Effects of Off-Street Bike Trails on Home Values in Hennepin County, Minnesota

By Jennifer Shillcox
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Abstract

In this paper, I use a hedonic price model to determine the effects of off-street bike trail proximity on home sale prices in Hennepin County, Minnesota. Findings indicate that proximity to off-street bike trails decreases home value; however, homes located close to bike trails integrated with open space sell for a slight premium over those that don't. This study concludes that more qualitative analysis is necessary to determine the true degree to which a large, highly connected network of bike trails at the local, county and regional levels improve quality of life for Hennepin County residents.

Introduction

Many transportation and land use planners believe that providing people with alternative modes of transportation increases travel efficiency, promotes equity among diverse populations, protects environmental health, and enhances quality of life. New Urbanists in particular favor design principles that support and encourage walking, biking, and transit use. Few people would argue that bike trails benefit people in Hennepin County, but to what extent? Because bike trails are a public good, their benefits are difficult to measure. When all benefits are not apparent to local, county, and regional decision-makers, bike trails may not be assigned their full weight in cost-benefit analysis. As a result, such multi-modal infrastructure is often trimmed from development projects and under-funded by communities that

could benefit most from them, deemed more of a luxury than a necessity in the face of budget constraints. Many communities don't realize that saving money on this type of infrastructure in the short-term can deprive them of property tax revenue and other economic, environmental, and social benefits in the long-term.

Despite Hennepin County's commitment to providing bike infrastructure, it still relies heavily on the support and cooperation of municipalities and other agencies, especially where crucial linkages are needed to better connect the system. In this paper, I determine the value of bike trails capitalized into home prices in Hennepin County using a hedonic pricing model. The model incorporates single-family home sales data from the Northstar Regional Multiple Listing Service (RMLS), Hennepin County street centerline and landmark data from The Lawrence Group (TLG), existing trail data from the Metropolitan Council, and demographic, housing, and economic data from the 2000 U.S. Census. My hypothesis is that homes located in close proximity to bike trails sell for higher prices than homes with similar characteristics not located near bike trails.

The remainder of this paper is divided into four sections. The first section provides background information on Hennepin County's bike trail system and explores current literature on the subjects of location choice and the use of hedonic pricing models to measure the value of public goods. The second section describes the data and methodology used in the hedonic pricing model. The third section analyzes the results and applies sensitivity analysis. The fourth and final section concludes with suggestions for improvements and additional research opportunities.

Section 1: Background & Literature Review

Background

Hennepin County, Minnesota has one of the most extensive networks of designated on-road bike lanes, off-road bike trails and greenways in the United States, providing over 400 miles of trails spanning the entire county[1]. Most off-street bike trails were constructed in city parks and along old railroad lines and road rights-of-way, with the majority of them financed cooperatively by Hennepin County and municipalities with local property taxes, as well as with state and federal funding sources. The Three Rivers Regional Park District, formerly known as Hennepin Parks, builds and maintains most rural bike trails. The second-ring suburbs of Eden Prairie, Maple Grove, and Plymouth currently maintain the most extensive municipal bike trail systems, followed by the City of Minneapolis. On-street bike lanes - comprising unmarked, standard 8-foot shoulders on county roads and well-marked city road lanes and sidewalks – were created and are maintained by Hennepin County and several municipalities with extensive on-street networks, including Minnetonka and Minneapolis. Inner-ring suburbs such as St. Louis Park and Brooklyn Center lack the necessary open space and road rights-of-way to create either off-street or on-street bike trails, and are currently under-served by bike trails.

Many people use Hennepin County's network of bike trails for commuting, daily service trips, exercise, and recreational opportunities. Adopted in 1996 and updated in 2001, the Hennepin County Bicycle Transportation Plan calls for the designation, creation and maintenance of a safe and convenient countywide bicycle transportation system to encourage commuting, utilitarian, and recreational uses by all county residents. The County is working to create a complete system connecting multiple origins and destinations, with alternative routes to each.

