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Jay K. Walker
Old Dominion University, j1walker@odu.edu

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Silence is Golden: Railroad Noise Pollution and Property Values*

Jay K. Walker

Department of Economics and Finance, Niagara University, USA

Abstract: This paper uses a unique dataset containing property values and manually collected noise measurements in Memphis, Tennessee to estimate the impact of train noise pollution on commercial and residential property values. Results show that a residential property exposed to 65 decibels or greater of railroad noise results in a 14 to 18 percent decrease in property value. Once a 65 decibel measure is included, there is no additional impact on price of distance to the closest railroad crossing. For commercial property, neither crossing proximity nor noise level significantly affect property value. The results provide evidence of a negative externality that is created by railroad noise for households and the need for more exact measures of noise levels. The findings are also consistent with previous literature suggesting firms have different ideas than individuals about desirable locational attributes.

Keywords: property value, railway noise pollution, externalities

JEL Codes: D6, D62, R32

1. INTRODUCTION

This study examines the monetary impact of regular train noise on appraised property values in the greater Memphis, Tennessee area. Primary data collection methods were incorporated using sound detection equipment resulting in a more exact noise exposure measurement relative to many prior studies and allowing for more exact knowledge of the duration and time of day of the noise exposure. To the author's knowledge, this is one of the few studies to include first hand frequency and duration of sound exposure measurements, as well as being one of the few studies to examine the effect of noise on commercial property values.

The rail line of study in Memphis is unique in that it travels east to west across the entire city through areas having high population densities, with many residential and commercial areas adjacent to the tracks. Residents and businesses in this area cross societal and socioeconomic boundaries with neighborhoods having a wide range of income and education levels. This allows the ability to account for neighborhood effects at the different crossings along with lot size, building characteristics, and the amount of noise pollution evident at each of the properties as it relates to property value. Figure 1 shows the location of the six specific crossings incorporated into the study within the city of Memphis.

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Jay K. Walker is an Assistant Professor of Economics in Lewiston, NY, USA. E-mail: jwalker@niagara.edu

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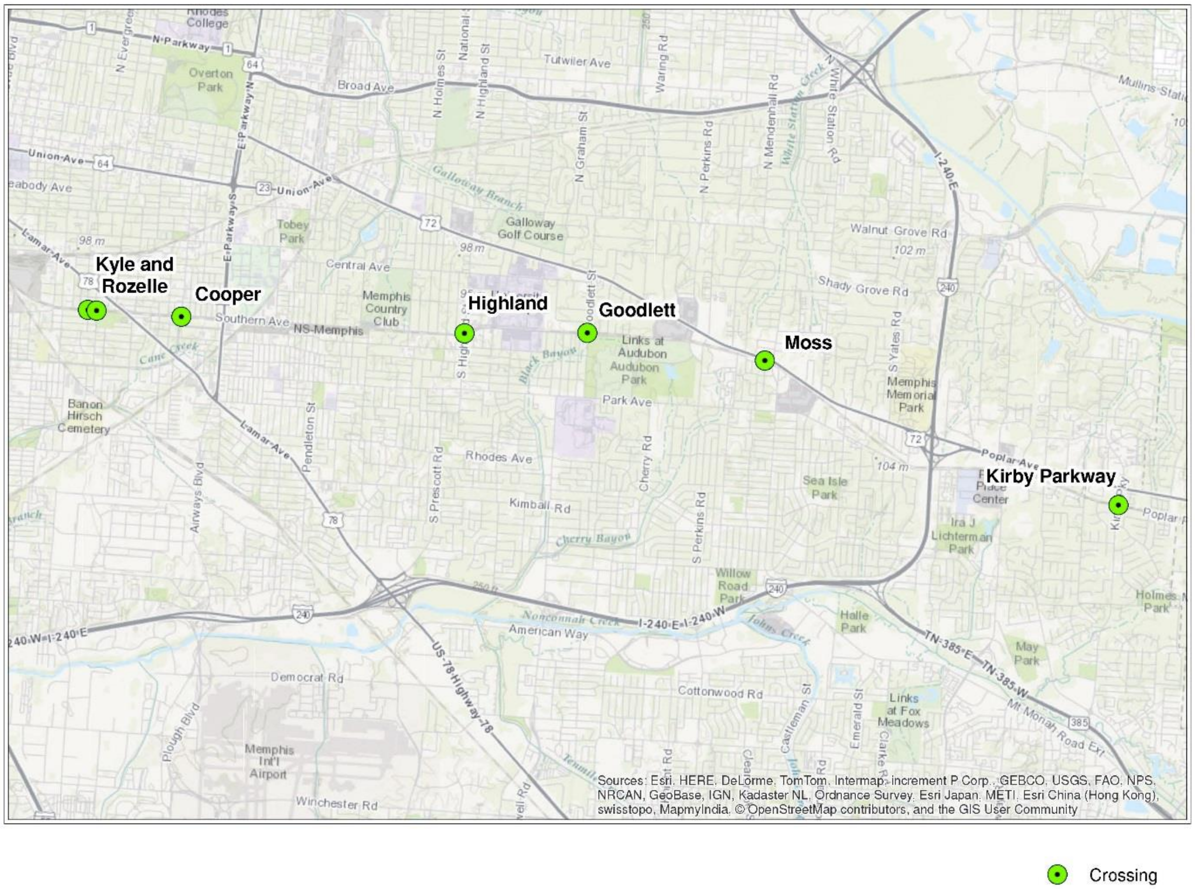
Figure 1: Memphis Area Railroad Crossings Incorporated into the Study



