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Quasi-experimental evidence on the effect of aircraft noise on apartment rents

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ABSTRACT

Inferring the implicit price of an environmental good hinges on *ceteris paribus* conditions that are often hard to justify. This paper uses an unexpected change in flight regulations as source of exogenous variation and identifies aircraft noise effects from price adjustments in the market for rental apartments. Controlling for spatial and apartment heterogeneity, we find that aircraft noise reduces apartment rents by about 0.5% per decibel. Our results indicate (i) that noise discounts are overestimated in cross-sectional studies because aircraft noise tends to be negatively correlated with omitted neighborhood and housing amenities and (ii) that noise effects are unlikely to be constant over the entire noise range.

1. Introduction

Since there is no explicit market for environmental goods, revealed-preference methods have often been used to derive an economic value. Most prominently, the hedonic approach of Rosen (1974) employs transaction data to infer an implicit price based on the idea that utility associated with the consumption of a composite product like housing is determined by the utility associated with its constituent parts. Conventionally, the hedonic method requires the regression of prices on the considered environmental good and all other attributes of the property (including structural and neighborhood characteristics) using a cross-section of housing data (overviews on cross-sectional studies are provided, e.g., by Smith and Huang (1995) and Nelson (2004)).

Recently, there have been increasing concerns about the validity of cross-sectional hedonic studies. Since unobserved neighborhood characteristics tend to be correlated with housing prices and the environmental good of interest, cross-sectional estimates are likely to suffer from omitted variable bias (e.g., Chay and Greenstone, 2005; Parmeter and Pope, 2009). As a result, quasi-experimental tests have become a popular tool in the hedonic literature (Greenstone and Gayer, 2009), and have been successfully employed to measure the capitalization of crime (Linden and Rockoff, 2008), school quality (Figlio and Lucas, 2004), air pollution (Chay and Greenstone, 2005), health risk (Davis, 2004), rail access (Gibbons and Machin, 2005), hazardous waste and toxic releases (Greenstone and Gallagher, 2008), or power plants (Davis, in press). Unlike in randomized field experiments, individuals are usually not randomly exposed to the environmental variable of interest, even in a quasi-experimental setup. In order to reduce potential selection bias, it is therefore important to control for time-varying observable confounders and for unobserved spatial and apartment heterogeneity (Greenstone and Gayer, 2009).

This paper is the first to combine a quasi-experiment with a repeat-rent model to study the effect of aircraft noise on rental rates. Repeat-sales or repeat-rent approaches have the advantage that they remove bias from unobserved apartment and neighborhood characteristics that remain unchanged over time (e.g., Case and Shiller, 1989; McMillen, 2003). In order to identify aircraft noise

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effects we use a change in flight regulations at Zurich airport that created variation in noise we argue to be exogenous conditional on apartment fixed effects and time-varying controls.

In April 2003, the German government issued a binding decree that prohibited landings from the north in the early morning and the late evening to protect German communities located close to the Swiss border from "Swiss" aircraft noise. In May 2003, the Swiss *Federal Office of Civil Aviation* allowed landings from the south, which had previously been prohibited. The new flight regime, enforced on October 30, 2003, stated that all aircraft landing in the early morning should approach from the south instead of from the north. The new flight regime serves as a quasi-experiment because (i) it considerably changed the levels of noise pollution around Zurich airport at a discrete point in time and (ii) it was largely unexpected.

A text analysis of articles published in several quality newspapers and weekly magazines, as well as reports from press agencies in Switzerland reveals no reference to the new flight regime before March 2003 (Fig. 1), and thus it is very unlikely that landlords or tenants could have anticipated it. Although one might argue that the existing runways would have allowed landings from the south, the airport's operating regulations (dated May 31, 2001 and still legally valid in April 2003) did not permit any such landings. We therefore deem it reasonable to interpret the change in flight regulations as a quasi-experiment. This allows us to extract causal information from differences in apartment rents before and after the intervention (see also Parmeter and Pope, 2009).