Literature Review

Many factors drive peoples' decisions in where to live. According to Tiebout Hypothesis, people will choose to live in communities with the mix of services providing them with the highest level of utility. Wilson (1960) found that people consistently chose "good neighborhoods" over accessibility to jobs. Neighborhood characteristics such as low density, beauty, recreational opportunities, and healthy environments for raising children were found to be far more important determinants than proximity to work. Other studies have shown that the criteria people use when deciding which neighborhood to reside in changes with stage in life. For example, young singles may choose to live in trendy areas located close to universities, work, or friends. Families with children often choose to live in a good school district. Retirees prefer to live close to health care facilities, recreational opportunities, and areas with high scenic amenities. While some people cannot choose the neighborhood that most suits their needs due to transaction costs, income or other social constraints, the fact remains that in a free-market system, areas offering high quality amenities attract people from all stages in life. This high demand drives up the cost of housing in those areas, which translates into higher property taxes sustained over long time periods.

Many high quality amenities - such as recreational facilities, open space, roads and bike trails - are public goods. Public goods do not have monetary values, and thus are difficult to measure. The hedonic pricing model provides a measure of value by teasing out increases in home price attributable to public goods. The model works on the assumption that consumers choose among homes in a competitive housing market, which is certainly the case in Hennepin County[2]. It also assumes that the value of certain public goods is fully reflected in real estate values. Many

[1] Information from the Hennepin County Bicycle Advisory Commission, 2003

researchers using this model have found a direct correlation between home value and public goods. Thorsnes (2002) determined that building lots directly abutting forest preserves near Grand Rapids, Michigan sold for 19 to 35 percent premiums over those that didn't abut preserves. Nelson, Genereaux, and Genereaux (1992) found that residential land value in Minneapolis and St. Paul, Minnesota rose as distance from landfills increased. West (2002) used hedonic pricing to determine the effects of open space proximity, size, and type on home values in the Twin Cities, Minnesota metropolitan region. Her results showed that proximity to golf courses, large parks, and lakes had a positive effect on home values in the inner cities of Minneapolis and Saint Paul and slightly so in the suburbs, while proximity to small parks and cemeteries generally had negative effects on home values.

Data and Methodology

I constructed a hedonic pricing model using data from the following sources:

- 2002 Home Sales Transaction Data from Northstar Regional Multiple Listing Service
- 2002 Spatial Data on Existing Metro Bike Trails from the Metropolitan Council
- 2002 Shopping Center Data from the Metropolitan Council
- 2002 Street Centerline and Landmark Data from The Lawrence Group
- 2000 U.S. Census Tract Data

My model is similar to one constructed by Sarah West (2002) to determine open space value. In this model, home location is defined by its structural attributes (S), neighborhood characteristics (N), location and accessibility (L), and environmental amenities (A). (Table 1) Because people choose the location that maximizes their utility, or "consumer satisfaction", the market price of a

[2] According to an interview with Steve Commers at Edina Realty, 2003, , Hennepin County has had a sellers real estate market for the past four years.

home is a function of its various attributes, which is commonly known as the equilibrium hedonic price function:

$$P = P(S, N, L, A)$$

Table 1: Variables in Hedonic Price Model

Attributes	Variable	Definition
Structural Attributes (S)	SALESPRICE	Sale price of home
	LOTSIZE	Lot size
	SQUAREFEET	Finished square feet of floor space
	BEDROOMS	Total number of bedrooms
	BATHROOMS	Total number of bathrooms
	YEARBUILT	Year home was built
	FIREPLACE	Total number of fireplaces
	GARAGE	Total number of garage stalls
Neighborhood Characteristics (N)	RACE	Percentage of census tract that is white
	INCOME	Median household earned income of census tract
	OWNER	Percentage of owner-occupied housing in census tract
	VALUE	Median home value in census tract
Location and Accessibility (L)	CBD	Distance from Minneapolis Central Business District (meters)
	SHOP	Distance to major shopping area (meters)
	CIVIC	Distance to nearest school, recreation center, town hall, library, or post office (meters)
Environmental Amenities (A)	OPENSPACE	Distance to nearest park, preserve, cemetery, lake, river, golf course or other open space (meters)
	TRAIL	Distance to nearest off-street bike trail (meters)
	TRAILOPEN*	Distance to nearest off-street bike trail in open space (meters)
	TRAILONLY*	Distance to nearest off-street bike trail not in open space (meters)
	OPENONLY*	Distance to nearest open space without trails (meters)

