Valuing Nuclear Energy Risks: Evidence from the Impact of the Fukushima Crisis on U.S Housing Prices*

Shinsuke Tanaka† and Jeffrey Zabel‡
December 2015

Abstract

On March 11, 2011, a 9.0 magnitude earthquake and tsunami struck Japan. This disabled the reactor cooling systems of the Fukushima Daiichi Nuclear Power Plant (NPP) that led to releases of radioactivity. The Fukushima accident was big news in the United States and it clearly led to a re-evaluation of nuclear safety. In this paper, we look at how house prices around NPPs in the U.S. changed after this event. Because it was unanticipated, it can be considered to be an exogenous shock and we can isolate changes in prices that were directly tied to the Fukushima accident. It is important to note that there was no change in the risk of a nuclear accident in the U.S. after Fukushima. We view this is as an information shock that led to a reassessment of this risk by residents near nuclear power plants.

We have data on transactions for single-family homes in 2009-2013 that are within 50 kilometers (kms) of 29 NPPs in seven states in the U.S. Our results provide some evidence that the impact on house prices was very local (within 0-4 kms of a NPP) and of a limited duration (around 6 months). This is consistent with polls taken in the U.S. that showed a significant drop in those who approved of building more NPPs soon after the Fukushima accident but also found a significant majority in favor of using nuclear power one year after the event.

Key Words: Fukushima, Nuclear Energy Risk, Hedonic Price Model
JEL Classification: R31, Q51

---

* Comments from Avery Cohn, Kyle Emerick, Laura Gee, Nancy Hite, Daiji Kawaguchi, Christopher Knittel are gratefully acknowledged. We also appreciate CoreLogic for sharing the data on housing transactions. Financial support from Hitachi Center for Technology and International Affairs are gratefully acknowledged. The views expressed here are those of the authors and do not reflect those of data provider or funder.
† The Fletcher School, Tufts University, 160 Packard Ave. Medford, MA 02155 (email: Shinsuke.Tanaka@tufts.edu).
‡ Department of Economics, Tufts University, 8 Upper Campus Road Medford, MA 02155 (email: jeff.zabel@tufts.edu).

I. Introduction

On March 11, 2011, a 9.0 magnitude earthquake and tsunami struck Japan. This disabled the reactor cooling systems of the Fukushima Daiichi Nuclear Power Plant (NPP) that led to releases of radioactivity. The Japanese government promptly established a 30 km evacuation zone surrounding the plant. This sent shock waves around the globe that led to a re-evaluation of the safety of nuclear power plants. In September of that year, all 151 nations that are members of the International Atomic Energy Agency unanimously adopted an Action Plan on Nuclear Safety to strengthen nuclear safety on a global level. Reactions by individual nations were varied. While Germany took the dramatic step to eliminate nuclear energy by 2020, most nations did little to reduce their reliance on nuclear energy. The Nuclear Energy Institute reported in 2012 that globally there were at least 60 reactors under construction and at least 150 nuclear power projects were in the licensing or advanced planning stages.[1]

The Fukushima accident was big news in the United States and it clearly led to a re-evaluation of nuclear safety. The results of a CBS News poll conducted nationally between March 18 and 21, 2011 found that fifty-three percent of respondents "were no more fearful about a nuclear accident occurring in the U.S."[2] Despite this, only 43 percent approved of building more nuclear plants - a drop of 14 points from a 2008 poll.[3] But this drop in support for Nuclear energy was short-lived. The results of a poll taken by Bisconti Research, in conjunction with GfK Roper in February 2012 showed that 64 percent of Americans favored the use of nuclear energy in the U.S. and 81 percent believed that nuclear energy was important for meeting the nation's future electricity needs.[4] And despite the fact that there has been no expansion of nuclear power infrastructure since the 1970s, the Nuclear Regulatory Commission (NRC) has approved the construction of two new reactors at the Virgil C. Summer Nuclear Generating Station in South Carolina and two more at the Vogtle Electric Generating Plant in Georgia.[5]

In this paper, we take a different approach to evaluate America's reaction to the Fukushima accident. We look at how house prices around NPPs changed after this event. Because it was unanticipated, it can be considered to be an exogenous shock and we can isolate changes in prices that were directly tied to the Fukushima accident. It is important to note that there was no change in the risk of a nuclear accident in the U.S. after Fukushima. We view this is as an information shock that led to a reassessment of this risk by residents near nuclear power plants. As such, nuclear power risk was capitalized into local house prices prior to Fukushima and any change in prices will reflect a change in the subjective assessment of this risk.

