Project 72

Aircraft noise exposure and market outcomes in the U.S.

Massachusetts Institute of Technology

PI: *R. John Hansman, Christopher Knittel, Jing Li, Steven Barrett, Florian Allroggen*

PM: *Sean Doyle*

Objective:

Provide empirical insights into:

(i) The impact of noise exposure on house prices in communities surrounding U.S. airports.

(ii) The heterogeneities associated with these impacts, which can be driven by factors such as time, location, or noise exposure patterns

Project Benefits:

1. Detailed noise modeling of real flight tracks
2. Updated understanding of impacts of aircraft noise on property prices, incl. heterogeneities among airports or neighborhoods
3. Comparison of revealed preference data with stated preference data

Research Approach:

Noise modeling

Model noise around U.S. airports with high spatial and temporal resolution.

Select airports with noise exposure changes due to changes in operating procedures.

Real Estate data

ZTRAX data adjusted for neighborhood amenity changes and housing attribute changes

Empirical model

Natural experiment:

$$\Delta Noise \rightarrow \Delta P \ ?$$

Noise changes following introduction of PBN procedures and runway changes (natural experiment)

Addresses concerns regarding:

- Omitted variable bias
- Causality concerns

Major Accomplishments (to date):

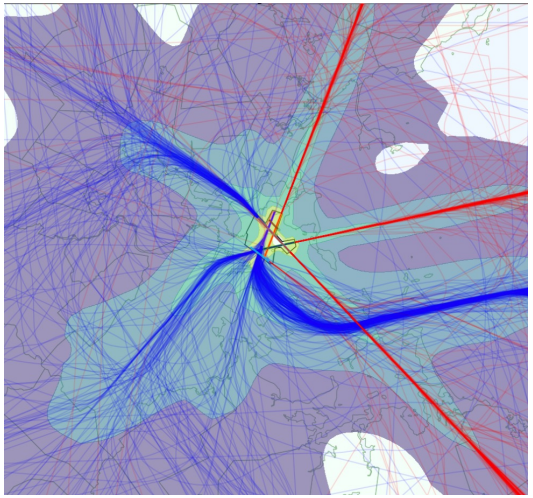
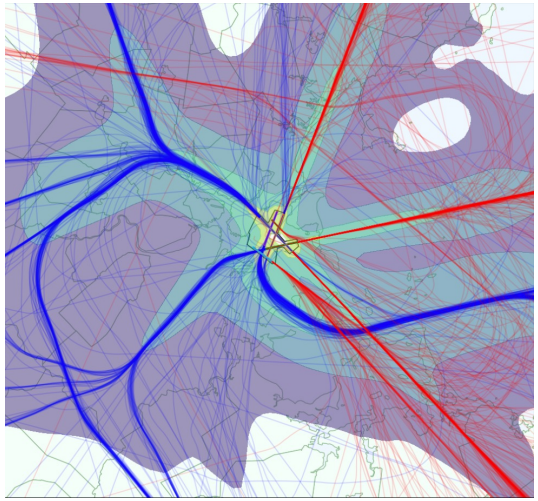
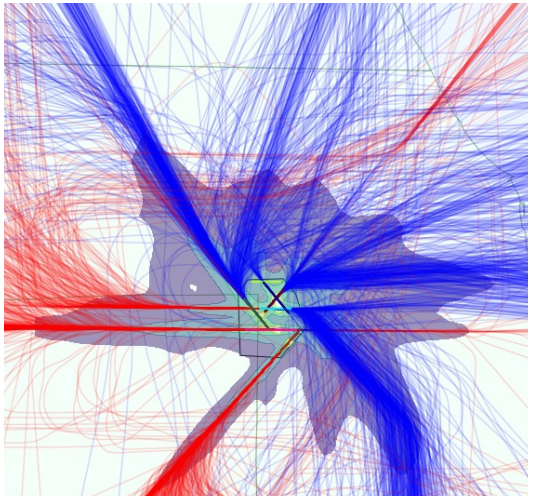
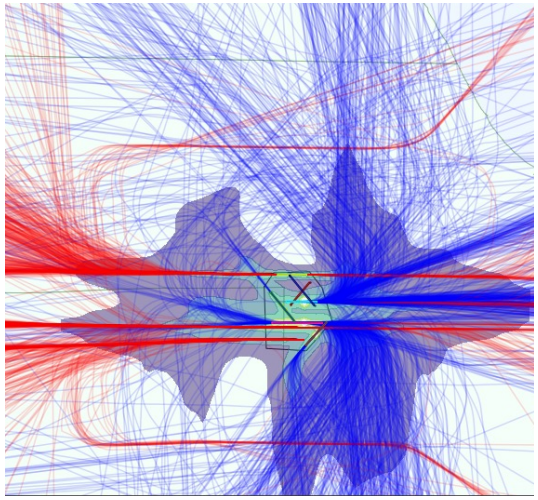
- Identified study airports based on ASDE-X equipment, community disputes, and changes in configuration
- Set up AEDT with years-worth of ASDE-X flight data to calculate noise based on real flight tracks, incl. alternative metrics
- Sourced and cleaned comprehensive real-estate data set
- Conducted initial empirical analyses for KBOS