**The last three variables were used as a substitute for "OPENSPACE" and "TRAIL" in the second model.*

I used data on all single-family homes sold in Hennepin County in 2002 from the RMLS to determine the variables for structural attributes, which totaled over 18,000 homes[3]. After eliminating records with missing information and homes with common walls, I was left with nearly 11,000 records. I geocoded these records using street centerline and address data from TLG in ArcMap, which yielded 1,494 matches. Thus, my sample was reduced to 1,494 records.

To create variables for neighborhood characteristics, I spatially joined the 2002 RMLS sales transaction data with a map of Hennepin County 2000 census tracts in ArcMap to assign each home to a census tract[4]. I then joined this new data set with demographic, economic and housing data from the 2000 U.S. Census using the tract number as the common field. Despite a temporal mismatch between home sales and census, data from the census tends to be consistent over time.

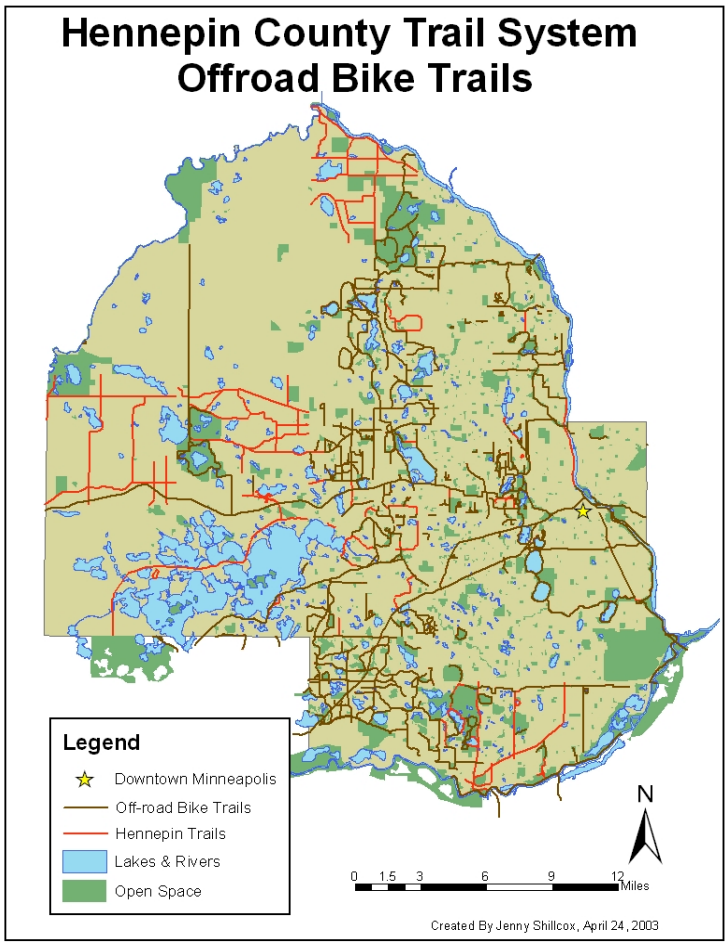
Location and accessibility to jobs, shopping, and civic needs variables were calculated by using the spatial join feature in ArcMap to assign distances from features in one map layer to features in another map layer. Thus, I joined 2002 sales transaction data with data on the Minneapolis Central Business District (CBD), shopping areas, and civic institutions such as schools, libraries, recreation centers, city halls, and post offices from TLG and the Metropolitan Council[5].