It has been decreed by the Federal Aviation Administration (FAA) that the 65 decibel noise level is a breakpoint. Properties with exposure to 65 to 74 decibels are considered "normally" incompatible with residential use, while housing units having exposure to less than 65 decibels are considered "normally" compatible with residential use (*Federal Register*, 2000). These guidelines were originally developed in the study of properties surrounding airports and the negative externalities from aviation noise, and serve as a guideline for noise levels that should be taken into account when discussing other sources of noise pollution. With FAA regulations in mind, the 65 decibel breakpoint will serve as an important marker in determining the economic value of noise originating from railroad activity for residential and commercial properties.[1]

Many papers within the literature that estimate the impact of various characteristics on property values rely upon the hedonic price method, modeling property value as a function of property attributes. Rosen (1974) defines hedonic prices as the implicit prices of attributes that are revealed from observed prices and these prices can be related to the characteristics each property holds. Roback (1982) discusses the implicit price of certain property attributes and how they are

[1] Noise measurements obtained for this analysis only denote whether or not a specific property is contained within the 65 dB contour and, as such, it is not possible to test other sound thresholds.

associated to the wages, rents, and quality of life in given areas with price ultimately viewed as a compensating differential for different amenities.

Prior studies have analyzed the economic effects of noise externalities on residential home values. These studies have often incorporated hedonic regression techniques to relate revealed demand preferences for specific home characteristics. McMillan, Reid, and Gillen (1980) describe home and property values as being represented as a bundle of characteristics. They acknowledge the difficulty in estimating a true marginal willingness to pay and utilize a forecasted noise imprint resulting from airport traffic. Espey and Lopez (2000) look at aviation noise and utilize individual sales data in the Reno, Nevada area, generating a mean elasticity of -0.055 relating price to decibels of noise exposure. These studies offer examples of prior work regarding airplane noise, with Theebe (2004) offering a bridge between airline and other types of noise. He uses a large database of European home sales in the Netherlands allowing for differential determination of price effects across income, residential property type, and density. His estimates show a maximum 12 percent discount for properties above the 65 decibel threshold. Pope (2008) relates a policy change requiring sellers to inform buyers that residential airport noise exposure leads to greater price impacts on residential property value, and estimates that after the policy change locations within the 65 dB contour experienced a 10.7 percent decrease in housing value.

Directly related to train noise, Brons et al. (2003) set the stage for discussing rail transport, arguing that there are relatively few studies in the field and offer a proposed framework for cost-benefit analyses from prior studies in Europe. Bellinger (2006) studies the impact of train horn noise on property values of transacted homes in a neighborhood in Wormsleysburg, Pennsylvania, basing sound measurements on estimates reapportioned from a prior study to a map of the neighborhood. His study incorporates properties sold during a 24-year period from 1980 to 2004, finding a 4.2 percent decrease in sales value for each additional 10 decibels of added noise exposure above a background level. Andersson, Johnsson, and Ögren (2010) argue road noise has a larger impact than does rail noise due to its more persistent nature. While rail and air noise may be more intrusive, these are generally more infrequent but higher impact events. They use a noise threshold of 45 decibels (also measuring thresholds of 50 and 55 decibels) and distance to nearest motorway or rail station for measures of sound, and are mainly concerned with which source of noise is most deleterious to property value. Andersson, Johnsson, and Ögren (2013) build upon their initial study of road and rail noise offering benefit measures from hedonic regressions, arguing that the time of day the noise pollution occurs should differentially matter for residents and ultimately property value, as much road traffic occurs during rush hour and the daytime while rail traffic is more evenly distributed. When controlling for noise level of properties within 150 meters of a motorway, they find no effect of distance on property value. They argue concavity in the impact from rail noise, with damage that lessens quickly but is much higher when decibel levels are higher (70 decibels is the threshold in their European study) compared to other noise sources. They offer no specific percentage impacts or elasticity estimates but aggregate sound impacts for social cost measurement in a cost-benefit analysis for abatement measures.

