The Effect of Freight Railroad Tracks and Train Activity on Residential Property Values

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abstract

This study evaluates the impact of freight railroad tracks on housing markets. A hedonic price model is used to estimate reduction in the sale price of residential properties near freight railroad tracks in Cuyahoga County, Ohio for 1996 and 1999. The findings indicate an average loss in value between $3,800 and $5,800 (5%–7%) for houses under 1,250 square feet located within 750 feet from a railroad track. Larger houses showed mixed results. After substantial publicity about a freight train company merger, freight trip counts showed a negative and statistically significant impact on the sale price of smaller houses, and some larger houses, for each additional daily freight train trip.

The benefits of transportation in linking markets and generating positive externalities are well established in economic theory. Access to transportation links, such as highway interchanges, airport hubs, train stations, and boat landings, is a positive factor. However, being too close to transportation uses that are far away from access links can have a negative effect on property values due to the nuisance and potential problems of accidents. This is particularly true for railroads that crisscross the country carrying freight and have very few access points. For freight railroads, the access points are not directly used by residential property owners. In addition, there is train noise and whistle blowing as the trains pass by, the fear of accidents exists, and potential for other related nuisances. The main questions addressed by the research here are how much markets discount houses near railroad tracks and whether the discount decreases with distance from the track and less freight trip volume.

Variables Related to Railroad Freight Lines

Periodically, train companies merge and consolidate track activity; sometimes this can lead to changes in trip volumes on specific segments. Because proximity to train tracks is considered a nuisance, nearby property values can be affected. The effect could be related solely to proximity or to the volume of activity (e.g., freight train cars passing by the property). Effects may also be more pronounced on properties adjacent to where the freight lines cross streets. Also, if trip counts change due to rerouting, would there be any differential effect on property values? This study finds that rail traffic, as opposed to simply proximity to tracks, makes a difference in the sale price of residential properties. Further, publicity is found to increase public awareness of this issue.

In the Cleveland, Ohio area in the mid- to late-1990s, CSX Corporation (CSX) and Norfolk Southern Corporation (Norfolk Southern) decided to reorganize and acquire another railroad, Consolidated Rail Corporation (Conrail). An environmental impact statement (EIS) was done to determine track reconfiguration. Freight trip counts on various segments were scheduled to change. Beginning in 1997, there was a lot of publicity regarding the reconfiguration, and the railroad lines negotiated with various cities about the impacts of the train reconfiguration on property values. Cities received millions of dollars, but none of the money went toward property damage awards. By 1999, the EIS process had been completed and changes to track volumes had been implemented.

This study examines the "before" and "after" of the reconfiguration in freight railroads in Cuyahoga County, Ohio, and comments on the inclusion of property damage awards in a process of this type. The study focuses on the effect of freight-carrying railroad tracks on single-family housing in Cuyahoga County, Ohio, which includes a total of 15 rail segments with over 50 miles of track. After a review of the extant literature, this article discusses the study area, data collection, and variables. Size-stratified hedonic regression models of the county residential real estate market are developed, and the proximity to railroad tracks is tested in various forms. The results are presented, as well as conclusions and implications for appraisers.

Overview and Literature Review

This study was inspired, in part, by a project done in a graduate urban planning class on the factors affecting the desirability of an urban neighborhood. A questionnaire was administered in person to 105 prospective homebuyers of inner-city homes on the near-west side of Cleveland, Ohio, during the summer of 2000. The questions mainly related to neighborhood characteristics that could have a positive or a negative effect on housing values. Residents were asked to weigh their willingness to live close to various urban factors (e.g., an auto junkyard, interstate, railroad tracks, city park) on a seven-point scale, where -3 was strongly negative and +3 was very desirable. The results of the questionnaire are shown in Table 1.

The least desirable site characteristics were junkyard (-2.81), leaking underground storage tank (LUST) (-2.71), and factory (-2.60). Living next to a train track had the next most negative score of -2.07, closely followed by proximity to a highway and main street (both about -1.9). Scores ranged up to +2.2 for lake views.[1]

Table 1 Survey of Prospective Homebuyers in Cleveland, Ohio: Urban Disamenities and Amenities

Site Characteristics	Scale of the Results
Next to an auto junkyard	-2.810
Next to a gas station with a tank leaking petroleum	-2.709
Next to a factory	-2.600
Next to a train track with about 15 trains per day	-2.067
Next to an interstate highway	-1.990
On a main 4-lane street	-1.933
Has no basement	-1.598
On a former brownfield; cleaned to state risk-based standards	-1.231
Next to a retail complex	-1.019
Next to a grade school	-0.567
Ohio City, south of Lorain Avenue	-0.388
Next to a new cemetery	-0.320
On a former brownfield; cleaned "clean enough to eat the dirt"	-0.192
Next to a secure and historic water tower park	-0.019
Has affordable housing mixed in	0.010
Next to old cemetery with trees	0.590
Next to a city park	0.683
View of downtown skyline	1.733
View of Lake Erie	2.229

$n = 105$

Effects of Other Linear Urban Uses on Residential Property

Roads are a linear land use similar in some ways to railroad tracks. Hughes and Sirmans found a significant 1% negative change in residential property values for each 1,000 annual average daily traffic (AADT) in city areas, and a 0.5% change per 1,000 AADT in suburban areas in Baton Rouge, Louisiana.[2] A related study by the same authors showed an 11% decrease in value for houses on high traffic streets, compared with low traffic streets.[3] However, this study did not explicitly control for street design. This same research also showed an average reduction of 0.8% in property values per 1,000 AADT.[4] For a typical collector street with 5,000 to 10,000 more trip counts per day than a purely residential street, this would equate to a 5%–10% reduction in property values, holding all else constant.