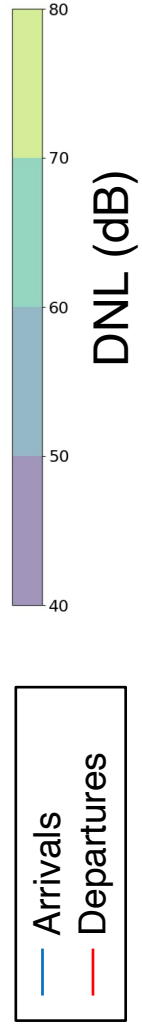
Future Work:

- Run additional noise analyses for airports with relevant noise exposure changes
- Apply empirical model (static and dynamic) to analyze impacts on house prices
- Identify short-term and long-term dynamics by adding additional short-term experiments

This research was funded by the U.S. Federal Aviation Administration Office of Environment and Energy through ASCENT, the FAA Center of Excellence for Alternative Jet Fuels and the Environment, project 72 through FAA Award Number 13-C-AJFE-MIT under the supervision of Sean Doyle. Any opinions, findings, conclusions or recommendations expressed in this this material are those of the authors and do not necessarily reflect the views of the FAA.

Changes in annual average noise exposure: *introduction of PBN and new runway configurations*

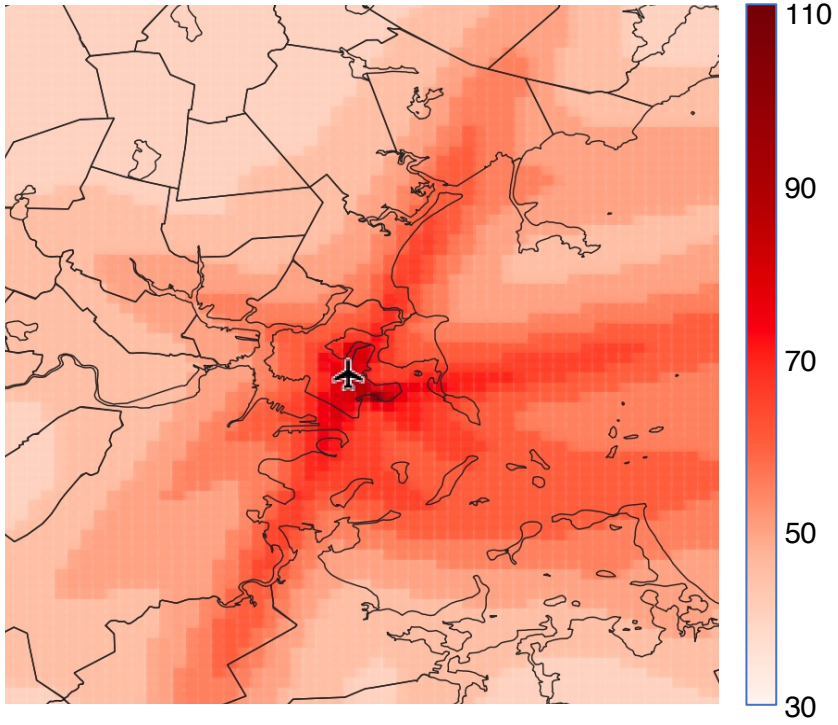
	2011	2016
Implementation of PBN: *concertation of flight paths (example: KBOS)*		
New runway configuration: *change in predominant flight paths (example: KORD)*		



