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Dollars and Decibels: Quantifying the Impact of Railroad Noise Pollution on Housing Prices in Cook County, IL

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Noise pollution is a harmful issue that affects all who have the ability to hear, especially those who live close to major noise sources. Some of the most pervasive noise pollutants are major freight and passenger trains, which are a constant nuisance for many citizens across the United States and around the world. One of the greatest impacts that railroad noise pollution has is on residential housing prices, both the value and appreciation of property are often harmed. My analysis quantifies the effect that elevated noise levels associated with proximity to railroad lines have on residential housing prices in Cook County, Illinois, which is comprised of the city of Chicago and its surrounding metropolitan area. At a broader level, noise pollution has consequences on the real estate market. Individuals will make tradeoffs within the housing market when purchasing a house; deciding which attributes are worth spending more or less money for, like deciding to spend less for a home that is close to a rail line. Providing quantitative evidence of the physical relationships between noise pollution and housing prices allows us to establish a concrete understanding of these underlying preferences for different housing trade-offs within the real estate market. While this understanding is useful in and of itself, it can also be an invaluable source of knowledge for both researchers and policymakers who have obligations to protect the residents and new home buyers of Cook County.

Non-market valuation, and specifically hedonic valuation, of noise pollution from a variety of sources is a topic that has been thoroughly studied. The literature definitively agrees and proves that noise pollution is detrimental to housing prices, especially for homes that are within very close proximity to a major noise source (Strand et al., 2001; Friedt et al., 2021). A study done in Memphis, Tennessee for example showed that a property being within a 65 dB range of the rail line was associated with a 14% decline in value (Walker, 2016). Additionally, the literature within this field consistently shows that noise abatement policy can eliminate the negative effects of noise pollution on housing prices. It suggests that various noise abatement policies can be effective at reducing the negative externalities that railway noise pollution presents. Studies like that of Lee et al. (2022) point to the effectiveness of physical noise barriers in reducing the negative pricing effects of noise pollution from passenger railways in Singapore.

While this specific research question is widely studied, nuances in the literature certainly exist. Variations in context, location, and regard for different abatement policies represent the main difference in the literature and point toward gaps in the knowledge that must be filled. One said gap is to study this relationship in a location in which this sort of analysis has not been done. Studying an unstudied city or county allows for new results to be found, which contributes to the overall pool of noise pollution knowledge. This specific gap is the one I lean into in this paper, there are no railroad noise pollution studies done for Cook County, Illinois, which allows me to fill this gap and provide new knowledge of how the relationship between noise pollution and housing prices varies in the greater Chicago metropolitan area. That being said, when duplicating existing noise pollution studies in a new location, it is important to justify why the

new area of interest is worth such an analysis. My justification for studying Cook County, IL specifically is that Cook County represents one of the greatest railroad hubs in the United States. Due to its centralized location within the United States, Cook County is often used as a distribution hub for major passenger and freight train companies and as such has the highest rates of railroad activity in the country (Illinois Commerce Commission). This suggests that the negative relationship between noise pollution from railroads and housing prices might be exasperated, more train activity means more noise pollution and possibly more detriment to property values in the area.

The theoretical framework that underpins the relationship between proximity to rail lines and housing prices is rather simple and shows that a home's vicinity to a disamenity should plausibly reduce its value. As real estate markets evolve, home buyers respond to the unattractiveness of living close to a rail line by buying those homes less, this drives down demand and consequently the prices for these houses. This reduction in housing prices associated with noise pollution represents the cost that noise pollution has, and is a measure of the underlying preferences individuals have for tradeoffs of varying housing characteristics (Taylor, 2008).

The practical methodology used in the effort to quantify this cost associated with noise pollution can be defined as non-market valuation. The economic model most commonly found in the non-market valuation of noise pollution is the hedonic price analysis, which is one of the most effective ways to study the relationship between disamenities (like noise pollution) and housing prices. The hedonic model dictates that a house's value is contingent on its individual characteristics, meaning that its price is determined by a multitude of factors such as size, age, condition, location, and most importantly in the case of noise pollution, proximity to a major noise source like a rail line. This model, with the inclusion of proximity to disamenities as a determinant of property value, allows us to gauge how much each characteristic affects value and thus allows us to quantify how damaging a major noise source can be to a house's values. Another advantage of hedonic valuation, and one that is understood in the field, is that this method allows us to gauge the costs of noise pollution using individual's real preferences (Dekkers et al. 2009). Hedonic valuation is commonly referred to as a revealed preference valuation method, meaning that we put a value to a disamenity by analyzing how people interact with the real estate market.

While the hedonic price model is a useful and preferred methodology in studying noise pollution and housing prices, it does not come without its fair share of issues regarding causal inference. While the hedonic valuation model allows us to determine the individual impact of the exposure or distance to the disamenity of noise pollution, we cannot reasonably conclude that differences in housing prices are solely explained by differences in exposure or distance to a disamenity like noise pollution. Properties with different levels of exposure might have different values, we might reasonably hypothesize that a home in a neighborhood far from the railroad might be more valuable than one that is very close. That being said, the difference in price cannot be immediately explained by differences in exposure to noise pollution. The home that is further away might be within a neighborhood that has more amenities or might be in an area that is desirable for new home buyers. These confounding factors disallow us from establishing a strong causal relationship between exposure or distance to railroad noise pollution and housing prices as they might be the cause of the difference in price.