1. Some of these items have been empirically tested. Leaking underground storage tanks, for example, have been linked to a 13%–17% reduction in residential property value in the same Cuyahoga County, Ohio area. See Robert A. Simons, William Bowen, and Arthur Sementelli, "The Effect of Underground Storage Tanks on Residential Property Values in Cuyhoga County, Ohio," *Journal of Real Estate Research* 14, no. 1/2 (1997): 29–42. Because this score was worse than for the railroad tracks, the expected result should be less than this amount.
2. William T. Hughes Jr. and C.F. Sirmans, "Traffic Externalities and Single-Family House Prices," *Journal of Regional Science* 32, no. 4 (1992): 487–500.
3. William T. Hughes Jr. and C.F. Sirmans, "Adjusting House Prices for Intra-Neighborhood Traffic Differences," *The Appraisal Journal* (October 1993): 533–538.
4. Ibid.

Another linear and visible type of land use that is somewhat similar to railroad tracks is high-voltage overhead electrical transmission lines (HVOTL). Studies by Colwell, and Kinnard and Dickey showed a significant reduction of 5%–8% in residential property values within a few hundred feet of the transmission lines.[5] Another use similar to trains in its linearity is pipelines. In a study of the effect of a pipeline rupture on non-contaminated residential property on the pipeline easement in Fairfax County, Virginia, Simons estimated that single-family housing experienced a loss in value of 4%–5% after the rupture.[6]

Rail Impact Studies

Noise, especially from train horns, is the primary negative externality generated by train traffic. A study by Rapoza, Rickley, and Raslear[7] found that residents living within 1,000 feet of a railroad track were severely annoyed by train horns.Consistent with this unsurprising finding, many communities have enacted regulations to ban the use of train horns especially during nighttime hours to reduce the interference of train noise with the comfort of local residents. However, numerous studies funded by the Federal Railroad Administration (FRA) have proven that banning train horns increases fatalities and that the bans are costly to both residents and railroad companies.[8]

The FRA's numerous studies on the impact of noise on communities have also evaluated the effectiveness of warning systems, specifically the wayside train horn at crossing sections. A study conducted by the U.S. Department of Transportation and the FRA indicated that the use of railroad horns in addition to wayside horns could reduce accidents by 69%. The same study surveyed actions taken by residents to reduce the interference of noise with their daily activities. While most residents, as reported by the study, would stop talking or close windows, 14% considered moving.[9]

Most studies measure the frequency and level of noise to assess their impact on residents or property values. Few studies have examined the effect of proximity to a railroad track in terms of distance. Clark used distance from a railroad track to measure loss in property values for the mostly rural districts of Middletown and Niles in Ohio.[10] The findings indicate property values decreased by 2.1% in Middletown and 2.8% in Niles for every additional rail line within a buffer of ¼ mile. The loss is even higher for properties located near a crossing section where the use of train horns is more frequent. Another study in Oslo, Norway, looked at the relationship between tracks and residential sale price, based on pure proximity. Residential sale price decreased by up to 7%–10% within 100 meters (about 330 feet) of a railroad track.[11] These results were derived from both hedonic modeling and a type of contingent valuation analysis done by real estate salespeople.

To summarize, the benefits of railroad transportation in connecting markets are well established in economic theory but there is still a tension between the need for safety and the need to reduce the level of annoyance generated by railroad activities. Based on previous train studies and the negative effect on property values from other similar urban land uses, property value decreases in the single digits are expected from trains and train traffic.

Railroad Merger in Cleveland

Railroads sometimes merge and consolidate. As previously noted, in Cleveland this began in 1997 as CSX and Norfolk Southern sought to combine operations, acquire Conrail, and streamline and consolidate track utilization in Cuyahoga County. The negotiations were accompanied by an environmental impact statement that examined reconfiguring lines and train volumes. Trip counts on various segments ranged from 0–75 trips per day before the

5. Peter Colwell, "Power Lines and Land Value," *Journal of Real Estate Research* 5, no. 1 (Spring 1990): 117-127; William Kinnard and Sue Ann Dickey, "A Primer on Proximity Impact Research: Residential Property Values Near High Voltage Overhead Transmission Lines," *Real Estate Issues* 20, no. 1 (1996): 23–29.
6. Robert. A Simons, "The Effect of Pipeline Ruptures on Noncontaminated Residential Easement-Holding in Property in Fairfax County," *The Appraisal Journal* (July 1999): 255–263.
7. Amanda S. Rapoza, Edward J. Rickley, and Thomas G. Raslear, "Railroad Horn Systems Research," prepared for U.S. Department of Transportation, Federal Railroad Administration, Report No. DOT-VNTSC-FRA-98-2, 1998.
8. John P. Aurelius and Norman Korobow, "The Visibility and Audibility of Trains Approaching Rail-Highway Grade Crossings," prepared for U.S. Department of Transportation, Federal Railroad Administration, Report No. FRA-RP-71-2, 1971 (available through National Technical Information Service, Springfield, VA); Amanda S. Keller and Edward J. Rickley, "The Safety of Highway-Railroad Grade Crossings: Study of the Acoustic Characteristics of Railroad Horn Systems," prepared for U.S. Department of Transportation, Federal Railroad Administration, Report No. DOT/FRA/ORD-93/25, 1993.
9. Jordan Multer and Amanda Rapoza, "Field Evaluation of a Wayside Horn at a Highway-Railroad Grade Crossing," prepared for U.S. Department of Transportation, Federal Railroad Administration, Report No. DOT/FRA/ORD-98/04, 1998.
10. David E. Clark, "Ignoring Whistle Bans and Residential Property Values: A Hedonic Housing Price Analysis" (working paper).
11. Jon Strand and Mette Vagnes, "The Relationship Between Property Values and Railroad Proximity: A Study Based on Hedonic Prices and Real Estate Brokers' Appraisals," *Transportation* 28 (2001): 137–156.

