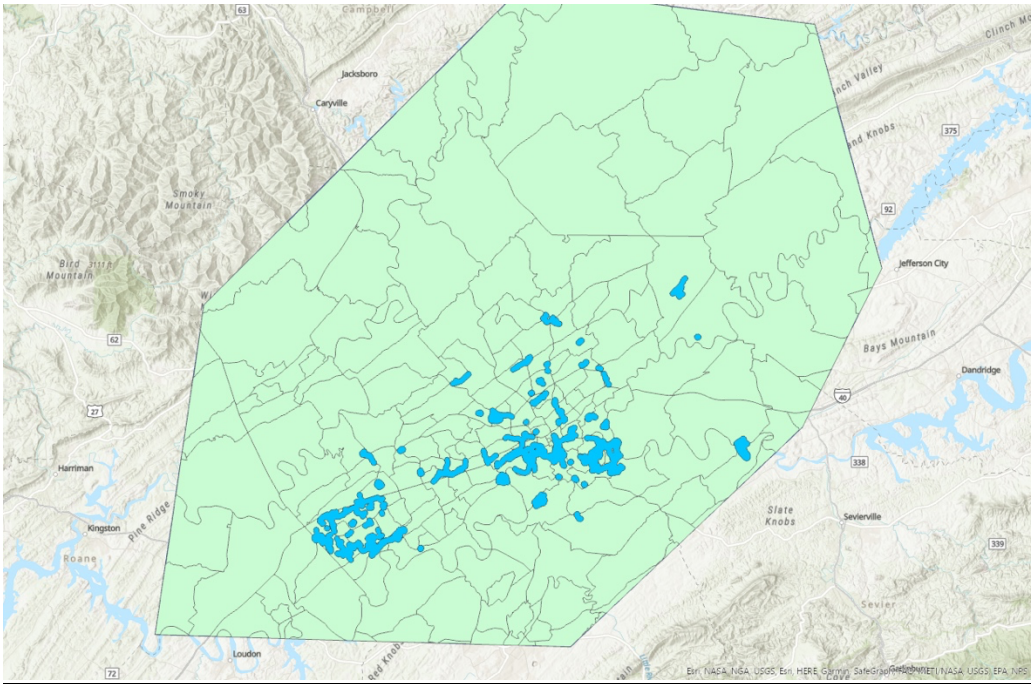
Knox County's greenways and trails are made up of 112.5 miles of both paved and unpaved trails with varying degrees of nature and difficulty. For those looking to be on the tamer side of nature, they can explore the urban trails of downtown Knoxville. Those looking for a challenge can explore some of the more remote unpaved trails such as house mountain. The beautiful urban landscape and nature encountered while traveling through the trails and greenways of Knox County provide a versatile source for recreation and wildlife conservation. The leisure and entertainment opportunities resulting from the proximity to greenways creates a desire to be in proximity to these features and has a positive impact on the perception of those in the market for property. That being said, these factors will undoubtedly add to the values of homes in close proximity to the greenways and trails. Using the hedonic property model we can estimate the impact of characteristics such as greenways and trails.

Data

For this hedonic property model, I used Geocoded addresses for Knox County and created a 1000-foot buffer around all greenways and trails which I mapped using data from knox county planning. I then added data for the characteristics of the houses from provided dwelling data and attributed those characteristics to the appropriate properties. For the Location characteristics, I used census-level data in order to be able to assign attributes to properties according to demographic characteristics. I also included provided sales data which in conjunction with FHA and tax assessor records, aided in modeling the valuation of the homes over time.

Map of Knox County greenways and trails including the 1000 foot buffer:





Hedonic Property Valuation

The hedonic property model serves to model the price at a period in time(p_{it}) as a function of housing characteristics(H_{it}), location characteristics(L_{it}), distance from greenways and trails(D_i), and changes in the market over time(T_t) denoted as follows:

$$p_{it} = P\left(H_{it}, L_{it}, D_i, T_t\right)$$

The model is attempting to capture the property price impact on proximity to greenways(D_i) while controlling for omitted variable bias and collinearity through the rest of the bundles. The specifications are as follows:

1. $\ln\left(p_{it}\right) = \beta_0 + D_i\beta_1$
2. $\ln\left(p_{it}\right) = \beta_0 + D_i\beta_1 + H_{it}\beta_2$
3. $\ln\left(p_{it}\right) = \beta_0 + D_t\beta_1 + H_{it}\beta_2 + L_{it}\beta_3$
4. $\ln\left(p_{it}\right) = \beta_0 + D_i\beta_1 + H_{it}\beta_2 + L_{it}\beta_3 + T_t\beta_4$

The first specification allows us to model the impacts of greenways on the price at a given time on their own. The second specification adds in the housing characteristics so that we can test the impact of both on the price of the home. The third specification gives us the location characteristics collected from the census data. The fourth specification captures all of the previous while controlling for changes in the market over a period of time using the price the property last sold for. We use the natural log to account for potential heteroscedasticity in the model, and it also allows us to interpret a 1-unit change in an independent variable all else held constant as a percentage change in the price.

