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Hedonic valuation of the perceived risks of nuclear power plants

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HIGHLIGHTS

- 2011 Fukushima accident increased public awareness of risks of nuclear power plants.
- Accident is used for quasi-experimental hedonic valuation of such risks.
- Rents near nuclear power plants in Switzerland decreased by 2.3% after Fukushima.
- Results corroborate earlier findings of imperfectly informed market participants.

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ABSTRACT

We use the 2011 Fukushima accident to evaluate the impact of the perceived risks of nuclear power plants on apartment rents in Switzerland. Using online advertisements over 12 years and a difference-in-differences approach, we find a 2.3% price discount after the accident for apartments near nuclear power plants.

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1. Introduction

Quasi-experiments have received considerable attention in the hedonic valuation of environmental goods (e.g., Parmeter and Pope, 2013). We use the 2011 Fukushima accident as a quasi-experimental shock in public awareness of the risks of nuclear power plants and estimate the impact of the perceived risks of nuclear power plants on rental prices.

Although previous research shows that the Fukushima accident significantly increased the perceived risks of nuclear power plants (Huang et al., 2013) and decreased the acceptance of nuclear power (Siegrist and Visschers, 2013), our study is the first to test the influence of the Fukushima nuclear disaster on rental prices. Our results indicate that the increased risk awareness decreased rents for apartments near nuclear power plants in Switzerland, at least in the short run, even though Fukushima had no direct impact on the danger of radioactive contamination in the local housing market. We provide an explanation of this result based on the availability heuristic (Tversky and Kahnemann, 1973).

2. Background and related literature

On March 11, 2011, an earthquake with a magnitude of 9.0 in the Pacific Ocean near Japan generated a tsunami that destroyed the cooling systems of the Fukushima Daiichi Nuclear Power Plant and caused partial meltdowns and massive releases of radioactive materials.

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Early studies on the impact of nuclear disasters on housing markets include Nelson (1981) and Gamble and Downing (1982) in the context of the Three Mile Island (TMI) accident in 1979 in Pennsylvania, United States. They find no significant effects of the distance to the nuclear power plant on property values and no evidence that the TMI accident had a significant adverse effect on property values.

Metz and Clark (1997) find no significant effect of decisions and announcements about spent nuclear fuel storage on the residential property markets near two California nuclear power plants. Gawande and Jenkins-Smith (2001) show that transitory nuclear waste shipments have no effect on residential property values in three South Carolina counties. Clark et al. (1997) find that property prices are higher in areas near two nuclear power plants than in other areas in California. However, they acknowledge that their estimates may capture omitted amenities, such as accessibility for plant workers. By contrast, using panel data on US land prices, Folland and Hough (2000) find that the installation of a nuclear power plant significantly decreases surrounding land values. Clark and Allison (1999) also find negative effects of nuclear power plants on the housing market in the Rancho Seco region in California by using data with extensive neighborhood characteristics to mitigate omitted variable bias.

3. Data and methods

Our analysis is based on data from *homegate.ch*, the largest online advertising platform for rental apartments in Switzerland. We focus on the rental housing market because we are interested in the short-term effects of the Fukushima accident and property markets usually adjust at much slower rates (Boes and Nüesch, 2011). Records of advertisements are available for the period from October 2001 to January 2013.

The treatment group includes all apartments within the danger zone defined by the Swiss government. The danger zone covers all communities within a radius of approximately 20 km from a nuclear power plant. As a protective measure against the detrimental health effects of potential atomic radiation, the government distributes an information brochure and iodine pills to each household within this zone. Our main control group consists of all apartments in communities that are not included in the treatment group but that are located within a 40 km radius from a nuclear power plant. As an alternative control group, we use apartments located within a fixed interval of 30–40 km. The results presented below are robust to the selection of treated apartments within a fixed radius of 20 km as well as alternative control group definitions (e.g., non-treated apartments located within a radius of 50 km or within an interval of 40–60 km; results are available upon request).

We use a difference-in-differences (DID) approach to identify the impact of the perceived risks of nuclear power plants on apartment rents. We specify the following model:

$$y_{ist} = \alpha * Treatment_s + \beta * Post_t + \delta * Treatment_s * Post_t + \gamma' X_{ist} + \varepsilon_{ist} \quad (1)$$

where y_{ist} denotes the log of the net apartment rent for apartment i in community s and year t. The parameter α measures time-constant differences of rental prices between the treatment and control groups. The parameter β measures how rental prices after March 11, 2011, differ from rental prices before March 11, 2011. Under the common DID assumptions (Imbens and Wooldridge, 2009), the parameter δ measures the average treatment effect on the treated (ATT). The vector X_{ist} contains apartment-specific covariates and controls: living surface, number of rooms, canton fixed effects to adjust for regional differences in rental prices, year fixed effects, and month of the year effects to control for seasonality patterns. Standard errors are robust and are adjusted for clustering at the community level.

Table 1
Means of the hedonic variables by region.

	Treatment region (danger zone)	Control region	
		(20–40 km)	(30–40 km)
Net rent (CHF)	1362.6 (523.5)	1649.3 (961.2)	1713.1 (1114.9)
Living surface (m^2)	84.2 (33.6)	81.7 (36.8)	81.2 (37.2)
Number of rooms	3.50 (1.17)	3.27 (1.24)	3.21 (1.26)
Number of observations	111,420	367,623	220,817

Notes: Standard deviations in parentheses.