merge, with 15–30 trains per day being typical. The reconfiguration was finalized and operational by 1998. As a result, some lines experienced substantial reductions in traffic (e.g., from 50 per day down to 5 per day), some increased (10 to 45 per day), while other segments remained the same.[12]

Beginning in 1997, there were many news reports regarding the impact of the merger, and the railroad lines negotiated with various cities about the impacts of the train reconfiguration on property values. Cities received considerable sums of money. For example, East Cleveland, with a population of about 33,000 in the year 2000, received $4 million; Cleveland, population 493,000, received over $20 million; and Lakewood, population 50,000, also received a multimillion-dollar award. These funds went toward noise mitigation and safety improvements; no monies were allocated to reductions in property values. By 1999, the EIS process had been completed and changes to track volumes had been implemented. This article examines the "before" (1996) and "after" (1999) of this decision in the Cuyahoga County, Ohio, residential resale market.

Model and Research Questions

The initial research question examines whether railroad tracks have the expected negative effect on nearby, single-family house prices. The second question examines whether the negative effect declines with distance from railroad tracks. It is expected that the loss in value of properties within 250 feet from the railroad tracks would be higher than the loss in value of properties located within 750 feet from the railroad tracks. If this holds true, it supports the notion of a gradient effect from the tracks. If there were negative effects but not decreasing with distance, then a zonal effect would be evident. Third, trip volumes (instead of pure proximity) are tested for their effect on sale prices, and whether this effect is stable over time when trip volumes change and the changes are publicly known. Proximity to railroad crossings, where noise and fear of accidents are expected to negatively impact sale prices, is also examined.

The hedonic regression model states that single-family housing sale price is a function of structural characteristics of the house, neighborhood characteristics, and its distance from railroad tracks. With respect to the model presented below, we expect β_3 (sale within several hundred feet of a freight line), β_4 (freight train traffic), and β_5 (gated railroad crossing) to be negative.

A reduced form of the hedonic model is used and is expressed as:

$$P = \beta_0 + \beta_1 S + \beta_2 Z + \beta_3 BUFF + \beta_4 TTRIPS + \beta_5 CROSSING + \varepsilon$$

where:

P = Sale price of the house
S = Vector for structural characteristics of the house
Z = Vector that consists of dummy variables for zip codes; a proxy for neighborhood characteristics
$BUFF$ = Dummy variables attached to properties located within 250, 500, and 750 feet from railroad tracks
$TTRIPS$ = Number of daily freight trains passing in both directions for the segment nearest each house within a railroad track's buffer
$CROSSING$ = Proximity to gated railroad crossing
ε = Error term

Because of potential market stratification issues, the data set is divided into three approximately equal parts based on building square footage. Parallel analyses are run for each market segment and compared.[13]

Study Area and Data Collection

The study area for this research is Cuyahoga County, Ohio; Cleveland is the main city in the county. The population of the city and county in the year 2000 was about 0.5 million and 1.6 million, respectively.

Data Collection

The data used for this research is from the Northern Ohio Data Information Service (NODIS) of the Maxine Goodman Levin College of Urban Affairs at Cleveland State University. House sale prices were obtained from Amerestate, Inc. data, based on county records, and were collected for all transactions that occurred during 1996 and 1999. The county data set included a set of variables related to the characteristics of the house and lot, similar to those included in standard hedonic price studies. Table 2 presents a description of the structural variables included in the hedonic model with descriptive statistics for year 1999. Overall, the typical house sold for $108,800, contained 1,600 square feet of living area, 1.6 garage spaces, and 1.5 bathrooms. It was 61 years old, had a basement of 800 square feet, and sat on a lot of 8,700 square feet. The mean values for the three sizes of units are detailed in Table 2. The data set was split into three parts based on square footage of the units: under 1,250 square feet; 1,251 to 1,700 square feet; and over 1,700 square feet.

The smaller units had an average size of 1,050 square feet, and a sale price of $81,000; the me-

12. Surface Transportation Board, Section of Environmental Analysis, Finance Docket No. 33388, Proposed Conrail Acquisition, 1998.

13. The authors would like to thank the reviewers for suggesting this analysis.

dium-sized units averaged 1,450 square feet and sold for $97,900; and the largest group averaged 2,200 square feet and sold for $138,500.

Dummy variables were also included for style and construction type. Only single-family residential units were included. Zip codes were employed to account for neighborhood characteristics and to capture the effect of distance from the central business district. A total of 38 dummy variables for the zip codes (with a minimal number of residential sales) were used. Because the zip code variables cannot be generalized, their results are of little interest and are not included (but are available upon request).

The data set contained over 33,000 house sale transactions that occurred in 1996 and 1999. The data cleaning process consisted of deleting all records that had data missing for the following variables: sale price, parcel number, zip code, building square footage, number of rooms, lot square footage, style and construction type specification, and age of the property.

Records clearly outside of a reasonable range that could be considered outliers were deleted. For sale price, only sales between $5,000 and $400,000 were retained for the analysis. Building square footage ranged from 500 square feet to 4,500 square feet. Properties with fewer than three rooms and those with more than 15 rooms were removed, as were properties with lot square footage of less than 2,000 square feet or more than 55,000 square feet. Finally, parcels with lot frontage of less than 20 feet or greater than 140 feet were excluded from consideration. The data set ended up with about 14,900 sales for the year 1996 and 17,800 sales for the year 1999.