	(1) ln_realsalesprice	(2) ln_realsalesprice	(3) ln_realsalesprice	(4) ln_realsalesprice
Buffer	0.160	0.0327	-0.00288	0.0172
	(1.33)	(0.91)	(-0.10)	(0.75)
age		0.0119***	0.0135***	-0.00511***
		(8.11)	(10.85)	(-8.93)
agesq		-0.00000230	0.00000125	-0.00000678***
		(-0.16)	(0.10)	(-5.58)
Total Living Area		0.000280***	0.000218***	0.000241***
		(13.65)	(11.56)	(16.47)
Bedrooms		0.0800***	0.0748***	0.0474***
		(8.01)	(8.51)	(8.71)
Half Baths		0.171***	0.113***	0.112***
		(9.60)	(8.35)	(11.31)
Full Baths		0.133***	0.0873***	0.105***
		(6.74)	(5.60)	(13.80)
Total Education			-0.000217**	-0.000140**
			(-3.10)	(-2.77)
Associates			0.000262	0.000234*
			(1.35)	(1.99)
Bachelor			0.000156	0.000189**
			(1.56)	(2.79)
Masters			0.000476**	0.000361**
			(2.69)	(3.26)
Professional School			0.000188	0.000435**
			(0.93)	(3.30)
Doctorate			-0.000128	0.00000705
			(-0.34)	(0.03)
Median Household Income			0.00000322***	0.00000262***
			(4.39)	(5.64)
Total Population			0.0000923*	0.0000303
			(2.07)	(0.94)
Black or African American Population			-0.000247***	-0.000144***
			(-5.59)	(-4.69)
Asian Population			-0.0000527	-0.0000235
			(-0.29)	(-0.23)
Constant	11.77***	11.50	11.05	8.618
	(243.17)	(0.03)	(0.00)	(0.00)
Observations	121947	106943	106913	106913
R^2	0.002	0.349	0.390	0.589

Results:

t statistics in parentheses

In order to maintain the readability I omitted the dummy variables but have summarized all the included variable elsewhere. According to the first specification of the model all other things constant, the buffer coefficient on its own can be interpreted as any property that is within 1000 feet of a greenway or trail will have its price increase by 16 %, but we can see with its relatively low R^2 that more variables are necessary in order to maximize the robustness of this model. In the second specification for this model, I added all the housing characteristics included in the bundle $H_{it.}$ We can conclude from the second specification that there is a 3.27 increase in price when in proximity to greenways. Surprisingly after adding in the location characteristics it actually show that there is a negative impact on property value so that its proximity to greenways and trail lowers the property value by .28%. In the final specification I controlled for the changes in the housing market over time by adding in the quarterly and yearly data. This resulted in greenways positively impacting the value of a property adding 1.72% to the value of a property all else equal. This final specification is also the most robust model with a relatively high R^2 meaning that 58.9% of the variance from the mean is explained by the model.

Descriptive Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
Buffer	106913	.101	.301	0	1
ln realsalesprice	106913	11.803	1.003	0	18.01
saleprice	106913	202302.63	398297.71	1	66292162
age	106913	19.206	18.608	-899	205
agesq	106913	715.093	2786.398	0	808201
TotalLivingArea	106913	1386.949	511.784	0	12718
Bedrooms	106913	3.086	.942	0	58
HalfBaths	106913	.455	.537	0	10
FullBaths	106913	1.784	.762	0	20
total edu	106913	3034.06	913.369	34	5430
associates	106913	276.837	154.186	0	775
bachelor	106913	746.903	401.029	0	1722
masters	106913	321.59	207.468	0	1109
pro school	106913	88.904	103.824	0	504
doctorate	106913	72.655	78.285	0	378
median household i~e	106913	74071.692	29807.079	2499	182870
total population	106913	4386.124	1302.201	1548	7710
african population	106913	301.421	396.573	0	2286

asian population	106913	102.521	129.457	0	657

Above are the variables excluding dummy variables. There are a total of 106,913 properties observed with 10.1% of the properties being within the buffer which means about 10,798 households are benefiting from the positive impact that proximity to greenways has on their properties. The average sales price for all homes $202,302.63 while the average age is right over 19 years old. One of the things I found most interesting in the model was that the most impactful coefficient was the one for full baths. Which in the final specification increases the value of the property by 10.5% for every bathroom all else constant.

