Project 072 Aircraft Noise Exposure and Market Outcomes in the United States

Massachusetts Institute of Technology

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- P.I.: Prof R. John Hansman
- FAA Award Number: 13-C-AJFE-MIT, Amendment Nos. 075, 081, 094, 111, 115, 130, and 143
- Period of Performance: August 11, 2020, to August 31, 2027
- Tasks (tasks listed below are general project tasks; reporting includes the period from October 1, 2024, to September 30, 2025):
    1. Literature review (not reported; completed during past reporting periods)
    2. Empirical identification strategy and scope of dataset (not reported; completed during past reporting periods)
    3. Calculation of noise impact metrics (not reported, completed during past reporting periods)
    4. Cleaning and aggregation of housing transaction dataset (not reported; completed during past reporting periods)
    5. Descriptive analysis of dataset (not reported; completed during past reporting periods)
    6. Empirical analysis of house prices and underlying market effects
    7. Analysis of noise exposure patterns

Project Funding Level

$1,080,000 FAA funding and $1,080,000 matching funds. Sources of match are approximately $236,300 from MIT, plus 3rd party in-kind contributions of $519,000 from NuFuels LLC, and $79,000 from Savion Aerospace Corp., and $245,700 from Earth Force Technologies.

Investigation Team

Prof. R. John Hansman, (P.I.), all tasks
Prof. Christopher R. Knittel, (co-P.I.), Tasks 1, 2, 4, 5, and 6
Dr. Florian Allroggen, (co-P.I.), all Tasks
Dr. Jasdeep Mandia, (postdoctoral associate), Tasks 4 and 6
Juju Wang, (graduate student), Tasks 3, 5, 6, and 7

Project Overview

As enplanements at United States (U.S.) airports have increased by almost 50% over the past two decades, the number of Americans exposed to substantial levels of aircraft noise has decreased. However, considerable concerns regarding aircraft noise remain in some airport communities. This project leverages revealed preference approaches to infer the “implicit price” of aircraft noise exposure from market outcomes in U.S. airport communities. More specifically, the research team quantifies the capitalized disutility associated with aircraft noise exposure through analyzing the empirical relationship between aircraft noise exposure and transaction values for residential properties in communities surrounding U.S. airports. The project leverages potential changes in noise exposure associated with quasi-experimental settings (e.g., the opening of new runways or changes in arrival and departure paths) to empirically identify potential effects on house prices.
The results provide insight into the average impacts of noise exposure on residential property values, while also assessing dynamic adjustment processes and potential heterogeneities in revealed preferences, by targeting factors such as time, location, or noise exposure patterns.

Task 6 – Empirical Analysis of House Prices and Underlying Market Effects

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Objectives

This task explores the impact of noise exposure on house prices to quantify the revealed preference for noise exposure. Under previous periods of performance, initial results for communities surrounding Boston Logan Airport, Seattle-Tacoma International Airport (SEA), and Chicago O’Hare International Airport (ORD) were derived.

During this reporting period, one objective of this task was to understand the underlying mechanisms behind such housing market responses. We started analyzing whether noise exposure changes may alter the prevalence of households to stay in, move into, or move out of a neighborhood. Because such behaviors directly affect supply and demand in housing markets, the analysis can help us validate and understand the causes of the potential housing price impacts discussed during previous reporting periods.

During this reporting period, the analysis focused on communities surrounding Boston Logan International Airport (BOS) to develop the analysis framework.

Research Approach

We combine household-level demographic and movement data with modeled aircraft noise exposure from the Aviation Environmental Design Tool (AEDT). Noise data are available for 2011 and 2016. For years in-between, we used the (preliminary) assumption that noise levels stayed constant within the pre-period (2011–2013) and post-period (2016–2019). Each property is matched to the nearest 0.25 nautical mile noise grid cell. The data used for BOS are shown in Figure 1.

(a) (b)

Figure 1. (a) Red dots show the points of the noise grid and green dots show the location of the households. Each household is spatially matched to the nearest noise grid, which assigns them to the noise exposure under different time periods. (b) Noise exposure changes from 2011 to 2016 at Boston Logan International Airport.

Household data were collected from Data Axle® (InfoUSA). The dataset follows millions of U.S. households each year. Each household has a unique identifier that allows us to track residential mobility and neighborhood composition over time. Table 1 summarizes key variables from the Data Axle household database, including unique identifiers, demographic characteristics, address information, and geographic coordinates used to link households to census tracts and modeled noise exposure grids.