From a survey of the literature, there appear to be no studies specifically examining commercial property value and noise exposure. Some prior work has discussed the differing motivations for owning residential and commercial properties which may be helpful in this framework. Roback (1982) offers the idea that firms likely choose to locate with an eye to the proximity of nearby amenities. Businesses are focused on maximizing profit and differ in the valuation of their set of preferred locational or geographic attributes a property would contain.

Gabriel and Rosenthal (2004) discuss the differences in motivation commercial owners would have versus residential owners in the valuation of characteristics for quality of life. It is thus anticipated that commercial properties may be less affected, or actually locate near rail, road, or airports specifically *because* of their proximity to these transportation sources in spite of noise externalities. It is not theoretically clear what effect noise pollution should have for these properties, and whether the locational benefits of proximity near railways, roads, or airports would outweigh the possible negative effects of noise on workplace productivity and employee health.

Results in this paper show that distance from a railroad crossing has a significant impact on residential property values when not initially controlling for location within a 65 decibel (dB) contour, although once an indicator variable for location in the contour is included distance is no longer statistically significant. Location within the 65 dB contour results in a 14 to 18 percent decrease in residential property value. Commercial property values are not significantly affected by noise pollution from this sample. From these results, it is implied that more exact noise measurement methods and incorporating frequency and duration of noise exposure can improve estimates of the true impact on residential property values.

The remainder of the paper will be organized as follows. The data used in the study and methods for quantifying the impacts will be described in Section 2. Empirical results are presented in Section 3. Conclusions and policy implications are offered in Section 4.

2. DATA AND METHODOLOGY

2.1 Methodology

When estimating hedonic pricing models for residential or commercial property, the technique used is based on the idea that the value of each individual property is a function of its characteristics. Using the same basic structure as Espey and Lopez (2000), the price of a property P_p can be represented as:

$$(1) \quad P_p = f(S_{i1}, \ldots, S_{ij}, N_{i1}, \ldots, N_{ik}, Q_{i1}, \ldots, Q_{in})$$

where S_i, N_i, and Q_i indicate vectors of structural, neighborhood, and environmental variables. Equation 1 represents the implicit, or hedonic, price function for properties with the price of any characteristic given as the partial derivative of this function with respect to the variable of interest, which will be estimated using a logarithmic form.[2] Cropper, Deck, and McConnell (1998) argue that when important attributes are omitted or observed imprecisely, simpler forms such as the logarithmic form may be most accurate. In order to facilitate the specific identification strategy incorporated into this study, I incorporate assessed residential property values. In prior studies, many only include homes bought and sold during certain time periods. This introduces the possibility of bias when studying the effect of negative externalities on property prices because those homes may have been sold *because of* the negative externality or characteristic being studied. Clapp and Giaccotto (1992) and Gatzlaff and Ling (1994) argue assessed values are effective in the preparation of house price indices, with indices only as correct as the values upon which they are based.

[2] Based on Cropper, Deck, and McConnell (1998), my Box-Cox test for a functional form proved inconclusive. It generated a lambda value of 0.45 relating an approximate square root transformation of the dependent variable. Without a further theoretical foundation for specifying housing prices in this manner, I applied a logarithmic function.