Table 2
DID estimates of the impact of perceived risks of nuclear power plants on the log of net apartment rents.

	Control region	
	(20–40 km)	(30–40 km)
Treatment (danger zone)	0.003 (0.016)	−0.067** (0.024)
Post-Fukushima	0.015* (0.005)	0.022** (0.007)
Treatment*Post (ATT)	−0.023** (0.007)	−0.025** (0.009)
Number of observations	479,043	332,237

Notes: Control variables as listed in the text. Standard errors in parentheses are robust and adjusted for clustering at the community level.
* Significance level: $p < 0.05$.
** Significance level: $p < 0.01$.

The identifying assumption of the DID model in (1) is that in the absence of the treatment time trends would be the same between the treatment and control groups (Imbens and Wooldridge, 2009). While we cannot directly test this assumption, the data structure at hand allows us to compare the pre-treatment average yearly growth rates of apartment rents (until December 2010) at the community level between the treatment and control regions. We find a small, non-significant difference in these growth rates of about 0.02% (SE = 0.08%) for our main control group, and a difference of about 0.07% (SE = 0.10%) for the alternative control group. Fig. 1 shows local polynomial smooths through the quarterly averages of the log of net apartment rents during the pre-treatment period for the treatment and the control regions, which follow almost identical paths and hence also support the common trend assumption.

4. Results

Table 1 displays the means of the net apartment rent, living surface, and number of rooms for the treatment and control regions. Apartments in the treatment region are less expensive on average and larger in size owing to the more rural environment surrounding nuclear power plants. It is important to note that such observable differences do not confound our results as long as the common trend assumption between the treatment and control groups holds.

Table 2 presents the main results of our analysis. The ATT shows a 2.3% price discount after the Fukushima disaster for apartments near nuclear power plants. The estimate of the ATT is very similar when we use apartments in the interval of 30–40 km as control.

As an additional robustness check, Table 3 shows the results from estimating further interaction effects in the DID model (1) with a "placebo Fukushima disaster" occurring one, two, or three years before the actual disaster. The estimates suggest that there are no significant placebo effects, again supporting the common trend assumption.

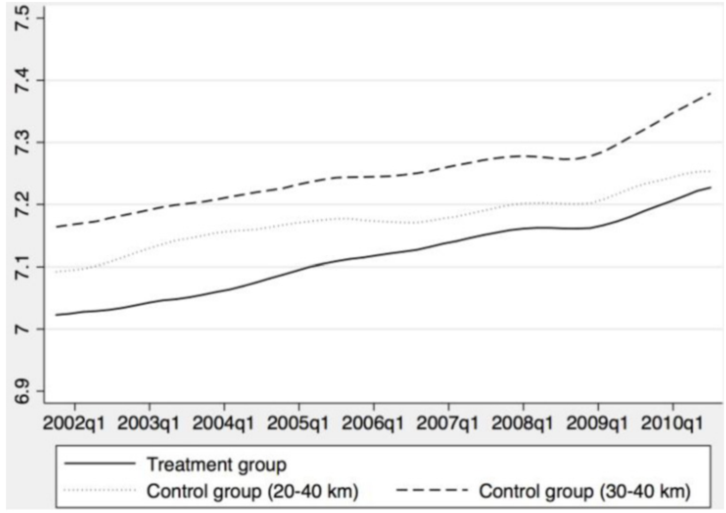

Fig. 1. Pre-treatment trends in the log of net apartment rents by region.

Table 3
DID estimates of the placebo treatment on the log of net apartment rents.

	Control region	
	(20–40 km)	(30–40 km)
Placebo 1 yr before	−0.0009	−0.0060
	(0.0056)	(0.0063)
Placebo 2 yrs before	−0.0068	−0.0079
	(0.0051)	(0.0058)
Placebo 3 yrs before	−0.0073	−0.0067
	(0.0071)	(0.0073)
Number of observations	479,043	332,237

Notes: See Table 2. Reported estimates are the DID interaction effects of the treatment region with post-accident indicators equal to 1 after March 11, 2010 (Placebo 1 yr), after March 11, 2009 (Placebo 2 yrs), and after March 11, 2008 (Placebo 3 yrs).

5. Discussion

The availability heuristic claims that the simple accessibility of information or recall of specific events influences individuals' assessments of probabilities (Tversky and Kahnemann, 1973). In this paper, we use the Fukushima nuclear disaster as a specific event that increased public awareness of the risks of nuclear power plants and we find a significant price discount for rental apartments near nuclear power plants after the accident. Our results corroborate earlier findings that market participants are imperfectly informed. For example, the introduction of mandatory seller disclosures about aircraft noise and the release of information about wildfire risk significantly decreased housing prices in affected regions (Pope, 2008; Donovan et al., 2007). Further, Bin and Landry (2013) show that price discounts within a general floodplain increase after major flooding events. And Naoi et al. (2009) find that the price discounts from locating within a quake-prone area are significantly larger after massive earthquakes in Japan than before.

In contrast to previous studies reporting no significant effects for the TMI accident (Nelson, 1981; Gamble and Downing, 1982), our results reveal a significantly negative effect of the Fukushima disaster on rental prices. A possible explanation for the difference in the results is that the TMI accident was classified as a level 5 accident, whereas Fukushima was classified level 7 (the highest possible category), only comparable to the 1986 Chernobyl disaster. Therefore, the expected impact on individuals' risk perception may be higher.

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