Environmental amenities included open space and bike trails, which are the focus of this study. I again used the spatial join feature in ArcMap to determine the distance of homes to the nearest

[3] Ideally, I would have liked to lot size as a variable, but this was too difficult to do with RMLS data, which listed lot dimensions that would need to be converted. Furthermore, lot dimensions were inconsistent and often missing.
[4] West (2002) included a variable on school spending. This data, which is available from Minnesota Department of Children, Families and Learning, was not included in my study due to time constraints, however it should be included in future studies.
[5] West (2002) included variables on distance to nearest major highway and CBDs of cities with populations over 10,000. I did not because I ran out of time. Incidentally, she found weak relationships with these variables.

open space using data on parks, lakes, rivers, golf courses and cemeteries from TLG[6]. I did the same with bike trails using metropolitan trail data from the Metropolitan Council, after selecting only trails on which biking was allowed[7]. Thus, trails used for other purposes and on-street biking opportunities were not included in this study. (Map 1) I created three additional variables for running a second analysis by clipping bike trails that intersected open space and naming it TRAILOPEN, and naming the remaining trails TRAILONLY and remaining open space OPENONLY.

Map 1: Off-Street Bike Trails



Once all variables were calculated, I ran two regressions in Excel, using a linear regression. I did not convert any of my variables to natural logs[8]. The first regression used all controls with TRAIL and OPENSPACE as the test variables (Table 2), and the second used all controls with TRAILOPEN, TRAILONLY, and OPENONLY as the test variables. (Table 3) I then created a correlation matrix based on the second regression to compare the relationships between each of the variables

[6] West (2002) differentiated between type of open space, which I did not have time to do, but should be done in future studies.
[7] After talking to Bob Byers and Bruce Thompson at the Hennepin County Bicycle Advisory Committee (BAC), I decided not to include on-street bike lanes in the study because they include unmarked road shoulders, sidewalks, and marked and unmarked lanes.
[8] West (2002) used a log-transformation of most of her continuous variables. A quick test in SPSS (thanks to Dan Petrick) showed that natural logs didn't enhance any linear relationships or yield significant changes.

in the model. (Appendix) I also re-ran both regressions in SPSS to check for consistency of my results and then ran a stepwise regression in SPSS to determine control variables generating the strongest model for sale price. (Appendix)

Summary of Results and Analysis

The first four regressions in Excel and SPSS yielded an adjusted R-Square of 0.654 - 0.655 for the models, indicating both models were fairly indicative of the factors contributing to sale price. The fifth stepwise regression indicated that the model yielding the highest R-Square of 0.811 included: SQUAREFEET, BEDROOMS, HOMEVALUE, YEARBUILT, GARAGE, INCOME, BATHROOMS, OPENONLY, TRAILONLY, FIREPLACE, OWN, and CIVIC.

In all five regressions, the coefficients for all structural attributes were significant, with finished square feet most strongly correlated with home sale prices. Bathrooms, garage stalls, and to a lesser extent fireplaces were positively correlated with price, while bedrooms and year built (age) were negatively correlated.

Table 2: Regression I Results (Excel)				
Adjusted R-Square=0.655				
Variable	**Coefficients**	**Standard Error**	**T-Score**	**Significance**
BEDROOMS	-40097.651	5196.147	-7.717	0.000
BATHROOMS	22094.466	6314.597	3.499	0.000
YEAR BUILT	-557.605	120.663	-4.621	0.000
SQUAREFEET	143.434	6.312	22.725	0.000
FIREPLACES	12939.550	4749.809	2.724	0.007
GARAGES	24579.950	5591.071	4.396	0.000
INCOME	-1.799	0.453	-3.970	0.000
HOME VALUE	0.754	0.098	7.731	0.000
OWN	868.873	328.321	2.646	0.008
RACE	71.661	517.892	0.138	0.890
SHOP	-1.417	2.406	-0.589	0.556
CIVIC	11.516	5.737	2.007	0.045
CBD	0.270	0.699	0.386	0.700
TRAIL	8.989	3.580	2.511	0.012
OPENSPACE	-54.123	13.914	-3.890	0.000