Train Variables

Information on train activities was added to the real estate data set. A geographical information system (GIS) was used to link neighborhood and structure information to data on properties located within 250 feet, 500 feet, and 750 feet from railroad tracks. A buffer for the specified distance was created from both sides of the track to include only parcels located within that distance, allowing creation of the dummy variables BUFF250, BUFF500, and BUFF750. The number of annual sales of smaller-sized units, within the distance buffer was 92, 201, and 269, respectively, for BUFF250, BUFF500, and BUFF750. Variables were also created for average daily freight train traffic, based on the number of freight train trips in 1996 and 1999 for each of about 15 different rail segments within Cuyahoga County. Trip data was unavailable for a few freight lines, and these were treated with a dummy variable. We also included buffers of up to 750 feet for proximity to gated train crossings. Because a few freight segments also serve rapid transit, the models also controlled for proximity to rapid transit lines and transit stations.

Regression Diagnostics

The variance inflation factor (VIF) index was used to check for the multicollinearity problem in the larger data set. Some variables such as number of rooms and bedrooms, and lot depth and width had a high VIF and were discarded from the model. For other variables, the multicollinearity was not severe, but for some cases like the fireplace variable, it generated a coefficient with a sign that was not consistent with theory. It also was removed from the model.

Table 2 Descriptive Mean Statistics for 1999

Variable	Small Units Under 1,250 Sq. Ft.	Medium Units 1,251–1,700 Sq. Ft.	Large Units Over 1,700 Sq. Ft.
Sale price	$ 81,007	$ 97,851	$ 138,510
Building sq. ft.	1,049	1,454	2,205
Garage capacity	1.38	1.54	1.75
Number of baths	1.03	1.18	1.80
Basement sq. ft.	682	745	913
Lot front feet	46.80	50.14	59.01
Lot sq. ft.	6,591	7,500	9,707
Age in years	60.79	65.30	59.53
Valid sample size	6,068	5,804	5,917

n = 17,789

For heteroscedasticity, scatter plots of the dependent variable and model residuals were examined for fanning. None appeared to be present.

Empirical Findings

The initial models (not shown here due to space considerations) were prepared for the large data set.[14] The use of dollars per square foot ($/SF) as the dependent variable was investigated, but results were much less satisfactory than the linear form used in later runs.[15] Table 3 shows the results of the structural variables for 1999 along with train buffers, without freight train trip counts or crossings, for the size-stratified sales data. Overall, the models fit the data well for 1999. The independent variables included in the model explain 62% of the variation in the dependent variable for the smallest units, and 77% for the largest units. The *F*-statistics were 133 to 265, and significant at the 99% level or better. The signs of the coefficients are as expected for the structural variables and are consistent with the findings of previous research in the Cleveland area.[16]

The statistical significance, the sign, and the magnitude of the coefficient for structural variables are as expected and consistent with theory. For example, for the building square footage variable, every additional square foot will increase the sale price by $21 for the smaller units and by $35 for the largest units. Every additional year in the age of the house will decrease the sale price by $367 for the smallest units and by $678 for the largest units. Garage space adds $4,630 to $4,770, and a square foot of lot size adds $0.48 for smaller units and up to $1.86 for the largest ones. All these are significant at well over a 90% confidence level.[17]

The train variables (BUFF250, BUFF500, and BUFF750) are generally consistent with theory and had the right sign. However, statistical significance was only apparent at the 95% level for the units under 1,250 square feet. For this group the results show that for 1999, houses located within 250 feet of railroad tracks sold for $4,400 less than other houses in the reference category. The loss changed somewhat with distance from the tracks, and decreased to about $3,800 less for houses located 251–500 feet away. However, the loss then increased to $5,800 for houses within 501–750 feet of a railroad track. These losses average 5%–7% of the average sale price. Hence, the diminution in property values appears to flatten out because the results for sales within both 500 feet and 750 feet from a track (before consideration of trip counts) did not monotonically decrease. This suggests the markets perceive a zonal effect rather than a gradient effect for freight tracks.

For the medium-sized units, all zones had negative signs, but only the middle ring (251–500 feet away) was statistically significant at 95%. The magnitude of this discount was $4,700 (about 5%). The same negative signs were apparent for the larger units, but no results were significant, even at an 85% level of confidence. Hence, it cannot be said that freight train tracks had a statistically significant effect on these units.[18]

A variable was also inserted to reflect proximity to a rapid transit station (Station RTA 1000 Feet). For smaller units, proximity to a station yielded a positive value from $10,300 to $12,500 (13%–15%) that was statistically significant at a 99% level of confidence. This indicates a value premium among those most likely to use rapid transit. Among the medium units, signs were negative but statistically insignificant. Among the larger units, they were positive but only statistically significant at about an 85% level of confidence, and barely at that level.

Moving along to the "before" and "after" effects of the information about the reorganization of freight train traffic, recall that the changes were announced in about 1997, that 1996 represents the "before" sce-

14. As with Table 3, the large model was run with structural variables and only a buffer around freight train lines. Overall, the model fits the data well for 1999. The independent variables included in the model explain 76% of the variation in the dependent variable. The *F*-statistics were over 750 and significant at the 99% level. The sign of the coefficients is as expected for the structural variables and is consistent with the findings of previous research in the Cleveland area. Of the 54 nongeneralizable variables that were included in the model (38 zip codes and other dummy variables for style and construction), about 40% were statistically significant at the 90% confidence level.