I incorporate regression discontinuity design as my identification strategy, taking properties located within the 65 dB contour and comparing their values with properties located just outside the contour. As stated earlier, the 65 decibel breakpoint is used due to FAA guidelines stating properties exposed to greater than 65 decibels of noise being considered "normally" incompatible with residential use. Figure 2 shows a mapped representation of the properties included at one of the six specific crossings used in this study to show how the comparisons are made. This is effectively the same method used as Black (1999), who compared homes within a certain distance of school districting lines to account for the relationship between school quality and home value.[3]

Federal law currently states that unless railroad crossings meet certain safety codes, train horns must be sounded for at least 15 to 20 seconds before entering all public grade crossings. The required routine for sounding the train horn as approaching railroad crossings is two long, one short, and one long sounding horn, repeated as necessary until the locomotive clears the crossing (Union Pacific Railroad, 2012). In addition to the normal noise that may be experienced near rail lines as trains traverse the corridor, the horn is likely to be the most intrusive noise.

Figure 2: Cooper Crossing with Residential and Commercial Properties Highlighted

[3] For more guidance, Imbens and Lemieux (2008) offer a guide to functional practice.

The following structural, neighborhood, and environmental variables are incorporated as part of the estimating equation:

ln(*Value*) the natural log of appraised property value in U.S. Dollars as determined using the CAMA property valuation system utilized by the Shelby County Appraiser,

ln(*Distance*) represents the natural log of the distance from each individual property to the nearest respective railroad crossing in linear feet,

65dB is a zero or one indicator variable of whether or not each individual property is located within the 65 decibel sound contour emanating from each respective railroad crossing,

Bedrooms represents the number of bedrooms contained within a structure,

Bathrooms represents the number of bathrooms contained within a structure,

Acre represents the size of the land parcel on which the structure is located, in acres,

Age represents the age of structure in years,

Agesq represents the age of structure in years squared to account for non-linear effects of age,

Stories represents number of stories of the structure, and

Condition represents a scale of the quality of construction and current physical condition of the structure and amenities for residential structures. Condition is on a one to five scale, where five is the best condition (available for residential properties only).

In addition to the controls above, I include dummy variables for location at each of the six specific crossings. These dummy variables control for numerous differing neighborhood effects, such as school quality.[4] I incorporate the variables described above to estimate a hedonic regression equation separately on commercial and residential properties. The estimating equation for commercial properties includes all variables as shown above, except the *Bedrooms* and *Bathrooms* designations which are included as simply *Rooms*, only noting the number of rooms within each commercial structure.

2.2 Data

The 2010 Shelby County, Tennessee, Assessor data file was merged with primary data collected along a major East-West rail corridor through the greater Memphis, Tennessee area. The data set incorporated into this study consists of 1,035 records, of which 263 are commercial properties and 772 are residential properties. Assessed property values are based on various characteristics of the property, such as use (residential or commercial), square footage, age, quality of construction and condition, amenities, and location. In addition to general characteristics of the property and home, the county assessor's office periodically visually inspects all properties to

[4] Properties at the individual crossings are almost wholly contained in the same school districts.

ensure the records reflect actual characteristics and reviews and verifies market sales in the vicinity of each individual property if a recent realized sale value on the property is not available. The assessor's office additionally takes into account cost and income data according to accepted appraisal practices, complete a market analysis using the Computer Assisted Mass Appraisal (CAMA) system, and compare properties of similar size, age, location, and description. CAMA is described as a system of appraising property that incorporates statistical analyses and adaptive estimation procedures to assist appraisers in estimating real property values.

Primary data collection consisted of on-site sound surveys conducted by Bowlby & Associates of Franklin, Tennessee, at six different rail crossings using sonic detection equipment to determine noise incidence of train traffic on adjacent properties. They ultimately mapped each property's location to be within a 65 dB noise exposure contour or not at each of the six rail crossings.[5] In addition to the specific sound contour mapping, from November 13 to December 12, 2010, individuals noted the number of trains passing through the railway corridor, the duration of each passing train, number of engines, number of cars, and speed of the train.

Summary statistics of the primary monitoring information are contained in Table 1. During the 30-day monitoring period, 465 trains were reported to have traversed the corridor, averaging 15.5 per day with a single-day minimum of 10 trains and a single-day maximum of 40 trains. Also shown in Table 1 is a grouping of when the trains passed. While the relative majority (40.6 percent) pass in the PM category from noon to 10 PM, 33.2 percent (almost a third) traverse the corridor in overnight from 10 PM to 6 AM when many residents are either asleep or in their homes and, hence, more apt to be affected by noise. The AM hours from 6 AM to noon report the remaining 26.2 percent of train traffic during the monitoring period. Weekday distributions show Sunday to have the highest average, but the number of trains are relatively evenly spread throughout the week. The average train length in rail cars is 87.7, with average passing speeds of 22.3 cars per minute, or 15.2 miles per hour, along the corridor.