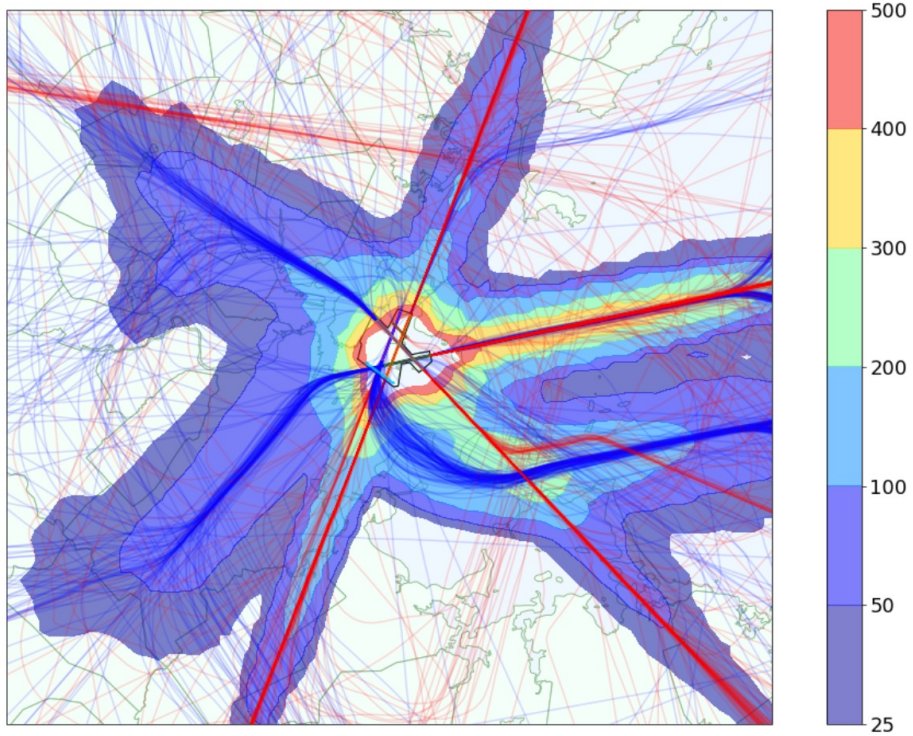
PRELIMINARY RESULTS

Noise metrics: *detailed modeling approach allows us to compute alternative metrics (1/2)*

Standard metric: Average noise level, *Annual average DNL KBOS, 2011*



Alternative metric: number/ frequency of events: *N60 for a specific day,* *KBOS, 4/29/2011*