Because the evidence from polling indicates that the reaction to Fukushima was short-lived, we focus on changes in prices that occurred during a limited time period after the accident. It is also

[1] http://safetyfirst.nei.org/safety-and-security/the-global-response-to-fukushima-daiichi/

[2] http://www.cbsnews.com/htdocs/pdf/poll_Obama_Libya_Japan_032211.pdf

[3] http://www.cbsnews.com/news/poll-support-for-new-nuclear-plants-drops/

[4] http://www.nei.org/News-Media/Media-Room/News-Releases/Majority-US-Public-Support-for-Nuclear-Energy-Has

[5] http://en.wikipedia.org/wiki/Nuclear_power_in_the_United_States

likely that any changes in prices were for units that were relatively close to nuclear power plants so we limit our analysis to transactions near these plants.

We have data on transactions for single-family homes in 2009-2013 that are within 50 miles of 29 NPPs in seven states in the U.S. The data includes the date of sale, structural characteristics of the house, and the latitude and longitude of each transaction. This allows us to calculate the distance from each unit to the NPP. We use the hedonic model to estimate the impact of the Fukushima accident on house prices. We include the standard set of structural characteristics, monthly time dummies, distance buffers around the NNPs, and zip code fixed effects. The latter are crucial for obtaining the causal estimates of Fukushima on house prices since neighborhoods near NPPs are likely to be different that ones that are father away and hence not controlling for neighborhood quality could result in omitted variables bias. The price impacts are captured in the coefficients for variables that are the interaction of the time dummies and the distance buffers. These provide the standard difference-in-difference interpretation; the impacts are identified by changes in prices in zip codes from before and after the Fukushima nuclear accident that are close to a NPP as compared to those that are far away.

The rest of the paper is organized as follows. Section II provides a survey of the related literature. Section III introduces the conceptual framework for evaluating the impact of the Fukushima accident on house prices. The data are described in Section IV and a simple graphical analysis is given in Section V. Section VI develops our regression strategy and results are provided in Section VII. Conclusions are draws in Section VIII.

II. Related Literature

There are three studies that are closely related to ours; Fink and Stratmann (2015), Kawaguchi and Yukutake (2014), and Bauer, Braun, and Kvasnicka (2015).

Fink and Stratmann (2015) examine if U.S. households updated their assessment of nuclear risk by looking at the prices of houses near nuclear power plants before and after the Fukushima crisis use monthly zip-code level housing indices from Zillow in 2011. The study compares the changes in house prices within various distance buffers around nuclear power plants across the country (within 5 miles, 5-10 miles, …20-25 miles) to the rest of the country. They find no change in house prices or if anything, an increase in house prices near nuclear power plants. Two major innovations of our study are that we focus more on the local effect taking into account that housing markets exit as the sub-national level. Further, there is evidence that house prices tend to be responsive only within the very proximate areas (cite). Another innovation is that we use house prices from individual house sale records. The prices indicated on Zillow are "estimated" values from various sources, including not only house sale prices but also assessment values and many other factors. Zillow does not explicitly share the functions as this is part of their intellectual property. However, using Zillow prices have a number of issues and may not reflect actual marginal willingness to pay by home buyers. We overcome this issue by using actual house sale prices for individual houses sold in the market.

Bauer, Braun, and Kvasnicka (2015) examine the effect of the Fukushima accident in Germany which led to the government closing eight of the seventeen nuclear power plants and announcing the phase out of the remaining 9 plants by 2022. They investigate the impact of these actions on the German housing market. Using a difference-in-difference approach, the authors find that after the Fukushima accident, prices within 4 km of the non-active nuclear power plants did not change, prices within 4 km of active nuclear power plants that remained open fell by 3.3 %, but prices within 4 km of sites that were shut down actually fell by 9.2%. This can be explained by the local negative economic consequences of the plant shutdowns; employment fell by 2.6% in the year after shutdown compared to areas without a nuclear power plant.

Kawaguchi and Yukutake (2014) estimate the effect of radioactive fallouts on land prices in Japan. They exploit the variation in contamination across 10 prefectures determined by meteorological conditions (wind and precipitation). They find that land prices fell in areas with greater exposure to the fallout.

To summarize, the second and third studies look at different mechanisms (nuclear power plant closures in Germany and local land prices in Japan). The first study is the most similar to our but we overcome two major issues associated with their study.

III. Conceptual Framework

Individuals establish a perceived risk of a nuclear disaster and the impact of nuclear fallout based on information they obtain about nuclear power plants. Given that the impact can be proxied for by distance to the site, this perceived risk manifests itself in the housing market such that WTP to live further from a nuclear power plant will result in higher house prices the further the unit is located from the site.