15. We also reran the basic 1999 model with train distance buffers and all ring configurations with the dependent variable as $/building square foot. This means we eliminated building square foot from the right side of the model. The resulting models had a much lower *R* squared: .52 to .72 compared with .62 to .77 in the comparably configured models. The parameter estimates for smaller units were -$4.30, -$3.30, and -$5.20, all significant at a 95% confidence level. Other results mirrored the model with the dependent variable using sale price. When the revised results are transformed into sale price at the average square footage of 1,050, the resulting price drops are $3,500-$5,500, almost identical to those found in Table 3.

16. Simons, Bowen, and Sementelli.

17. A 1996 baseline model for the large data set with the same variables was also run. The *R* squared was 0.80, and the *F*-statistic was over 810. The variable parameter estimates were consistent with theory and with the 1999 results.

18. The results over space should in theory decrease monotonically, but this is not always observed in practice. One explanation is that there is model misspecification, and this may be partly the case here, as evidenced by the superior and more logical results obtained by the model shown later in Table 4b which uses freight trips, as opposed to pure distance, to gauge impacts. Alternatively, results could be attributable to influential outlier sales. Finally, it could be that nuisance from track activity has a zonal (in or out of an affected area) rather than gradient (decreasing over distance within an impact zone) effect on property values. We have ruled out insufficient observations and multicollinearity as potential sources of difficulty on this issue.

Table 3 Effect of Proximity to Railroad Tracks, 1999

Small units under 1,250 square feet	**Within 250 feet**		**251–500 feet**		**501–750 feet**	
	Coefficients	**Sig.**	**Coefficients**	**Sig.**	**Coefficients**	**Sig.**
(Constant)	45,571.41	0.00	45,687.44	0.00	49,375.77	0.00
Bldg. sq. ft.	20.99	0.00	20.91	0.00	20.89	0.00
Garage capacity	4,630.00	0.00	4,649.48	0.00	4,594.30	0.00
Bath number	3,069.35	0.04	2,940.55	0.55	2,833.87	0.06
Basement sq. ft.	14.75	0.00	14.79	0.00	14.73	0.00
Lot frontage	0.19	0.00	0.19	0.00	0.19	0.00
Lot sq. ft.	0.48	0.00	0.47	0.00	0.48	0.00
Age of house	-366.58	0.00	-365.55	0.00	-366.68	0.00
Station RTA 1,000 ft.	10,576.51	0.01	10,291.85	0.01	12,495.16	0.00
BUFF250	-4,384.95	0.03				
BUFF500			-3,816.25	0.00		
BUFF750					-5,809.50	0.00
Adjusted *R* Square	0.62		0.62		0.62	
Degrees of freedom	5,992.00		5,992.00		5,992.00	
F-statistic	133.17		133.29		133.87	
Durbin-Watson	1.75		1.76		1.76	
Medium units 1,251 to 1,700 square feet	**Within 250 feet**		**251–500 feet**		**501–750 feet**	
	Coefficients	**Sig.**	**Coefficients**	**Sig.**	**Coefficients**	**Sig.**
(Constant)	84,888.26	0.00	84,958.68	0.00	84,951.02	0.00
Bldg. sq. ft.	30.83	0.00	30.79	0.00	30.86	0.00
Garage capacity	4,762.51	0.00	4,727.63	0.00	4,768.08	0.00
Bath number	4,538.45	0.00	4,516.23	0.00	4,521.53	0.00
Basement sq. ft.	8.34	0.00	8.32	0.00	8.36	0.00
Lot frontage	0.15	0.00	0.15	0.00	0.15	0.00
Lot sq. ft.	0.70	0.00	0.70	0.00	0.70	0.00
Age of house	-498.98	0.00	-497.07	0.00	-498.93	0.00
Station RTA 1,000 ft.	-5,586.79	0.33	-4,570.52	0.43	-5,447.28	0.35
BUFF250	-2,840.92	0.35				
BUFF500			-4,661.28	0.02		
BUFF750					-385.71	0.82
Adjusted *R* Square	0.64		0.64		0.64	
Degrees of freedom	5,728.00		5,728.00		5,728.00	
F-statistic	135.95		136.10		135.92	
Durbin-Watson	1.56		1.56		1.56	
Large units over 1,700 square feet	**Within 250 feet**		**251–500 feet**		**501–750 feet**	
	Coefficients	**Sig.**	**Coefficients**	**Sig.**	**Coefficients**	**Sig.**
(Constant)	48,814.89	0.00	48,616.56	0.00	48,818.87	0.00
Bldg. sq. ft.	35.42	0.00	35.49	0.00	35.42	0.00
Garage capacity	4,771.95	0.00	4,768.55	0.00	4,766.54	0.00
Bath number	16,216.11	0.00	16,209.55	0.00	16,198.56	0.00
Basement sq. ft.	10.13	0.00	10.12	0.00	10.11	0.00
Lot frontage	0.28	0.00	0.28	0.00	0.28	0.00
Lot sq. ft.	1.86	0.00	1.85	0.00	1.85	0.00
Age of house	-677.67	0.00	-676.75	0.00	-676.61	0.00
Station RTA 1,000 ft.	5,670.17	0.17	5,241.39	0.22	6,021.75	0.15
BUFF250	-4,735.30	0.24				
BUFF500			-882.21	0.76		
BUFF750					-3,385.17	0.17
Adjusted *R* Square	0.77		0.77		0.77	
Degrees of freedom	5,840.00		5,840.00		5,840.00	
F-statistic	265.42		265.34		265.45	
Durbin-Watson	1.51		1.51		1.51	

nario, and that 1999 represents "after" the information became known. Tables 4a and 4b present results for 1996 and 1999, respectively. These models were run with the same structural and zip code variables, but without the train buffers. The new train variables FREIGHT TRIP 250 FEET, FREIGHT TRIP 500 FEET, and FREIGHT TRIP 750 FEET are of particular interest and reflect the number of train trips per day on each segment. Other new train variables include CROSS250, CROSS500, and CROSS750, which indicate distance from a gated train crossing, and RTA1000, which indicates proximity to a rapid transit track (but not station) carrying a number of shorter train trips (2–5 cars).