Conclusion

In conclusion, the amenities and benefits added by the proximity to greenways and trails in Knox County is able to be modeled in conjunction with the housing, location, and time characteristics for those properties. This is possible because these are things that people desire and generally consider beneficial to their overall wellbeing. Like we would do with any nonmarket good we were able to tease out the impact that the coefficient for the buffer has on the price of properies located both inside and outside the buffer. So that on average, all remaining constant, being near a greenway or trail adds approximately 1.72% value to your property while being outside the buffer you receive no benefit from the the greenways or trails.

Expanded Variable List

Descriptive Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
Buffer	106913	.101	.301	0	1
ln realsalesprice	106913	11.803	1.003	0	18.01
saleprice	106913	202302.63	398297.71	1	66292162
age	106913	19.206	18.608	-899	205
agesq	106913	715.093	2786.398	0	808201
TotalLivingArea	106913	1386.949	511.784	0	12718
Bedrooms	106913	3.086	.942	0	58
HalfBaths	106913	.455	.537	0	10
FullBaths	106913	1.784	.762	0	20
total edu	106913	3034.06	913.369	34	5430
associates	106913	276.837	154.186	0	775
bachelor	106913	746.903	401.029	0	1722
masters	106913	321.59	207.468	0	1109
pro school	106913	88.904	103.824	0	504
doctorate	106913	72.655	78.285	0	378
median household i~e	106913	74071.692	29807.079	2499	182870
total population	106913	4386.124	1302.201	1548	7710

african population	106913	301.421	396.573	0	2286
asian population	106913	102.521	129.457	0	657
cndtdmy1	106913	.325	.468	0	1
cndtdmy2	106913	.004	.065	0	1
cndtdmy3	106913	.055	.228	0	1
cndtdmy4	106913	.23	.421	0	1
cndtdmy5	106913	.008	.09	0	1
cndtdmy6	106913	.372	.483	0	1
cndtdmy7	106913	.006	.074	0	1
qtrdmy1	106913	.204	.403	0	1
qtrdmy2	106913	.294	.456	0	1
qtrdmy3	106913	.279	.448	0	1
qtrdmy4	106913	.224	.417	0	1
yrdmy1	106913	0	.003	0	1
yrdmy2	106913	0	.004	0	1
yrdmy3	106913	0	.003	0	1
yrdmy4	106913	0	.003	0	1
yrdmy5	106913	0	.003	0	1
yrdmy6	106913	0	.003	0	1
yrdmy7	106913	0	.003	0	1
yrdmy8	106913	0	.003	0	1
yrdmy9	106913	0	.005	0	1
yrdmy10	106913	0	.005	0	1
yrdmy11	106913	0	.004	0	1
yrdmy12	106913	0	.005	0	1
yrdmy13	106913	0	.005	0	1
yrdmy14	106913	0	.005	0	1
yrdmy15	106913	0	.005	0	1
yrdmy16	106913	0	.007	0	1
yrdmy17	106913	0	.009	0	1
yrdmy18	106913	0	.014	0	1
yrdmy19	106913	0	.016	0	1
yrdmy20	106913	.001	.036	0	1
yrdmy21	106913	.001	.035	0	1
yrdmy22	106913	.002	.039	0	1
yrdmy23	106913	.002	.044	0	1
yrdmy24	106913	.001	.029	0	1
yrdmy25	106913	.001	.027	0	1
yrdmy26	106913	.001	.027	0	1
yrdmy27	106913	.001	.024	0	1
yrdmy28	106913	.001	.027	0	1
yrdmy29	106913	.004	.062	0	1
yrdmy30	106913	.003	.059	0	1
yrdmy31	106913	.003	.057	0	1
yrdmy32	106913	.003	.052	0	1
yrdmy33	106913	.002	.045	0	1
yrdmy34	106913	.002	.044	0	1
yrdmy35	106913	.003	.057	0	1
yrdmy36	106913	.004	.063	0	1
yrdmy37	106913	.004	.066	0	1
yrdmy38	106913	.006	.076	0	1
yrdmy39	106913	.006	.077	0	1
yrdmy40	106913	.006	.079	0	1
yrdmy41	106913	.006	.08	0	1
yrdmy42	106913	.007	.081	0	1
yrdmy43	106913	.007	.086	0	1
yrdmy44	106913	.01	.099	0	1
yrdmy45	106913	.01	.099	0	1
yrdmy46	106913	.011	.102	0	1
yrdmy47	106913	.011	.106	0	1
yrdmy48	106913	.011	.106	0	1
yrdmy49	106913	.012	.109	0	1
yrdmy50	106913	.014	.118	0	1
yrdmy51	106913	.016	.124	0	1
yrdmy52	106913	.014	.118	0	1
yrdmy53	106913	.017	.131	0	1
yrdmy54	106913	.019	.136	0	1
yrdmy55	106913	.021	.145	0	1
yrdmy56	106913	.022	.148	0	1
yrdmy57	106913	.024	.154	0	1
yrdmy58	106913	.025	.155	0	1
yrdmy59	106913	.025	.155	0	1
yrdmy60	106913	.02	.141	0	1
yrdmy61	106913	.02	.14	0	1
yrdmy62	106913	.021	.145	0	1
yrdmy63	106913	.021	.143	0	1
yrdmy64	106913	.026	.161	0	1