This can best be described by formulating the representative consumer's expected utility maximization problem within the framework of the hedonic model. Since we are concerned with the contamination risk of the local nuclear power plant, the maximization problem is best described using a Von Neumann-Morgenstern expected utility model with state dependent utilities. That is, we assume that individuals maximize expected utility over two states of the world, with U_1 representing utility in the nuclear disaster state and U_2 representing utility in the non-disaster state. We assume that for any given level of income, people prefer being healthy (i.e., $U_2 > U_1$) and that the marginal utility of income is positive. Utility in each state is a function of a vector of characteristics of the house (z) and a composite good (x). The consumer's subjective assessment of the probability of a nuclear crisis is a function of their risk assessment prior to the accident, a, and the additional information conveyed by the Fukushima crisis, f;

$$\pi = \pi\left(\mathrm{a,f}\right),\ 0 \le \pi \le 1 \qquad (1)$$

For simplicity and without loss of generality, we assume that the posterior individual risk assessment is a a convex combination of prior and new information.

$$\pi = \gamma \mathrm{a} + (1-\gamma)\mathrm{f} \quad \text{where } 0 < \gamma < 1 \qquad (2)$$

A household maximizes its expected utility over house characteristics and the composite good;

$$\text{Max EU} = \pi(a,f)U_1(z,x,d) + [1-\pi(a,f)]U_2(z,x) \qquad (3)$$

subject to the budget constraint:

$$y = x + rP(z, \pi(a,f), d)$$

where *d* is the distance of the house to the nuclear power plant., *r* is the interest rate, and $P(\cdot)$ is the house price. The equilibrium condition is:

$$\frac{\partial P}{\partial f} = \frac{(U_1 - U_2)\cdot\frac{\partial \pi}{\partial f}}{\pi\frac{\partial U_1}{\partial x} + (1-\pi)\frac{\partial U_2}{\partial x}} \qquad (4)$$

Empirical Predictions
If the Fukushima crisis led individuals to update their subjective risks toward nuclear energy ($\partial\pi/\partial f > 0$), then house prices will fall ($\partial p/\partial f < 0$). This could be a temporary or permanent change depending on whether the update in subjective risks is temporary or permanent. If the Fukushima crisis did not lead individuals to update their subjective risks toward nuclear energy ($\partial\pi/\partial f = 0$), either because prior assessment accurately accounted a positive probability of nuclear crisis, or individuals did not respond to the Fukushima crisis, then house prices will not change.

IV. Data

We obtained data on single-family house sales in arms-length transactions for the years2009-2013 from CoreLogic, a private company that gathers the information from various public sources. Our information includes the sales price, date of sale, the exact location of the property as well as various house characteristics (i.e., number of beds, square footage, etc). The current data focus on the seven largest states in terms of the number of nuclear power plants; Illinois (6), Pennsylvania (5), New York (5), South Carolina (4), North Carolina (3), New Jersey (3), and Michigan (3), with the numbers in the parentheses indicating the number of nuclear power plants in each respective state. The rest of the states have no more than three nuclear power plants. We also eliminate the highest and lowest one-percentile as outliers.

In total, we cover 29 nuclear power plants out of 65 in the United States, and they were all in operation at the time of the Fukushima crisis.

Sales that were not standard market transactions such as foreclosures, bankruptcies, land court sales, and intra-family sales are excluded. Furthermore, for each year, observations with the bottom and top 1% sales prices are excluded to further guard against non-arms-length sales and transcription errors. The data include typical house characteristics: age, living space, lot size, and the number of bathrooms. The sample is limited to units with at least one bathroom and 500 square feet of living space and no more than 10 bathrooms, 8000 square feet of living space, or 10 acres. A number of observations are missing values for these structural characteristics. We set the missing values to zero and include a flag that indicates the missing observations for each variable.

Summary statistics are given in Table 1. These are included for the full sample and for distance buffers around NPPs of 0-4 kms, 4-8 kms, and 8-12 kms. The means for sales prices within 4 kms and between 4 and 8 kms are quite similar. Those in the 8-12 km ring are more expensive, newer, and larger than units sold within 8 kms of a NPP. Clearly, we will need to control for these structural characteristics in our regressions.

V. Graphical Evidence

To get some preliminary idea about how the Fukushima accident affects the prices of houses near NPPs, Figure 1 plots the impact of the distance to nuclear power plants on house prices for one year before the crisis (in blue) and one year after the crisis (in red). It is clear that house prices were substantially lower after the crisis in areas extremely close to nuclear power plants. However, the gap in house prices before and after the crisis appears to be constant beyond 4 kms, which simply captures the general time trend in prices.

This finding indicates an issue with the identification strategy laid out by Fink and Stratmann (2015) that the effect is much more localized than their analysis can reveal. Our evidence suggests that only the areas within 4 kms are affected by the crisis.

Figure 2 plots the trends in house prices over the four-year period separately for the transactions within 4 kilometers of a NPP and those between 4 kms and 8 kms away from NPPs. The figure highlights that house prices were very similar in the two areas up to the day of the crisis (day = 0), after which time house prices within 4 kms started falling relative than those in the counterpart area, and reached the bottom about a half year after the crisis. House prices in the 4 km buffer then rose relative to those in the 4-8 km buffer and were essentially the same after one year.