Table 3: Regression II Results (Excel)				
Adjusted R-Square= 0.654				
Variable	**Coefficients**	**Standard Error**	**T-Score**	**Significance**
BEDROOMS	-40724.214	5196.982	-7.836	0.000
BATHROOMS	22283.030	6329.236	3.521	0.000
YEAR BUILT	-534.313	121.627	-4.393	0.000
SQUAREFEET	144.491	6.303	22.925	0.000
FIREPLACES	13188.961	4755.305	2.774	0.006
GARAGES	24425.576	5599.999	4.362	0.000
INCOME	-1.764	0.458	-3.852	0.000
HOME VALUE	0.736	0.098	7.502	0.000
OWN	809.881	332.565	2.435	0.015
RACE	-0.118	523.294	0.000	1.000
SHOP	-3.127	2.606	-1.200	0.230
CIVIC	13.693	5.796	2.363	0.018
CBD	0.666	0.696	0.957	0.339
TRAIL & OPEN	-1.124	4.578	-0.245	0.806
OPEN ONLY	-30.595	10.874	-2.814	0.005
TRAIL ONLY	8.935	3.859	2.316	0.021

Neighborhood characteristics weren't as consistent across variables or among the first four regressions. In all four regressions, the coefficient for median home value of the census tract was highly significant and positively correlated with sale price. The coefficient for percent of home ownership in census tract was positively correlated with home price, but not significant. The percent of white people in census tract was not significant, but was highly correlated with income. The coefficient for median household earned income was significant across all four regressions, but surprisingly was negatively correlated with sale price. This negative relationship could be attributed to a number of factors, including the presence of wealthy retirees with small earned income, divorcees, or extended families (particularly of Asian or Hispanic descent) with several generations living together in small homes and combining incomes or sending money to families in their home countries[9]. Of all neighborhood characteristics, only median household earned income and percent of home ownership were included as constants in the fifth stepwise regression. (Appendix)

None of the coefficients for location and accessibility variables were significant in the first four regressions, although proximity to civic institutions was included as a constant in the fifth stepwise regression. Of these, only proximity to shopping areas showed a positive (but insignificant) relationship to home sale price, indicating that sale price decreased as distance from shopping areas increased.

Of the two environmental amenities - open space and the test variable of off-street bike trails - only open space showed a significant and positive correlation to home sale price in the first

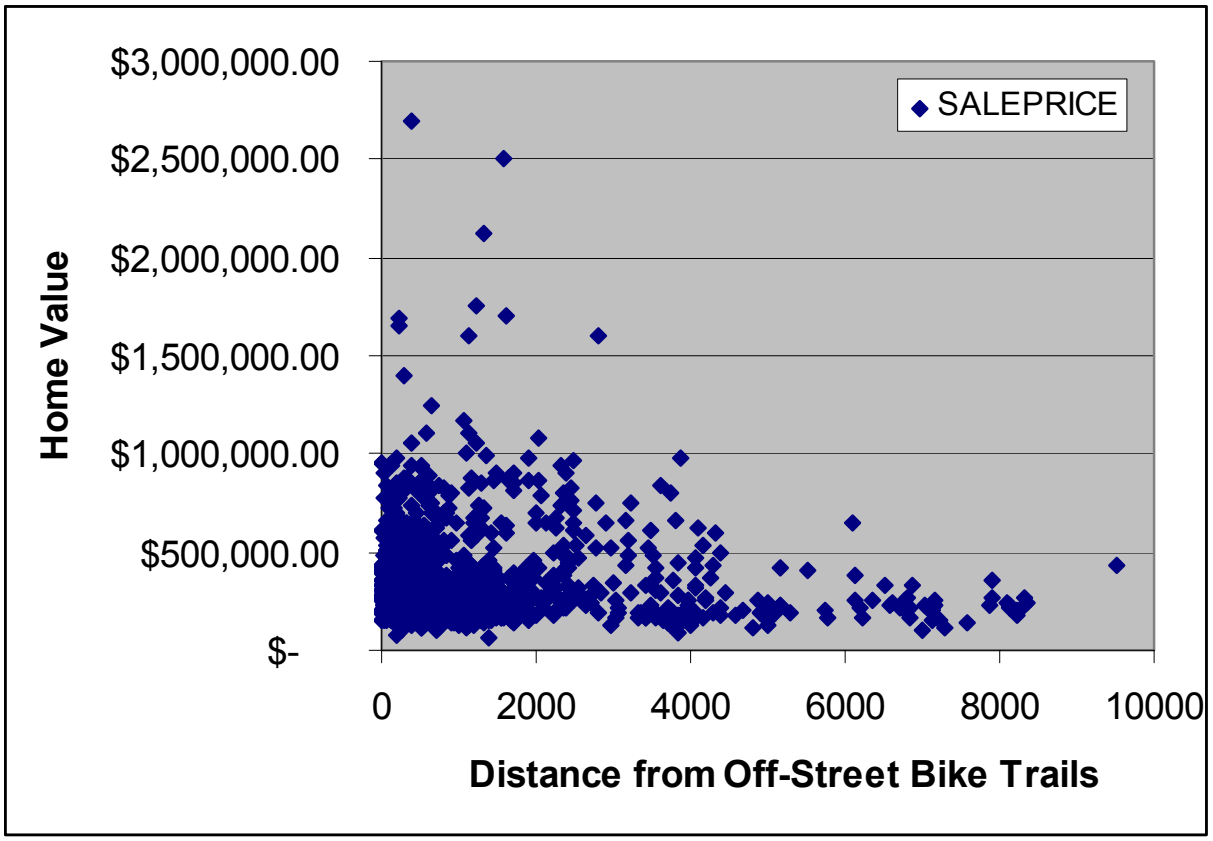
[9] Future studies should include variables on percent of population over 65, median household size, and percent population Hispanic and Asian.