With respect to the volume of daily freight train trips (FREIGHT TRIP 250 FEET), the 1996 and 1999 models showed quite different results, as expected by theory. For 1996 (Table 4a), only smaller- and medium-sized unit sales had the expected negative sign, and only one cell (smaller units, 501–750 feet away, with a parameter estimate of $80 loss per additional freight train trip) was statistically significant at a 90% or better level of confidence. One parameter estimate (largest units, 501–750 feet away) was positive and statistically significant.

For 1999 (Table 4b), however, after much publicity, the market was able to distinguish the effects of freight trips quite clearly. It was found that per average daily freight trip, sale prices of smaller units within 250 feet (TRIP250) went down by $194. Sale prices of units between 251-500 feet dropped by $85 and by $94 on units between 501-750 feet per average daily freight trip.

All results were statistically significant at a 95% or better level of confidence.[19] This generally reflects a gradient rather than zonal pattern.

For medium-sized units, it was found that per average daily freight trip, sale prices of units within 250 feet dropped by $262. Sale prices of units between 251-500 feet fell by $107 and by $72 on units between 501-750 feet.

All results were statistically significant at 85% or better level of confidence, and the closest result was significant at a 95% level of confidence. This demonstrates a gradient pattern of impact.

For larger-unit sales within 250 feet, a price reduction of $264 was evident, but it was only significant at an 85% level of confidence. Other results were not statistically significant. Thus, the results with freight train trips per day were improved in terms of statistical significance, especially for small- and medium-sized units.

These models also address the effects of gated railroad crossings (CROSS250, CROSS500, and CROSS750) with freight trip counts in the models. For 1996, proximity to a railroad crossing is negative and mostly significant only for the group of smaller units, where units 251–750 feet from a gated crossing experienced negative results of about 5%, holding all else constant. They were not significant for most other categories of units. For 1999, all the losses associated with gated train crossings evaporated, except for the largest units 501–750 feet from a gated crossing. Hence, the overall results for gated crossings were mixed.

Finally, these same models also had a variable if a sale was within 1000 feet of a rapid transit track without a transit station (RTA1000). For 1996, only medium-sized sales showed negative and significant losses for this variable (about 10% of sale price). For 1999, the significant and negative losses (about 5%) associated with RTA1000 were confined to the sales of the smallest units. Hence, the overall results for proximity to rapid transit tracks were also mixed.

Conclusion

The results generated by the hedonic models for 1996 and 1999 are consistent with previous results in the literature. The structural variables are generally of the expected sign. For railroad-related variables, smaller houses of up to 1,250 square feet and located within 250 feet, 500 feet, or 750 feet of a railroad track experienced a statistically significant loss in sale price of $4,300 within 250 feet, $3,800 within 500 feet, and $5,800 within 750 feet from a freight track line; this is equivalent to losses of 5%–7% of sale price. For the medium and larger units, many had negative signs, but only the middle ring (251–500 feet away) was statistically significant at a 95% confidence level, with a discount of about 5%. The lack of a consistent declining pattern implies that markets perceive a zonal rather than gradient effect for this negative amenity when modeled with pure proximity.

Proximity to a gated railroad crossing at grade was associated with a reduction in sale price of about 5% under some circumstances, but results were not robust over all subcategories of sales.

Results improved substantially when freight train trip counts, separate from simple proximity to a

19. A model with all rail variables with the larger data set of all sizes together was run, and the pure proximity buffers performed the most consistently. However, they also had the highest multicollinearity problems. Therefore, these results are considered not very reliable.

Table 4a Effect of Freight Train Trip Counts on Property Values, 1996

Small units under 1,250 square feet	Within 250 feet		251–500 feet		501–750 feet	
	Coefficients	**Sig.**	**Coefficients**	**Sig.**	**Coefficients**	**Sig.**
(Constant)	40,806.72	0.00	40,538.76	0.00	40,678.68	0.00
Building sq. ft.	19.45	0.00	19.52	0.00	19.46	0.00
Garage capacity	3,915.99	0.00	3,914.75	0.00	3,918.24	0.00
Bath number	1,948.19	0.19	2,004.96	0.17	2,158.74	0.14
Basement sq. ft.	13.16	0.00	13.15	0.00	12.99	0.00
Lot frontage	0.16	0.00	0.16	0.00	0.16	0.00
Lot sq. ft.	0.41	0.00	0.40	0.00	0.40	0.00
Age of house	-365.87	0.00	-363.15	0.00	-362.40	0.00
Station RTA 1,000 ft.	8,603.06	0.05	8,309.17	0.06	9,472.28	0.03
RTA track 1,000 ft.	-2,356.82	0.32	-1,588.63	0.53	262.67	0.92
Crossing 250 ft.	-2,265.19	0.62				
Freight trips 250 ft.	**-116.28**	**0.19**				
Crossing 500 ft.			-6,029.84	0.03		
Freight trips 500 ft.			**-39.63**	**0.20**		
Crossing 750 ft.					-4,197.31	0.04
Freight trips 750 ft.					**-80.45**	**0.06**
Adjusted *R* Square	0.68		0.68		0.68	
Durbin-Watson	1.90		1.89		1.90	
Degrees of freedom	5,191.00		5,191.00		5,191.00	
F-statistic	148.96		149.25		149.81	