We now give a more concrete description of the length of time nearby homes were exposed to train noise. During the study period the average length of time for a single train to pass the monitor was 2.3 minutes. Given the average number of 15.5 trains passing and an average passing time of 2.3 minutes, this results in approximately 35.7 minutes of the most intrusive train noise for residents living near the tracks each day. If a third of those 15 trains pass by overnight, then those affected by noise from rail traffic would have their sleep disturbed about five times each night, with the most intrusive noise expected to last almost 12 minutes. Over time, such sleep disruptions could lead to significant negative externalities and could pose health risks. For more information on these health risks, see Muzet (2007) or Passchier-Vermeer and Passchier (2010).

Road and air traffic (except commercial) is generally heaviest during the early morning to late evening hours. Here, we see rail traffic pretty evenly dispersed across day of the week and hour of the day. Based on primary data collection, one can see railway noise along this rail corridor is concentrated near residential properties during evenings, nights, and weekends, when their owners are most apt to be at home and, thus, be most exposed. This highlights the importance of why differing noise sources could have differential impacts on property values.

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[5] Although the company obtained exact sound measurements, the only deliverable was the indicator of each property's location in relation to the 65 dB sound contour.

Table 1. Characteristics of Traffic in the Rail Corridor 11/13/2012 to 12/12/2010

Time of day traversed corridor	Number	Percent
AM (6AM to 12PM)	122	26.2%
PM (12PM to 10PM)	189	40.6%
Overnight (10 PM to 6 AM)	154	33.2%
Total trains	465	
Average trains per weekday		
Sunday	17.8	
Monday	16.0	
Tuesday	17.0	
Wednesday	16.8	
Thursday	15.0	
Friday	12.3	
Saturday	13.6	
Other diagnostics	Mean	Std Dev
Average number of cars	87.7	41.3
Speed (cars per minute)	22.3	8.8
Speed (miles per hour)	15.2	8.7
Average time train to pass (minutes)	2.3	49.4
Average number of engines at front	2.2	0.6

Table 2 contains summary statistics for all variables used to estimate the impact of train noise on residential and commercial property values. There are 772 residential properties included in the study and 263 commercial properties, purposely selected from the properties near the six crossings with all properties contained within the 65 dB contours included and properties outside the contour that are within the same city block. Student t-tests for differences in property characteristics by 65 dB indicator status are also calculated and shown. The mean residential property value is $116,472 with approximately half of the properties located within the 65 decibel contour. The average residential structure in the full sample has 2.8 bedrooms, 1.5 baths, and a lot size of 0.2 acres. The average age of structures is 71.4 years, which coincides with the existence of many long-standing neighborhoods located along the rail corridor. The only two residential characteristics that have initial statistical differences are distance to crossing and the log of appraised value; those properties nearer the crossing have a lower appraised value.

The mean commercial appraised value for properties in this study was $329,706, with approximately 60 percent of the structures included in the sample located within the 65 decibel contour. Commercial properties have larger average lot sizes than do residential properties at 0.4 acres. Commercial buildings have on average 2.7 rooms and are relatively younger with an average age of 57.9 years. Commercial properties show more statistical differences by contour location, with only lot size having no difference across 65 dB contour designation

Table 2. Summary Statistics

		Inside 65 dB contour		Outside 65 dB contour		*t*-test
Variable	Description	Mean	Std Dev	Mean	Std Dev	*p*-value
Residential Property						
ln(*Value*)	Log of appraised value	11.3	0.8	11.4	0.8	.01
ln(*Distance*)	Log of distance (in feet) to nearest crossing	6.2	0.5	6.6	0.3	.00
Bedrooms	# of Bedrooms contained in structure	2.9	0.9	2.8	0.9	.96
Bath	# of bathrooms contained in structure	1.5	0.7	1.5	0.7	.83
Acre	Lot size, in acres	0.2	0.1	0.2	0.1	.65
Age	Age of structure, in years	71.5	24.0	71.3	23.6	.89
Stories	Number of stories	1.1	0.3	1.1	0.3	.75
Condition	Appraised condition of home, from 1 to 5	2.8	0.5	2.8	0.5	.87
Commercial Property						
ln(*Value*)	Log of appraised value	11.8	1.1	11.5	1.3	.07
ln(*Distance*)	Log of distance (in feet) to nearest crossing	6.0	0.4	6.5	0.2	.00
Rooms	# of Rooms contained in structure	2.2	2.9	3.3	3.0	.00
Bath	# of bathrooms contained in structure	0.4	0.8	0.8	1.0	.00
Acre	Lot size, in acres	0.3	0.5	0.3	0.7	.51
Age	Age of structure, in years	56.4	14.3	60.4	19.2	.04
Stories	Number of stories	1.1	0.3	1.3	0.4	.00