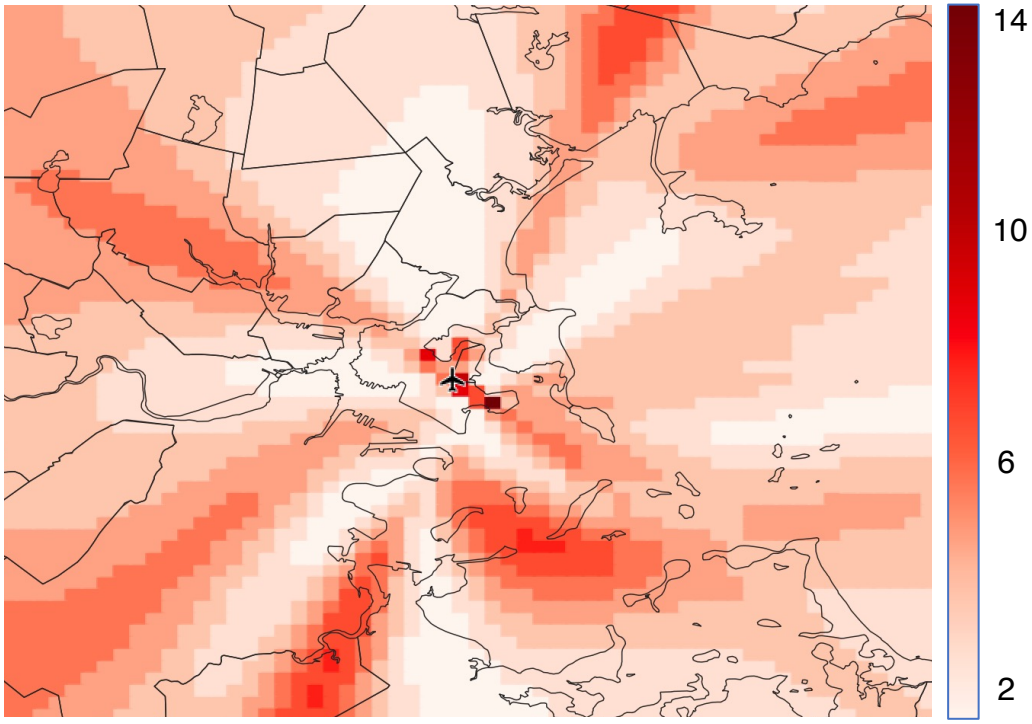
N60 is the number of times an overflight event exceeds an LAmax threshold of 60 dB in a specified time period (here: 4/29/2011)

PRELIMINARY RESULTS

Noise metrics: *detailed modeling approach allows us to compute alternative metrics (2/2)*

…

Alternative metric: variability in noise levels: *Standard deviation of daily DNL KBOS, 2011*



Variability in DNL is measured using the standard deviation in daily average DNL values over a specified time period (here: year 2011)

High-resolution noise modeling allows us to use different metrics to **capture different dimensions of noise exposure**, including effects of

- Average exposure
- Number/frequency of events
- Variability in noise exposure

We are interested in studying whether we can identify **distinct signals of these metrics in residential property prices**.

PRELIMINARY RESULTS

House price measurement: *data inputs and processing*

Zillow ZTRAX data

- Contains transaction data (incl. actual prices) for residential property transactions for 2009 to 2018
- Includes data on additional house characteristics, such as year built, square footage, lot size, etc.

Processing

Cleaning

- *Exclude houses with unfair market price, wrong geo-location, and negative house age*
- *Restrict samples to housing price below $10M*