Table 1. Selected variables from the Data Axle household database. The variables capture household demographics, property characteristics, and geospatial identifiers that enable linkage to census tracts and modeled noise exposure grids.

Category	Variable	Description
Household Attributes	FAMILYID	Unique 12-digit household identifier used to track families across years
	HEAD_HH_AGE_CODE	Age of household head or individual
	MARITAL_STATUS	Modeled likelihood that the head of household is married
	CHILDREN_IND	Indicates presence of children in the household.
	WEALTH_FINDER_SCORE	Modeled prediction of household wealth level
	PPI_DIV_1000	Estimated purchasing power index adjusted for local cost of living.
Household & Property Attributes	ADDRESS	Complete address of the property
	LATITUDE/LONGITUDE	Geographic coordinates of the household location
	LENGTH_OF_RESIDENCE	Number of years at current address.
	OWNER_RENTER_STATUS	Indicates whether the household owns or rents its home.
	FIND_DIV_1000	Estimated annual household income (in $1,000s).

The analysis uses panel regressions with multiple levels of spatial controls. We start with county-year and tract-year effects and plan to add town-year effects for finer spatial detail. These models are designed to empirically isolate how changes in noise relate to changes in household flows.

® Data Axle is a registered trademark of Data Axle, Inc., Dallas, Texas.

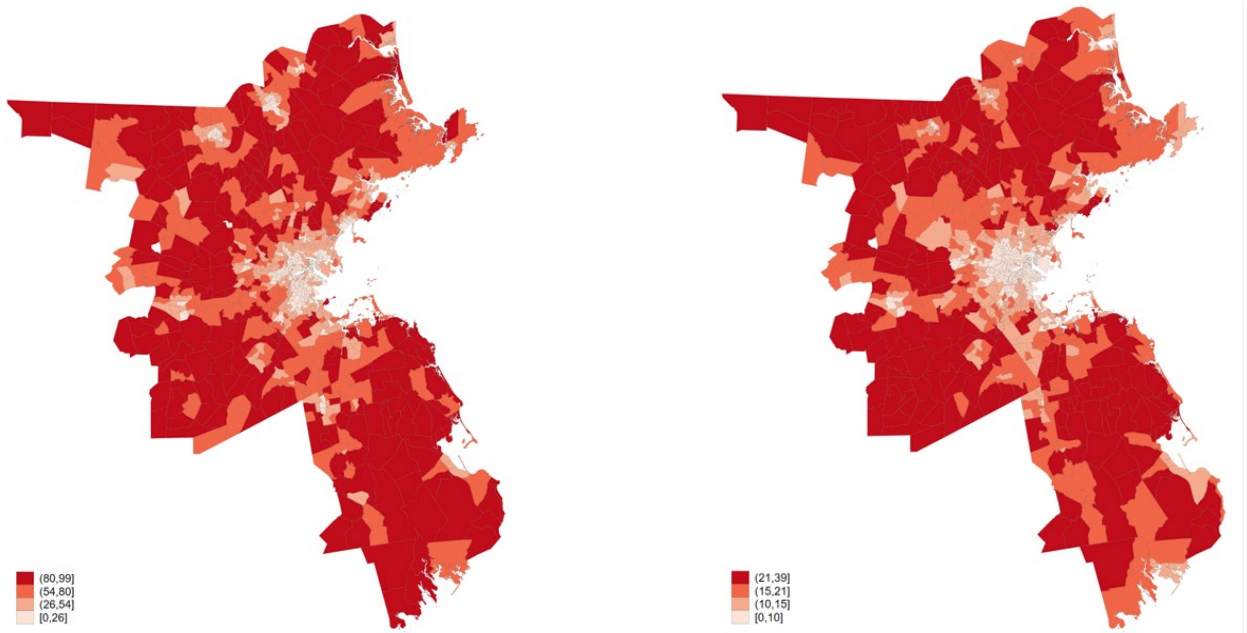
Milestones

- Created tract-level measures of stay, move-in, and move-out rates for Essex, Middlesex, Nantucket, Norfolk, and Suffolk counties.
- Matched over 6,400 AEDT noise grid points to property data in a 25 by 25-mile area around Boston Logan.
- Built baseline regression models with tract and county-year controls.