Notes: Residential property sample size inside (outside) the 65 dB contour is 401 (371) and commercial property sample size is 155 (108) for all variables. Property values have been winsorized at the above/below the 97.5 percentiles.

3. RESULTS

3.1 Residential

Results from the hedonic regression models are contained in Tables 3 through 7. Table 3 contains residential property value estimates relating the distance to each property's railroad crossing and an indicator variable noting whether or not it is in the 65 dB contour. All specifications in all tables include dummy variables for the relevant railroad crossing. In model 1, note that location within the 65 dB contour results in a 20 percent decrease in appraised value. Once additional controls are added, this coefficient declines slightly, but remains relatively stable. In the most fully specified model, location within the 65 dB contour results in a 14 percent decline in value. Only in specification three is the logged distance statistically significant when accounting for location within the 65 dB contour. In looking through the other housing characteristic covariates, all take on the anticipated sign with the number of bedrooms, bathrooms, and acreage having positive and statistically significant effect on property value.[6] All of these variables are expressed in levels with property value in logs, thus for a one unit increase in the number of additional bedrooms the housing value would be expected to increase by 25 percent. Looking at some of the remaining variables in the model, additional bathrooms would increase property value by 17 percent and each additional acre translates into a 117 percent increase in value. Age of

[6] Models were estimated including square feet of living space with the main variables of interest being consistent with those shown. Square feet was excluded from the primary analysis due to its correlation with the bedrooms and bathrooms variables.

Table 3. Property Values Regressed on Distance to Crossing and 65 dB Contour

	Dependent variable all specifications: ln(*Property value*)				
	(1)	(2)	(3)	(4)	(5)
Noise factor(s)					
65dB	-0.20**	-0.14**	-0.13**	-0.14**	-0.14**
	(0.05)	(0.04)	(0.04)	(0.04)	(0.04)
ln(Distance)		0.08	0.12*	0.09	0.09
		(0.05)	(0.05)	(0.05)	(0.05)
Housing characteristics					
Bedrooms		0.29**	0.26**	0.26**	0.25**
		(0.02)	(0.02)	(0.02)	(0.02)
Bath		0.26**	0.19**	0.17**	0.17**
		(0.04)	(0.04)	(0.04)	(0.04)
Acre			1.08**	1.22**	1.17**
			(0.18)	(0.18)	(0.18)
Age				-0.02**	-0.02**
				(0.00)	(0.00)
Agesq$^{\alpha}$				0.15**	0.15**
				(0.03)	(0.03)
Condition					0.05
					(0.04)
R^2	.51	.66	.67	.69	.69
Sample size	772	772	772	772	772

Notes: Includes full sample of residential properties. All regressions include dummy variables to differentiate railroad crossings. Distance is expressed in natural logarithms, its coefficient can be interpreted as an elasticity. All remaining variables are in levels. Robust SEs in parentheses. $^{\alpha}$To facilitate coefficient interpretability, *Agesq* is expressed in (000s) of years. *p<.05, **p<.01

structure has two opposing effects which results in property values decreasing at a decreasing rate with age, a linear decrease of 2 percent in value per year and a nonlinear positive effect when taking into account the squared term.

Table 4 contains residential property values regressed on only logged distance from the crossing for each property while location within the 65 dB contour is excluded. All remaining controls are consistent with those from Table 3. Note that distance is now statistically significant. As the two variables of interest are expressed in natural logarithms, this can be interpreted as an elasticity. When the 65 dB contour is not taken into account, distance is now statistically significant. With the more in depth methods used in this study measuring sound exposure, a more exact measurement of the sound impact can be estimated. Table 5 contains a robustness check which excludes the distance measure and only includes the 65 dB measurement. When this adjustment is made to the model, the adverse impact on property value now increases to 18 percent in the most fully specified model. Based on the results from Tables 3 and 5, the impact of noise on property values along this rail corridor lies within the range of a decrease of 14 to 18 percent.