In my own effort to quantify the effects of railroad noise pollution in Cook County, IL, informed by the hedonic pricing framework, I aim to address this specific issue with causal inference. I do this by employing neighborhood fixed effects regression, which allows me to address and negate the variation in prices associated with differences between neighborhoods. For this empirical analysis, I draw on the data sets available through the Cook County Assessors Open Data Website. I use and merge available 2021 data on property sales and housing characteristics for homes within Cook County, IL, as well as spatial data on neighborhoods and most importantly distance to the nearest railroad in feet. When combined, my final set is made up of 25,636 observations, where each row is an individual property that is located within 1 of 262 neighborhoods. Below are summary statistics of the most important variables used in my analysis; distance to the nearest railroad and sale price.

Summary Statistics

	Mean	SD	Min	Max	Count
Sale Price	428034.1	506431.8	100	2.11e+07	25636
Distance to Railroad	997.7133	537.5998	.8051604	1999.949	25636
N	25636				

I use this data in my econometric model, which is specified by Equation [1]

$$P_i = \beta_0 + \beta_1 D_i + \beta_2 N_i + \sum_{j=1}^{J} \beta_{3j} X_{ij} + \varepsilon_i \quad [1]$$

Where Pi represents the price of housing unit i, Di represents the distance in feet to the nearest railroad for housing unit i, Ni represents the neighborhood code for housing unit i, and Xij represents the jth housing characteristic for housing unit i where j ranges from 1 to J. The inclusion of the neighborhood code (Ni), which is a dummy variable for each of the 262 neighborhoods in the data set, represents the fixed effects approach to my empirical analysis. By including the neighborhood code, I isolate within-neighborhood variation in house prices based on within neighborhood distance from railroads.

When Equation [1] is regressed using neighborhood fixed effects, we establish the estimates of the relationship between property sale prices and exposure to railroad noise pollution, measured in distance to the nearest railroad in feet, presented in Table 1.

Table 1

	(1) Neighborhood FE
Distance to Railroad	34.55***
	(7.81)
Land SqFt	4.713***
	(26.11)
3 Bathrooms	87483.1***
	(8.60)
1 Half Bathroom	32388.0***
	(5.98)
cons	-37921.6
	(-0.11)
N	25636
adj. R^2	.5521

* $p < .10$, ** $p < .05$, *** $p < .01$

The estimated coefficient on distance to railroad reveals the nature of the relationship of interest, namely that a 1-foot decrease in the distance to the railroad is associated with a $34.55 decrease in sale price. While this interpretation is accurate, it might not be particularly useful as 1 foot in regards to noise pollution and property boundaries is not a meaningful change, as seen in the summary statistics where the mean distance to the railroad is 997.7 feet. A more useful interpretation in this context is that a decrease in the distance from the railroad by 500 feet is associated with a $17,275 decrease in sale price. On a broader scale, these results suggest that homes that are closer to railroads are less valuable on average. Important to note is that this interpreted coefficient represents the increase in sale price in response to increases in distance to railroads explicitly for homes within the same neighborhood. This detail allows us to determine a stronger causal interpretation of the impact of distance to the railroad on property sale prices because we are now only comparing homes within the same neighborhood, the confounding factors like exposure to amenities or the desirability of the neighborhood are now negated because we are comparing homes that share these traits.

Despite the movement towards a stronger causal inference through the use of neighborhood fixed effects, several casual issues remain. One such issue is that differences in home values within neighborhoods could still be explained through other confounding factors not controlled for in the model. While neighborhood fixed effects address variation in home

prices between neighborhoods, negating characteristic differences between neighborhoods, the issue of price variation within neighborhoods remains. It is plausible that the observed differences in home values within neighborhoods could be due to confounding factors related to distance to the railroad. One confounding factor that presents such an endogeneity issue is aesthetic value. Homes both near and far from the railroad have varying levels of surrounding “beauty”, and homes near railroads are likely situated in areas that are less aesthetically pleasing. This aesthetic beauty or value is both correlated with distance to the nearest railroad and is a determinant of a home's value, which presents a potential for upward bias of the effect of noise pollution on housing prices in my model. Another issue with causal inference in my study is the measurement of noise pollution that I use, namely distance to the nearest railroad. The issue is that distance to the nearest railroad is a problematic measure of noise pollution, certain geographical and infrastructural factors tend to distort the relationship between distance and noise pollution. When using distance as a substitute for real noise exposure data, there is again potential for upward bias within my model. I must note that these factors still remain unaccounted for in my final analysis, due to data availability constraints. Ideally, my model would account for both within-neighborhood endogeneity and a more representative measure of noise pollution. That being said, data on the aesthetic beauty of varying areas of a neighborhood remain unobservable, and a proper measure of noise pollution remains cost-prohibitive.

The negative relationship between noise pollution and housing prices is a well-established relationship that has been proven to be true in countless cities and counties in the United States and around the world. The analysis presented in this paper adds Cook County, IL to the list. Through the use of neighborhood fixed effects regression within a Hedonic pricing framework, I have shown that properties near railroads in Cook County are less valuable on average, where a 500-foot decrease in the distance from the railroad is associated with a decrease in a home's sale price of $17,275. This finding is also indicative of individuals underlying preferences against living near railroads, consumers within the real estate market of Cook County, IL buy property near railroads less which my analysis has picked up on. While this relationship has been proven, it must be considered with scrutiny. Several issues with the causal inference I have estimated still remain, including within-neighborhood endogeneity and a less-than-ideal measure of noise pollution exposure.

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