Medium units 1,251 to 1,700 square feet	Within 250 feet		251–500 feet		501–750 feet	
	Coefficients	**Sig.**	**Coefficients**	**Sig.**	**Coefficients**	**Sig.**
(Constant)	56,488.09	0.00	56,538.94	0.00	56,397.24	0.00
Building sq. ft.	26.49	0.00	26.43	0.00	26.50	0.00
Garage capacity	4,478.43	0.00	4,478.38	0.00	4,528.09	0.00
Bath number	2,701.08	0.01	2,727.01	0.01	2,697.55	0.01
Basement sq. ft.	9.31	0.00	9.42	0.00	9.37	0.00
Lot frontage	0.10	0.00	0.10	0.00	0.10	0.00
Lot sq. ft.	0.91	0.00	0.91	0.00	0.91	0.00
Age of house	-523.31	0.00	-525.11	0.00	-524.87	0.00
Station RTA 1,000 ft.	10,441.52	0.11	9,276.93	0.16	9,661.90	0.14
RTA track 1,000 ft.	-10,393.28	0.01	-10,930.67	0.01	-10,213.85	0.01
Crossing 250 ft.	2,207.11	0.66				
Freight trips 250 ft.	**-164.92**	**0.24**				
Crossing 500 ft.			1,741.49	0.58		
Freight trips 500 ft.			**-27.61**	**0.63**		
Crossing 750 ft.					2,814.19	0.24
Freight trips 750 ft.					**-35.52**	**0.61**
Adjusted *R* Square	0.70		0.70		0.70	
Durbin-Watson	1.99		1.99		1.99	
Degrees of freedom	4,775.00		4,775.00		4,775.00	
F-statistic	147.54		147.61		147.52	

Large units over 1,700 square feet	Within 250 feet		251–500 feet		501–750 feet	
	Coefficients	**Sig.**	**Coefficients**	**Sig.**	**Coefficients**	**Sig.**
(Constant)	42,628.11	0.00	42,833.68	0.00	42,036.57	0.00
Building sq. ft.	39.38	0.00	39.29	0.00	39.40	0.00
Garage capacity	6,301.06	0.00	6,268.31	0.00	6,262.75	0.00
Bath number	12,914.22	0.00	12,928.01	0.00	12,980.06	0.00
Basement sq. ft.	9.63	0.00	9.62	0.00	9.59	0.00
Lot frontage	0.19	0.00	0.19	0.00	0.19	0.00
Lot sq. ft.	1.52	0.00	1.53	0.00	1.52	0.00
Age of house	-744.37	0.00	-744.51	0.00	-740.95	0.00
Station RTA 1,000 ft.	1,722.10	0.79	-2,615.66	0.70	-667.42	0.93
RTA track 1,000 ft.	376.34	0.94	-1,602.79	0.75	-3,951.61	0.45
Crossing 250 ft.	5,360.47	0.56				
Freight trips 250 ft.	**-42.74**	**0.88**				
Crossing 500 ft.			1,200.04	0.80		
Freight trips 500 ft.			**30.48**	**0.64**		
Crossing 750 ft.					-4,562.12	0.19
Freight trips 750 ft.					**227.57**	**0.01**
Adjusted *R* Square	0.81		0.81		0.81	
Durbin-Watson	1.97		1.97		1.97	
Degrees of freedom	4,927.00		4,927.00		4,927.00	
F-statistic	267.59		267.85		268.16	

Signif. = statistical significance level. For example, .04 = 96% confidence level

Table 4b Effect of Freight Train Trip Counts on Property Values, 1999

Small units under 1,250 square feet	**Within 250 feet**		**251–500 feet**		**501–750 feet**	
	Coefficients	**Sig.**	**Coefficients**	**Sig.**	**Coefficients**	**Sig.**
(Constant)	46,203.13	0.00	46,277.68	0.00	46,479.72	0.00
Building sq. ft.	20.85	0.00	20.80	0.00	20.88	0.00
Garage capacity	4,623.29	0.00	4,597.04	0.00	4,579.06	0.00
Bath number	3,107.99	0.04	3,034.27	0.04	2,850.52	0.06
Basement sq. ft.	14.64	0.00	14.69	0.00	14.62	0.00
Lot frontage	0.19	0.00	0.19	0.00	0.19	0.00
Lot sq. ft.	0.48	0.00	0.48	0.00	0.48	0.00
Age of house	-369.09	0.00	-369.17	0.00	-365.27	0.00
Station RTA 1,000 ft.	18,183.18	0.00	16,751.99	0.00	17,259.53	0.00
RTA track 1,000 ft.	-8,152.28	0.00	-6,749.18	0.02	-3,946.57	0.18
Crossing 250 ft.	-4,183.39	0.48				
Freight trips 250 ft.	**-193.87**	**0.02**				
Crossing 500 ft.			884.50	0.78		
Freight trips 500 ft.			**-84.92**	**0.05**		
Crossing 750 ft.					-2,363.30	0.27
Freight trips 750 ft.					**-94.17**	**0.00**
Adjusted *R* Square	0.62		0.62		0.62	
Durbin-Watson	1.75		1.76		1.76	
Degrees of freedom	5,989.00		5,989.00		5,989.00	
F-statistic	128.39		128.23		128.77	