Filter

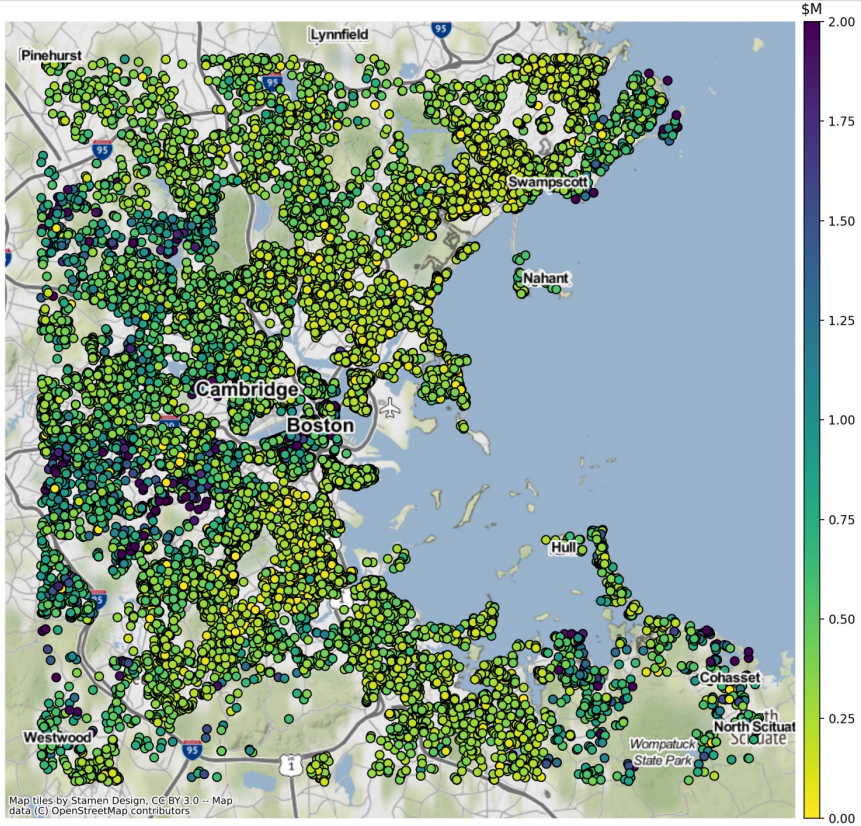
Difference-in-difference: Data points from houses that have been sold at least once in each time window:

- *2009-2011*
- *2016-2018*

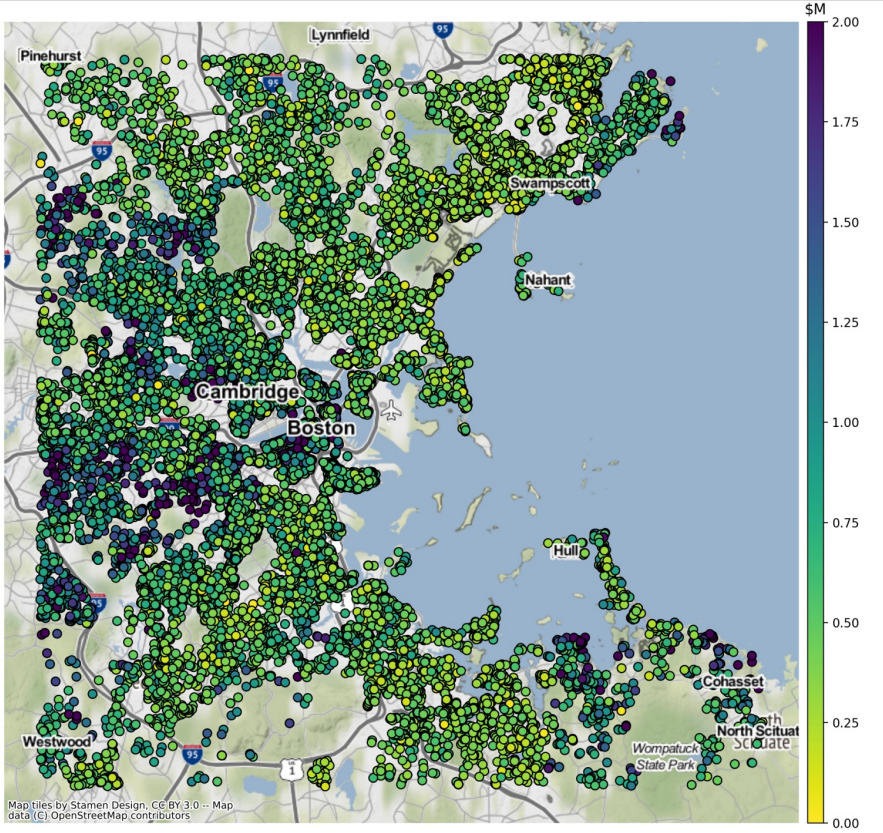
Dataset of interest

Observed transaction prices for residential property, Boston

Transaction prices in 2009-2011, *$2011,*
only houses with transaction 2009-2011 and 2016-2018