Major Accomplishments

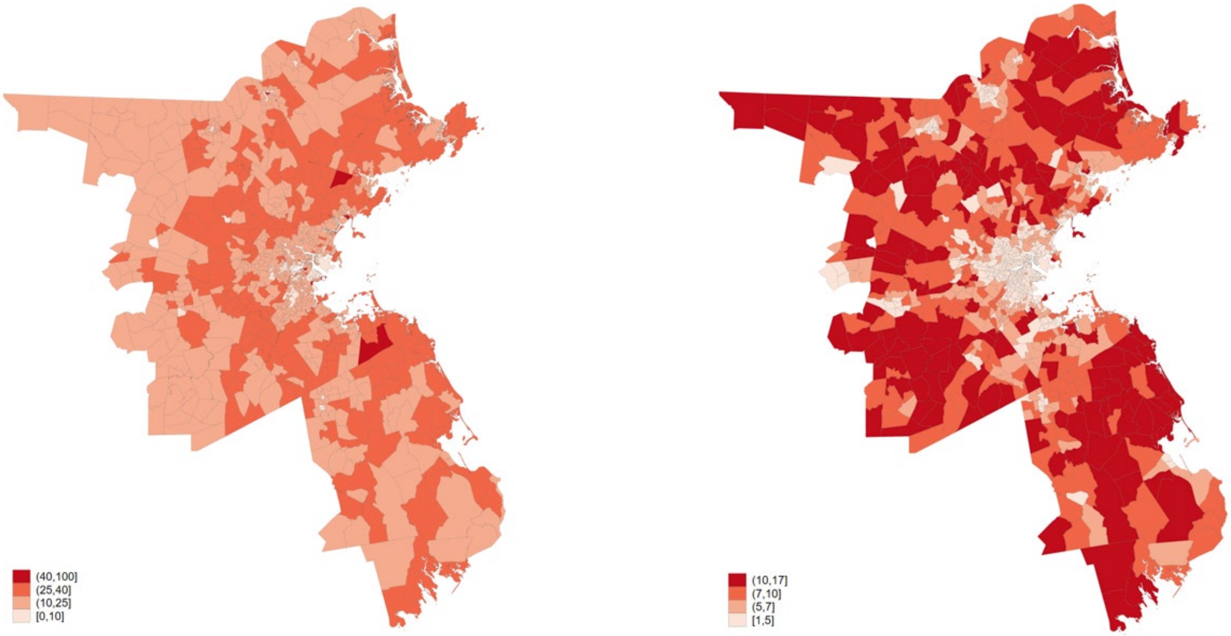
We first explored the spatial variation in household characteristics that may influence moving patterns. We plotted the spatial distribution of key neighborhood attributes using the Data Axle household data for 2012. Figure 2 illustrates this variation across five counties surrounding BOS—Essex, Middlesex, Norfolk, Plymouth, and Suffolk. Panel (a) shows the share of homeowners, panel (b) shows the share of households with children, panel (c) shows the share of households where the head of household is aged 65 or older, and panel (d) shows the median length of residence.

Urban tracts in Boston and Cambridge tend to have lower homeownership rates, fewer families with children, and shorter median years of residence. These areas tend to attract younger, more mobile populations who are often renters and early in their housing or career cycles. This pattern likely corresponds to a lower stay rate, as reflected in the shorter residential tenure. In contrast, suburban tracts surrounding the city show the opposite pattern: higher ownership rates, more families with children, and older household heads. These areas are characterized by longer residence durations and greater neighborhood stability, reflecting both life-cycle factors and the prevalence of owner-occupied housing. The differences between urban and suburban areas highlight how demographic composition and housing market structure can shape observed mobility rates even before accounting for noise exposure.



(a) share of households that are homeowners

(b) share of households with children



(c) share of households where the head of household is aged 65 or older

(d) the median length (years) of residence.

Figure 2. Spatial variation in household demographics across the Boston metropolitan area (2012) Panel (a) percentage of households that are homeowners; panel (b) share of households with children; panel (c) share of households where the head of household is aged 65 or older; panel (d) median length of residence among households

We then estimated the relationship between aircraft noise exposure and household mobility using a panel regression at the census tract–year level. Specifically, we modeled the tract-level move-in rate as a function of average noise exposure and fixed effects for tracts and years. The inclusion of tract fixed effects accounts for time-invariant differences across neighborhoods, such as location, long-term housing characteristics, or baseline demographics. The year-fixed effects control for common shocks affecting all tracts in a given year, such as macroeconomic conditions or policy changes. Preliminary results for the Boston Logan Airport area suggest that higher noise exposure is associated with modest declines in move-in rates, indicating that noise may influence neighborhood attractiveness and residential sorting patterns.