yrdmy65	106913	.033	.18	0	1
yrdmy66	106913	.036	.187	0	1
yrdmy67	106913	.047	.212	0	1
yrdmy68	106913	.057	.231	0	1
yrdmy69	106913	.066	.247	0	1
yrdmy70	106913	.072	.259	0	1
yrdmy71	106913	.08	.272	0	1
yrdmy72	106913	.096	.294	0	1
yrdmy73	106913	.063	.243	0	1
Heating	106913	2.048	.409	1	6
Heatingdmy1	106913	.005	.072	0	1
Heatingdmy2	106913	.971	.169	0	1
Heatingdmy3	106913	.014	.118	0	1
Heatingdmy4	106913	.001	.03	0	1
Heatingdmy5	106913	0	0	0	0
Heatingdmy6	106913	.009	.095	0	1
roofcover1	106913	0	.003	0	1
roofcover2	106913	.029	.168	0	1
roofcover3	106913	.958	.202	0	1
roofcover4	106913	0	.004	0	1
roofcover5	106913	.006	.077	0	1
roofcover6	106913	.004	.06	0	1
roofcover7	106913	.003	.054	0	1
roofcover8	106913	0	.004	0	1
roofcover9	106913	.001	.023	0	1
roofcover10	106913	0	.016	0	1
roofcover11	106913	0	.009	0	1
storyheight1	106913	.002	.039	0	1
storyheight2	106913	.067	.25	0	1
storyheight3	106913	.01	.1	0	1
storyheight4	106913	.716	.451	0	1
storyheight5	106913	0	.003	0	1
storyheight6	106913	.002	.044	0	1
storyheight7	106913	.204	.403	0	1
storyheight8	106913	0	.005	0	1
extwall11	106913	0	.004	0	1
extwall12	106913	.002	.047	0	1
extwall13	106913	.119	.324	0	1
extwall14	106913	.541	.498	0	1
extwall15	106913	.014	.118	0	1
extwall16	106913	.008	.09	0	1
extwall17	106913	.271	.445	0	1
extwall18	106913	.023	.151	0	1
extwall19	106913	.016	.126	0	1
extwall110	106913	.001	.038	0	1
extwall111	106913	.002	.049	0	1
extwall112	106913	0	.008	0	1
extwall113	106913	0	.006	0	1
extwall114	106913	.001	.028	0	1
lowlevel1	106913	.659	.474	0	1
lowlevel2	106913	.017	.131	0	1
lowlevel3	106913	.062	.241	0	1
lowlevel4	106913	.04	.195	0	1
lowlevel5	106913	.222	.416	0	1
lowlevel6	106913	0	0	0	0

Works Cited

NCEE 2015-07.pdf Download NCEE 2015-07.pdf
KnoxResidentialAddrPoint_Geocoded1_TableToExcel.xlsx Download KnoxResidentialAddrPoint_Geocoded1_TableToExcel.xlsx
Knox_2021_Assesor_Export_20210921_Record Layout.docx Download Knox_2021_Assesor_Export_20210921_Record Layout.docx
Tax Roll File Layout.xlsx Download Tax Roll File Layout.xlsx
2021 Dwelling File.xlsx Download 2021 Dwelling File.xlsx
2021 Land File.xlsxDownload 2021 Land File.xlsx
2021_Real_County_Rev2.csv Download 2021_Real_County_Rev2.csv

"Greenways & Trails." City of Knoxville, Tennessee, Government, Parks and Recreation Department, 2023, https://www.knoxvilletn.gov/government/city_departments_offices/parks_and_recreation/greenways_trails.

"Knox County Greenways." ArcGIS, Esri, 2023, https://knoxgis.maps.arcgis.com/home/item.html?id=ca752264d14d405dbc29bae16096d9d5.