Since there is no *a priori* reason why the effect of aircraft noise on apartment rents should be constant, we specify a flexible generalized additive model where the unknown noise function is estimated semi-parametrically using splines. Our results indicate that a linearization of noise effects is justified only for medium noise levels, with significant deviations from linearity for high and low noise values. Based on these results, we conduct a difference-in-differences (DID) analysis which suggests that rents of apartments affected by additional aircraft noise decreased by about 3.5% due to the new flight regulation. Taking advantage of our detailed continuous noise data, we find a corresponding noise discount of about 0.5% per decibel, controlling for spatial and apartment heterogeneity. When estimating pooled cross-sectional models, we find considerably higher noise discounts (about twice as large).

Previous research on quasi-experimental aircraft noise effects has focused on American airports, where noise measures are only available in noise contour bands above 65 and/or above 70 decibels. Most notably, Pope (2008) uses the introduction of a mandatory airport noise disclosure, whereas McMillen (2004) and Cohen and Coughlin (2009) use changes in noise contour bands due to airport expansions and the technological progress of aircraft. This paper, however, deploys continuous and longitudinal noise data on a 100 m-by-100 m square lattice, which enables us to estimate detailed noise discounts *per decibel*.

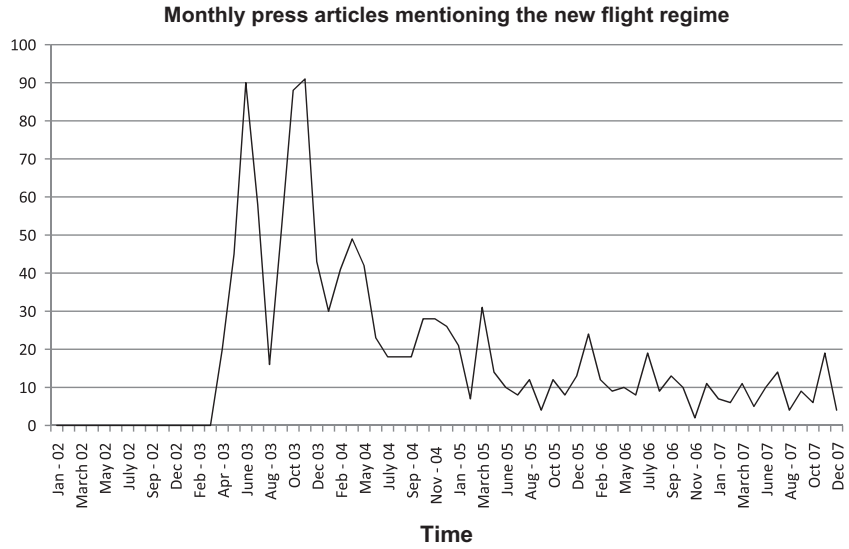
The paper proceeds as follows. In the next section, we describe the institutional framework and provide a chronological order of events related to the introduction of the new flight regime. In Section 3, we describe the housing and noise data, and how we matched both data sources. Section 4 explains the identification strategy and presents the results. Section 5 concludes.

2. Changes in flight pattern around Zurich airport

Zurich airport is the largest international flight gateway in Switzerland. It operates about 260,000 take-offs and landings per year on three different runways. Fig. 2 provides an overview of the airport. The relative frequencies indicate the distribution of incoming and outgoing aircraft by flight direction in 2007.

Until 2002, over 90% of all aircraft were approaching from the north, more precisely from the northwest on runway 14. Since Zurich airport is located close to the German border (dark dashed line in Fig. 2), incoming aircraft fly at an altitude of less than 4000 feet over German communities. In April 2003, the German government issued a binding decree that prohibited landings from the north in the early morning and the late evening. The flight ban over German territory covers the times 6–7 am and 9 pm to 12 am on weekdays, and 6–9 am and 8 pm to 12 am on weekends. As a result, landings in these time periods had to be redirected to runway 28 (east) as the flight regulations at that time did not allow any other direction.

On May 21, 2003 the *Federal Office of Civil Aviation* changed the regulations such that after October 30, 2003 landings were also permitted from the south on runway 34. The new landing policy at Zurich airport stated that aircraft landing between 6 am and 7 am on weekdays (6 am and 9 am on weekends) should generally approach from the south, and aircraft landing between 9 pm and 12 am on weekdays (8 pm and 12 am on weekends) should



Source: LexisNexis, own calculations.

Fig. 1. Monthly number of press articles mentioning the new flight regime.