Publications

Working Paper

Allroggen, F., Knittel, C. R., Hansman, R. J., Li, J., Wan, X., & Wang, J. (2025). *Planes Overhead: How Airplane Noise Impacts Home Values* (No. w34431). National Bureau of Economic Research. https://doi.org/10.3386/w34431

Outreach Efforts

The research team presented during the ASCENT Spring and Fall meetings.

Awards

None.

Student Involvement

Juju Wang (PhD Student)

Plans for Next Period

Finalize our pilot analysis for Boston Logan airport and then roll out the framework to SEA, ORD, and other airports.

Task 7 – Analysis of Noise Exposure Patterns

Massachusetts Institute of Technology

Objective

The objective of this task is to analyze spatial patterns of aircraft noise exposure across 22 major U.S. airports and the profiles of exposed communities.

Research Approach (Data and Method)

The empirical work leveraged the following data:

- Flight-track data: Threaded Track (2019).
- Demographics: American Community Survey 5-year (2019).
- Noise metrics: Average Daily N60 (number of overflights > 60 dBA per day) and day–night noise level (DNL).

Noise exposure was modeled using flight-track data for the year 2019 and the AEDT Fast model (see year 2021 report). This Fast model uses AEDT outputs for various aircraft types to set up a noise lookup table. It then applies the noise–power–distance curves from the AEDT to obtain accurate noise data for specific flight tracks. The noise contours were geospatially linked to demographic and population data taken from American Community Survey data to identify where and how noise affects communities. We then explored patterns and trends in exposure intensity and spatial concentration across multiple airports.

Milestones

- Modeled noise data for 22 airports using 2019 flight track data.
- Created geospatial database linking noise metrics (Average Daily N60, DNL) to population data.
- Produced comparative exposure maps showing variation across airports.
- Identified key approach patterns and exposure gradients near arrival/departure corridors.

Major Accomplishments

The results of our analysis show that noise exposure patterns differ by airport, reflecting differences in operational layouts and navigational procedures. For example, airports with concentrated arrival paths show more localized high-noise zones, while airports with dispersed operations have spatially larger, moderate exposure areas. By way of example, we compared flight operations and noise exposure patterns for LaGuardia Airport (LGA) and SEA (see Figure 3). The top panels display aircraft movements, where red lines represent departure paths and blue lines represent arrivals. As shown, SEA flight paths are more concentrated, with both departures and arrivals aligned along a north-south axis. In contrast, there are different corridors for take-off from and landing into LGA which, over time, spreads departures and arrivals in several directions. Contours of noise exposure (Average Daily N60) are subsequently concentrated along the axes for SEA, whereas the contours for LGA show less concentrated patterns.