Table 4. Property Values Regressed on Distance to Crossing

	Dependent variable all specifications: ln(*Property value*)				
	(1)	(2)	(3)	(4)	(5)
Noise factor(s)					
ln(Distance)	0.15**	0.17**	0.20**	0.18**	0.18**
	(0.05)	(0.04)	(0.04)	(0.04)	(0.04)
R^2	.502	.653	.671	.685	.685
Sample size	772	772	772	772	772

Notes: Includes full sample of residential properties. Control variables in specifications match Table 3. All regressions include dummy variables to differentiate railroad crossings. *Distance* is expressed in natural logarithms, its coefficient can be interpreted as an elasticity. Robust SEs in parentheses. All remaining variables are in levels.*p<.05, **p<.01

Table 5. Property Values Regressed on 65 dB

	Dependent variable all specifications: ln(*Property value*)				
	(1)	*(2)*	*(3)*	*(4)*	*(5)*
Noise factor(s)					
65dB	-0.20**	-0.18**	-0.18**	-0.18**	-0.18**
	(0.05)	(0.04)	(0.04)	(0.04)	(0.04)
R^2	.510	.657	.672	.688	.689
Sample size	772	772	772	772	772

Notes: Includes full sample of residential properties. Control variables in specifications match Table 3. All regressions include dummy variables to differentiate railroad crossings. *Distance* is expressed in natural logarithms, its coefficient can be interpreted as an elasticity. Robust SEs in parentheses. All remaining variables are in levels.*p<.05, **p<.01

As a final robustness check on the finding where distance does not affect property value within the 65 dB contour, I limit the sample to only those properties within the contour and rerun the analysis in Table 6. In all specifications, distance is now not statistically significant at conventional levels.

These results show that there is a threshold beyond which increased rail noise levels do not become more detrimental to residential home values. Comparing the coefficients from Tables 3 and 4, there is not a statistical relationship between distance to the rail crossing and property values once a more accurate measurement of noise exposure is taken into account, here at the 65 dB level. At the mean residential home value based on this sample, a *ceteris paribus* movement of a home inside to outside the 65 decibel contour would result in an approximately 14 percent, or $16,306, increase in appraised value. This is in agreement with Andersson, Jonsson, and Ögren (2013) who find that above a certain threshold, there is a large impact that seems to dissipate below a certain decibel level. Theebe (2004) also finds the 65 decibel contour to be the level at which traffic noise has a significant impact on prices at a 12 percent maximum amount of discount.

3.2 Commercial

Table 7 contains estimates of the hedonic model of commercial property values and contains measures of both distance from nearest rail crossing and location within the 65 decibel contour. In the model relating noise to commercial property value, note that both measures of noise

Table 6. Property Values Regressed on Distance to Crossing (65 dB Sample)

	Dependent variable all specifications: ln(*Property value*)				
	(1)	(2)	(3)	(4)	(5)
Noise factor(s)					
ln(*Distance*)	-0.02	0.02	0.04	0.02	0.02
	(0.07)	(0.06)	(0.06)	(0.06)	(0.06)
R^2	.564	.697	.714	.729	.729
Sample size	401	401	401	401	401

Notes: Sample includes only properties located within the 65 dB contour. All regressions include dummy variables to differentiate railroad crossings. Distance is expressed in natural logarithms, its coefficient can be interpreted as an elasticity. Robust SEs in parentheses. All remaining variables are in levels. *p<.05, **p<.01

exposure, distance to crossing and location within the 65 decibel contour, are not statistically significant. The noise coefficient values are not statistically different from zero in any specification. The same models used to estimate the impact of rail noise on residential property values were also completed for commercial properties, with the exception of only including a variable for the number of rooms (instead of bedrooms/bathrooms for residential).

The two statistically significant variables in determining commercial property value in this sample are lot size in acres (arguably a proxy for the number of square feet contained in the building which was not included in the data) and the number of stories. The average lot size for a commercial property is 0.4 acres and from personal knowledge of the areas studied, these crossings are generally high density usage areas, which could explain its importance. The fact that an additional story has such a large coefficient may be a signal that space is not available for retail usage, thus decreasing its market value. Many retail stores and other locations that rely on shopper traffic locate near the areas studied. Ultimately, the noise coefficients in this case show no impact on commercial property values.