Transaction prices in 2016-2018, *$2011,*
only houses with transaction 2009-2011 and 2016-2018

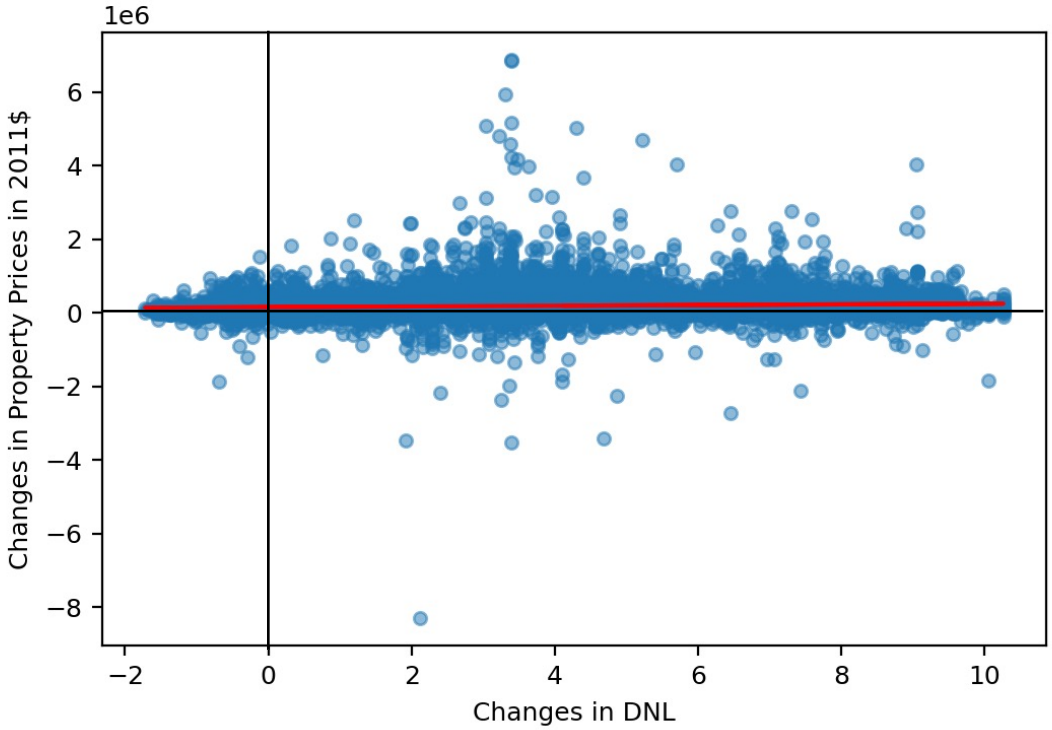


Average price:	$ 464,718	+43%	$ 663,867
Average price (p. sq ft):	$ 234	+47%	$ 344

PRELIMINARY RESULTS

Correlation analysis: noise changes vs. property price changes

Changes in average noise levels vs. changes in house prices for KBOS: *Noise levels in DNL (2016 vs. 2011); property prices in 2011$ (2016 vs. 2011)*



No obvious first-order trends visible in the data.
House price analysis likely driven by other underlying trends.