regression. (Table 2) Off-street bike trails were significant, showing a weak negative correlation to home sale price, indicating that home sale prices actually increased by $9 for every meter of distance away from trails. Only when combined with open space in the second regression did off-street bike trails show a positive (but insignificant) relationship to home sale price, indicating that sale prices decreased by $1 for every meter away from trails in open space. (Table 3) Trails without open space in the second regression showed a similar relationship to sale price, as all off-street bike trails in the first regression. (Table 3) Open space without trails didn't increase home value as much as all open space in the first regression.

A closer look at the scatter of home doesn't reveal much, except that expensive homes in excess of $1,000,000.00 (which are extreme outliers) tend to be located within 4,000 meters of off-street bike trails, most of which are located within 2,000 meters of open space. (Graph 1) Also, a higher density of high-priced homes appear to be clustered within 1,000 meters of off-street bike trails, however, it appears that most homes of all values are clustered within this distance.

Furthermore, a look at the distribution of 2002 single-family home sales reveals that most sales occurred in the outer, developing suburbs and not in older suburbs or the inner city of Minneapolis. (Map 2) Because developing suburbs have considerably more open space and less traffic congestion, biking may be perceived as safer on streets or sidewalks, thus off-street bike trails both within and out of open space might be valued higher in densely populated areas.

Graph 1: 2002 Home Sale Price and Distance to Off-Street Bike Trails (Meters)