4. CONCLUSION

The central estimates show a range of between a 14 to 18 percent decrease in property value for residential properties for being located within the 65 decibel contour across the six crossings studied in the greater Memphis area. Given the average home value included in the study of $116,472, this results in a decrease in property value of $16,306 to $20,965. When trying to place these findings in the context of other geographic areas, frequency and duration of noise exposure should be considered as described in this study. The differing importance of distance point towards the possibility that prior studies that relied solely on distance to proxy for noise exposure or noise mapping without specific data measurement could be miscalculating the true effect, in that there could be a critical level of sound where below or above which the amount of noise does not affect property values. For commercial properties, there is no evidence of any impact (positive or negative) of noise exposure in this sample using either a property's location within the 65 dB contour or as a proxy for noise exposure for a property's distance to the nearest rail crossing.

Table 7. Commercial Property Values Regressed on Distance to Crossing and 65 dB Contour

	Dependent variable all specifications: ln(*Property value*)				
	(1)	*(2)*	*(3)*	*(4)*	*(5)*
Noise factor(s)					
ln(*Distance*)	0.06	0.02	-0.18	-0.19	0.04
	(0.20)	(0.21)	(0.15)	(0.17)	(0.15)
65dB	0.18	0.10	0.00	-0.05	-0.01
	(0.17)	(0.17)	(0.14)	(0.13)	(0.12)
Housing characteristics					
Rooms		0.11	0.06	0.01	0.11
		(0.07)	(0.06)	(0.07)	(0.06)
Bath		-0.54	-0.34	-0.07	-0.31
		(0.27)	(0.22)	(0.23)	(0.21)
Acre			0.83**	0.81**	0.76**
			(0.18)	(0.17)	(0.16)
Age				0.06	0.00
				(0.04)	(0.02)
Agesq				0.00	0.00
				0.00	0.00
Stories					-1.02**
					(0.19)
R^2	.314	.331	.563	.592	.634
Sample size	263	263	263	263	263

Notes: All regressions include dummy variables to differentiate railroad crossings. Distance is expressed in natural logarithms, its coefficient can be interpreted as an elasticity. Robust SEs in parentheses. All remaining variables are in levels. *p<.05, **p<.01

It should be kept in mind that this 14 to 18 percent decrease in residential property value was the result of a home being placed within the 65 decibel contour of a unique and active rail line. On average during the period of monitoring in 2010, 15.5 trains a day traversed the corridor. This resulted in over half an hour of the most intrusive noise pollution each day, with on average five trains traveling the corridor during the overnight hours between 10 PM and 6 AM when many residents would be sleeping. Arguably due to the time of day of much of the exposure of rail traffic, this could be a higher-end estimate compared to other residential homes exposed to other sources of noise such as road or air. Future studies should try to account for not only a more specific time measurement and to use GIS techniques to determine sound exposure: they should also account for time of day and frequency of exposure. Road traffic has previously been attributed with a higher rate of discount toward property values, arguably due to its consistency throughout the day, although much road noise occurs during rush hour and early evening. Air travel at many airports begins in the early morning and ends late evening which may not directly overlap with the hours many residents try to sleep. Rail noise is dispersed fairly evenly throughout the day and night, with many trains passing overnight. Ultimately, this is in accordance with much of what Theebe (2004) found for there being a distinct level of 65 decibels to be a break point at which there begins to be an impact on property value. His most sizable finding was a maximum 12 percent decrease in property values for properties within the 65 decibel contour, with my estimate being relatively close at 14 percent. While the Memphis area does not have noise notification laws as described in Pope (2008), the railroad tracks in its residential areas are very noticeable. It is quite likely that the railroad tracks would be more salient, and possibly having a larger impact, than locations near less visually noticeable noise sources.

For future studies, more exact sound measurements than those incorporated here could result in more exact noise thresholds for property value impacts. Due to limitations with the source of the estimates, only values for whether a property was located within or without the 65 decibel contour were available. In future studies, a more exact determination of the deleterious noise level merged with the information about frequency and duration of noise exposure used in this study is a natural extension. Another possibility for future research would be incorporating how different sources of noise affect health, and incorporating the increasingly more sophisticated models of sound exposure to account for different sources of noise pollution. While the economic impact of noise on property values has been discussed at length, it may understate the value to society if the health impacts are considered.

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