PRELIMINARY RESULTS

Hedonic Price model for controlling other underlying factors

Housing Price Changes p_i

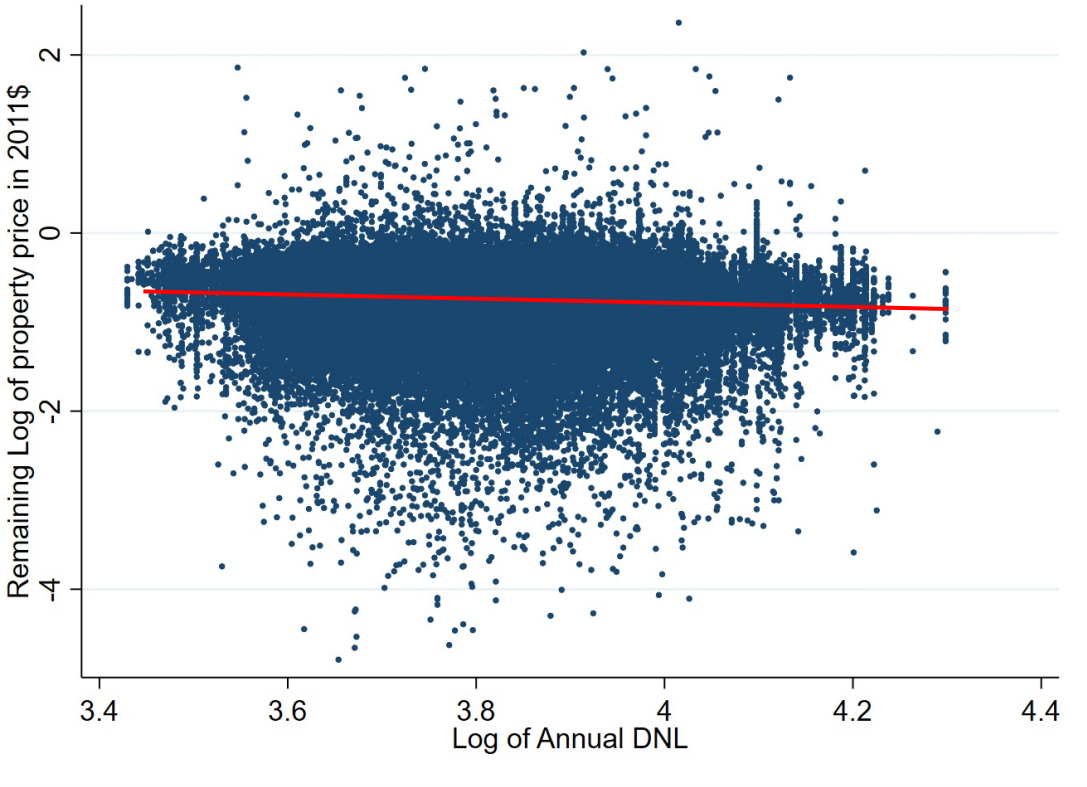
Noise Exposure Changes	• Average Noise • Noise events / frequency • Variability	Metric $Noise_{it}$
House Attribute Changes	• Size • Age • Total rooms	Vector Z_{it}
Neighbor-hood Amenity Changes	• Crime • Air pollution • School quality • Water amenity	Census block fixed effects γ_{bg} Zip-code-by-year fixed effects θ_{jt}
Time trends	• Macroeconomic and regional economic effects • Seasonality	Month fixed effects T_t

Model for empirical estimation

$$ln^{(P_{ijt})} = \beta_0 + \beta_1 ln^{(Noise_{it})} + \beta_3 Z_{it} + \gamma_{bg} + \theta_{jt} + T_t + \epsilon_{ijt}$$

Preliminary results from the hedonic price model

The relationship between property price and average noise levels (controlling for houses attrbutes, neigborhood effects, and time trend)



- Evidence of a slightly downward-sloping relationship between property price and average noise levels
- Trend falls in line with previous noise impact literature (0.4-0.7% housing price decrease due to 1 dBa increase in DNL)

Remaining log of property price in 2011$: the log of property price remaining after subtracting the value from house attributes, neighborhood effects, and time trend.

PRELIMINARY RESULTS

Next steps

Noise modeling

- Run noise analyses for additional airports identified for the study
- Further research the viability of alternative noise metrics to be included in the analysis

Property value analysis

- Analyze impacts of different noise metrics (beyond average exposure)
- Analyze combinations of noise metrics in the model
- Identify short-term and long-term dynamics by adding additional short-term experiments
- Roll-out the modeling to additional airports

Project team	**MIT AeroAstro:** John Hansman, Steven Barrett, Florian Allroggen, Zhishen Wang **MIT Sloan:** Christopher Knittel, Jing Li, Xibo Wan **FAA PM:** Sean Doyle