Medium units 1,251 to 1,700 square feet	**Within 250 feet**		**251–500 feet**		**501–750 feet**	
	Coefficients	**Sig.**	**Coefficients**	**Sig.**	**Coefficients**	**Sig.**
(Constant)	84,403.28	0.00	84,794.33	0.00	85,017.69	0.00
Building sq. ft.	31.10	0.00	30.90	0.00	30.91	0.00
Garage capacity	4,753.83	0.00	4,709.66	0.00	4,734.70	0.00
Bath number	4,575.45	0.00	4,553.61	0.00	4,523.77	0.00
Basement sq. ft.	8.45	0.00	8.34	0.00	8.36	0.00
Lot frontage	0.15	0.00	0.15	0.00	0.15	0.00
Lot sq. ft.	0.69	0.00	0.70	0.00	0.69	0.00
Age of house	-499.04	0.00	-498.42	0.00	-498.39	0.00
Station RTA 1,000 ft.	-5,510.36	0.40	-5,683.83	0.39	-5,162.14	0.44
RTA track 1,000 ft.	843.34	0.81	905.54	0.81	1,726.68	0.65
Crossing 250 ft.	311.96	0.97				
Freight trips 250 ft.	**-262.01**	**0.04**				
Crossing 500 ft.			-4,487.92	0.19		
Freight trips 500 ft.			**-107.15**	**0.15**		
Crossing 750 ft.					-511.54	0.83
Freight trips 750 ft.					**-71.87**	**0.15**
Adjusted *R* Square	0.64		0.64		0.64	
Durbin-Watson	1.56		1.56		1.56	
Degrees of freedom	5,725.00		5,725.00		5,725.00	
F-statistic	131.09		130.81		130.71	

Large units over 1,700 square feet	**Within 250 feet**		**251–500 feet**		**501–750 feet**	
	Coefficients	**Sig.**	**Coefficients**	**Sig.**	**Coefficients**	**Sig.**
(Constant)	48,622.51	0.00	48,540.41	0.00	47,957.39	0.00
Building sq. ft.	35.54	0.00	35.55	0.00	35.61	0.00
Garage capacity	4,717.35	0.00	4,748.98	0.00	4,790.22	0.00
Bath number	16,186.00	0.00	16,198.41	0.00	16,227.67	0.00
Basement sq. ft.	10.06	0.00	10.05	0.00	9.99	0.00
Lot frontage	0.28	0.00	0.29	0.00	0.28	0.00
Lot sq. ft.	1.85	0.00	1.85	0.00	1.85	0.00
Age of house	-675.69	0.00	-675.32	0.00	-671.90	0.00
Station RTA 1,000 ft.	9,888.68	0.10	9,783.25	0.11	9,969.80	0.10
RTA track 1,000 ft.	-6,750.15	0.16	-6,768.64	0.17	-7,124.08	0.17
Crossing 250 ft.	-2,950.71	0.73				
Freight trips 250 ft.	**-264.38**	**0.14**				
Crossing 500 ft.			-4,837.08	0.30		
Freight trips 500 ft.			**4.46**	**0.96**		
Crossing 750 ft.					-9,701.36	0.00
Freight trips 750 ft.					**0.82**	**0.99**
Adjusted *R* Square	0.77		0.77		0.77	
Durbin-Watson	1.51		1.51		1.51	
Degrees of freedom	5,837.00		5,837.00		5,837.00	
F-statistic	255.51		255.31		255.83	

Signif. = statistical significance level. For example, .04 = 96% confidence level track, were modeled. In 1996, prior to announced track reconfigurations, trip counts had little effect on prices, with only one cell having results indicating market awareness of trip counts. In 1999, after the announced changes, among smaller units each trip count was associated with a reduction in sale price of around $194 per additional average daily freight train trip within 250 feet. The reduction in sale price decreased to about $85 and $94 per trip within 500 feet and 750 feet away, respectively. Medium-sized units exhibited a gradient-type effect ranging from $262 to $72, at generally lower significance levels. Larger units also had a drop in sale price of $264 per trip at the closest distance. Thus, adding trip counts substantially improved pricing effects of train trips. It also represents more of a gradient, rather than zonal, pattern of impact.

To put this into perspective, for example, if a $100,000 house were located near a freight train track, and the daily train count were to go from 10 trains per day to 30 trains per day, this would imply a reduction in value of $5,000 (20 trips times $250/trip), or 5%. This is a new finding and represents a contribution to the literature.

In a recent financial settlement related to the train reorganization in the Cleveland area, the railroads negotiated with communities for mitigation of noise and safety concerns, but no funds were provided specifically to compensate residents for losses in property value. Of course, this research has not calculated the net effect (some lines gained trips, some lost), so there is no statement made here about the fairness of these payments, but loss in property values should be included in future negotiations of this type. The train-trip count impact was insignificant before the merger talks and accompanying newspaper publicity. After the publicity, significant modest price reductions were evident and these were consistent with theory. This is evidence that the markets were able to price the train volume data reasonably well, and that the talk of train line reorganization did have a substantial effect on the parameter estimates after the change in trip volumes.

The models appear to work better for smaller-sized units, regardless of distance from the tracks. One possible explanation could be that a higher percentage of the larger units are located in affluent suburbs outside the central city, where other locational amenities outside the model (e.g., school districts) may be affecting value. Smaller sales tended to be in the central city or in a few, inner-ring working-class suburbs.

The implication of this research for appraisers is that they should include proximity to rail lines, train trip counts, and potentially gated crossings in determining the value of residential property.

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