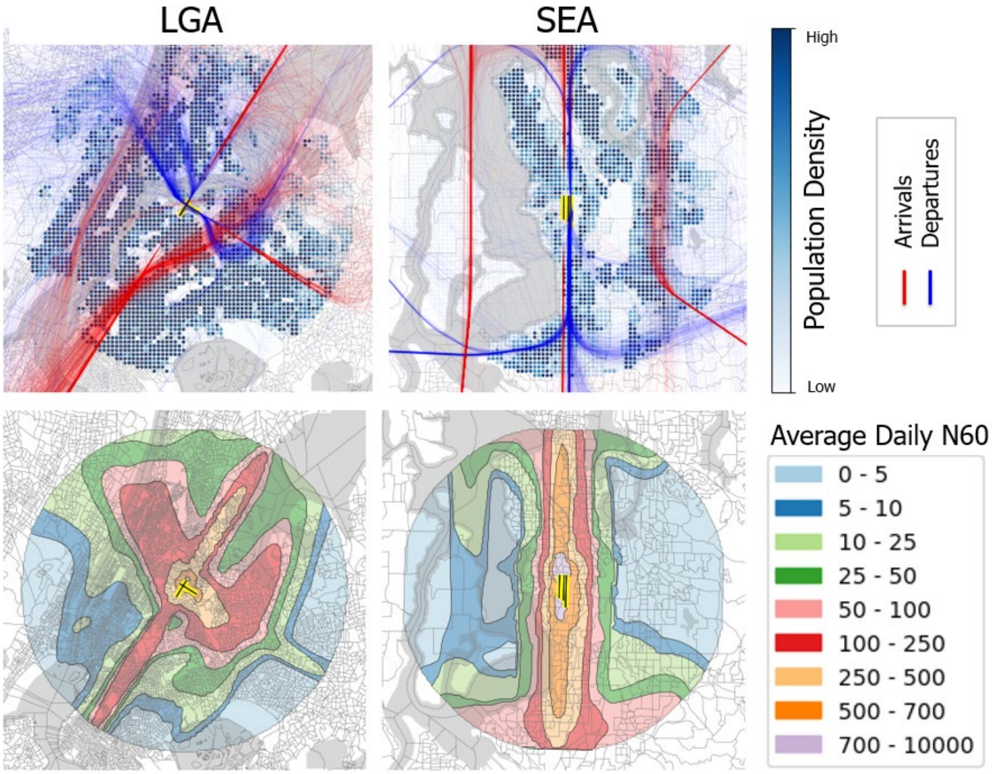
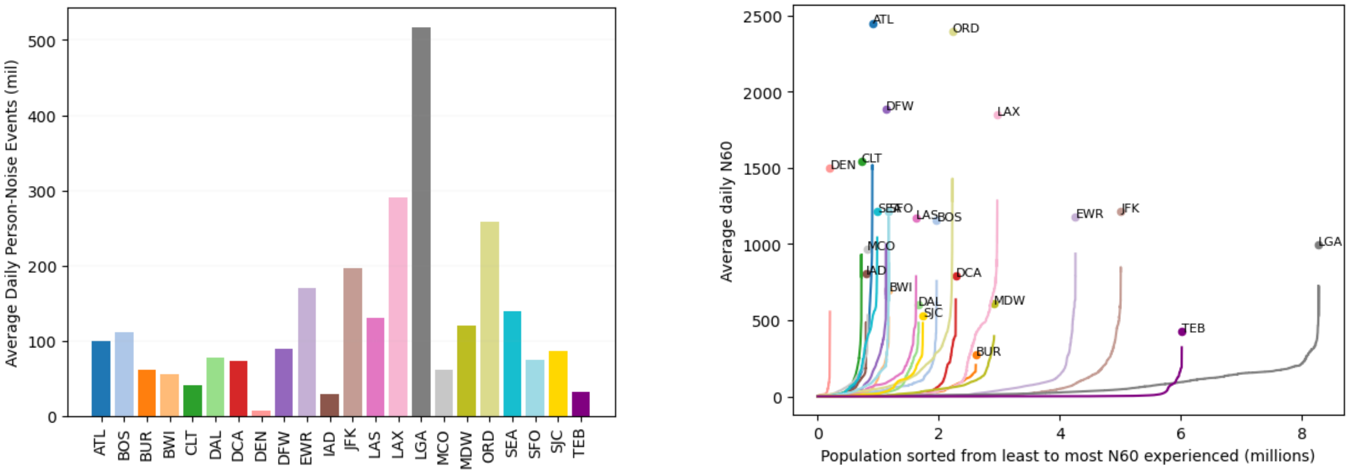


Figure 3. Flight Paths and noise exposure (Average Daily N60) at LaGuardia Airport (LGA) and Seattle-Tacoma International Airport (SEA). The top panels show aircraft arrival (red) and departure (blue) paths overlaid on population density. The bottom panels show modeled Average Daily N60, representing the number of overflights above 60 dBA per day.

Figure 4 illustrates how different airports in this study compare in noise exposure. The number of person-noise events (overflights over 60dBA averaged over 2019) is shown in Figure 4a. The metric captures both the scale of airport operations and the density of nearby population. LGA shows the highest average daily person-noise events among all airports in the sample. More generally, airports with the highest surrounding population and most operations tend to have the highest number of person-noise events. The result subsequently reflects not only LGA's high volume of operations but also its location within a densely populated urban area. Other large airports such as Los Angeles International Airport (LAX) and ORD also record high noise-population interactions. In Figure 4b, we show how noise exposure is distributed within communities surrounding airports, using the N60 metric. The x-axis shows the population sorted from least to most noise exposure, the y-axis shows the average daily N60 values. The total number of flights and population for each airport is also shown as a plotted point. For most airports, the curve rises steeply near the right tail, indicating that a relatively small portion of the population experiences high noise exposure.



(a) (b)

Figure 4. Comparison of noise exposure across airports: (a) shows the average daily person-noise events (millions) for each airport in 2019, while panel (b) plots the distribution of average daily N60 exposure, with population sorted from least to most exposed.

Publications

Dissertation thesis of Dr. Juju Wang, to be made available by MIT.

Outreach Efforts

The research team presented during the ASCENT Spring and Fall meetings in 2025.

Awards

None.

Student Involvement

Juju Wang (PhD Student) conducted research under this task. She graduated with a PhD in the summer of 2025.

Plans for Next Period

Publish results.