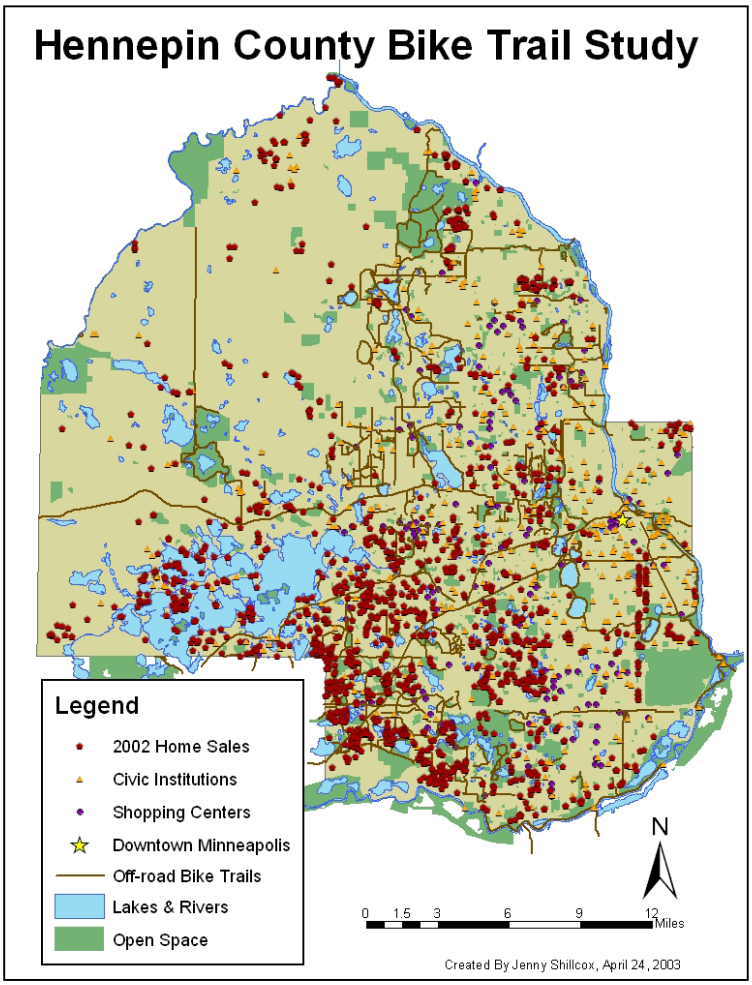


Conclusion

The findings of this study suggest that trails alone do not increase home sale prices, and in fact may decrease them. However, trails integrated with open space, which positively impacts home value, seems to increase the value of trails and subsequently homes located close to them. While the results of this study seem to call for the creation of bike trails only if integrated with open space, and actually implies that open space with trails adds less value than open space without, I would argue that they are too inconclusive make such a claim. This is largely due to the limitations of this study. First, the study was limited in the control variables it included and could be strengthened by adding in variables for lot size or density, as well as neighborhood age, family size, race, and percentage of population speaking English as the primary language. It

would also be helpful to differentiate between the different types and sizes of open space to gain a better understanding of how and where trails inter-relate with open space.

Map 2: Distribution of Homes and Trails



Perhaps a more pertinent limitation to this study is that it did not account for trail length, substrate, use, or accessibility to other trails connecting to a large network of origins and destinations. Other studies have shown that well connected bike trail systems with other supportive bike infrastructure increases bike usage, which in turn benefits society by reducing automobile dependence, thus decreasing air pollution, impervious road surface and traffic congestion (Dill, 2003 and Nelson and Allen, 1997). Bike trails also promote equity by providing people living close to bike infrastructure a less expensive transportation alternative for getting to work, conducting daily errands and maintenance activities, and partaking in leisure activities. These factors have important implications for how bike infrastructure is designed, where it is placed, and the degree to which it connects to other uses. Therefore, Hennepin County and its municipalities – especially those inner-ring suburbs with a shortage of bike trails, should consider these factors in unison with property value impacts

when contemplating additional bike trails. Bicycle rider counts for existing trails, and data on mode share in census tracts and travel behavior in travel analysis zones might aid in this analysis.

A third limitation of this study is that it does not account for the use and value of land prior to its conversion to off-street bike trails. Many off-street bike trails have been converted from old railroad beds and rail yards that were holding down the price of surrounding land values for generations. For example, neighborhoods surrounding the Metro Greenway in Minneapolis - a recently converted railroad - are just beginning to witness the benefits of the new off-street bike trail. Thus, a study tracking the value of homes over time (upon conversion to bike trails) might provide a better indication of the true positive externalities of bike trails. A further study might look at how land value surrounding railroads converted to industrial, residential, highways, or other uses compares to land value surrounding railroads converted to bike trails. Studies may reveal that bike trails add more value to the community than other new uses might.

In conclusion, I believe that further analysis is needed before understanding the true benefits of bike trails and making policy implications as to how and where they are funded, built and maintained.

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Appendix

Excel Correlation Matrix for Regression II

SPSS Linear and Stepwise Regressions