The gradual decrease in house prices near power plants is plausible because many houses sold/purchased right after the crisis were likely to have already been under agreement before the crisis, and thus the prices did not immediately reflect the updated risk assessment.

What we take away from this simple graphical analysis is that the impact of the Fukushima accident on house prices is very local and of limited duration. This will inform our regression strategy that we develop in the next section.

VI. Regression Strategy

Initially, we specify a model where the impact of the proximity to a nuclear power plant is constant across all NPPs. Depending on the number of observations, we will later estimate separate regressions for states and individual nuclear power plants. The hedonic model is specified as

$$\ln(P_{injt}) = \beta_{0t} + X_{injt}\beta_1 + f(dist_j, time_t, \beta_{2t}) + e_n + \varepsilon_{ijnt} \qquad (5)$$

where the dependent variable is the log of sales price of house i, in zip code (neighborhood) n, near NPP j, sold at time t, X_{injt} is a vector of house characteristics, e_n is a neighborhood fixed effect, and ε_{ijnt} is the error term. Note that the intercept is allowed to vary over time to capture general price effects in the housing market.

The impact of NPP j on local house prices depends on the distance to site, $dist_j$, and the number of days since the Fukushima nuclear accident, $time_t$, where t = 0 is March 11, 2011. This relationship is captured in a general way by f(.).

In its most general form, one could estimate a smoothed function of time from the accident and distance from the nuclear site. The graphical analysis in the previous section showed that the impact was very local such that there was no impact beyond 4 kms. We include two distance buffers; 0-2 kms and 2-4kms such that the impact is assumed to be constant within each buffer. We also use a buffer of 4-8 kms as the control. The impact is allowed by vary smoothly over time from the Fukushima accident; we specify a cubic function of time.

A key assumption is that the Fulushima accident was an unanticipated shock. Hence any reaction to the accident came only after it occurred. The additional assumption that allows for a causal interpretation of these price changes is that without Fukushima, market price changes would have prevailed over the entire market. Hence including the outside ring will net out these price changes and any remaining differences are due to the Fukushima accident. Figures in the previous section illustrate that this is a plausible assumption – house prices have similar trends in the years leading up to the crisis, and one year after the crisis. The timing of dipartites in house prices is commensurate with the exogenous event of the Fukushima crisis.

VII. Empirical Results

Based on the graphical evidence, we limit the sample to transactions that occurred within 8 kms of a NPP and within one year of the Fukushima accident. The dependent variable in our regression model is the natural log of house price. The structural characteristics include living space is square feet and its square, lot size in acres and its square, the year the house was built, and the number of bathrooms.

We include a cubic polynomial in time since the Fukushima accident (March10, 2011) and three distance buffers, 0-2 km, 2-4 km, and 4-8 km; Ring0_2, Ring2_4 and Ring4_8 where the latter is the left out (control) group. The impact of the Fukushima accident on house prices is captured by the interaction of Ring0_2 and Ring2_4 with the polynomial in time. We include zip code fixed effects and standard errors are clustered at the zip code level.

We first estimate one model for the full sample. The estimate of the impact of the Fukushima accident on house prices near U.S. NNPs if a weighted average of the impacts across the 29 NNPs in our sample. These impacts are likely to vary due to the fact that actual housing markets in which they are located are much smaller (typically an MSA). But we present the results at this level of aggregation for two reasons. First, this is the level as which Fink and Stratmann (2015) present their results and hence we can compare our results with theirs. Second, there is a distinct tradeoff between accuracy and efficiency based on the level of aggregation at which the regressions are estimated. That is the degrees of freedom available for estimating the coefficients associated with the polynomial in time for Ring0_2 and Ring2_4 will decline when the model is estimated at lower levels of aggregation. Table 2 gives the number of such observations for the full sample for the Ring0_4 x Month and Ring4_8 x Month interaction terms. One can see that there are typically less than 100 transactions within 4km of a NPP in each month after the Fukushima accident.

The results for the interaction terms for Ring0_2 and Ring2_4 and the polynomial in time in days since the Fukushima accident are included in Table 3.[6] Columns (1) and (2) give the estimates when year by state and year by plant fixed effects are included. We calculate the maximum (in absolute value) impact and the number of days since the Fukushima accident that it occurred for both Ring0_2 and Ring2_4. For Ring0_2, the maximum impact is -10.48% when using state by year fixed effects and it occurs at 148 days after Fukushima. While this impact is not statistically significant, it is large. The impact is zero after 346 days which is consistent with the public opinion polls that showed little attention to Fukushima one year after the accident. The impact is smaller, -6.86%, when plant by year fixed effects are included.

The results in Table 3 assume a national housing market which can obscure effects at a more disaggregated level. So next we consider estimates at the State level. The issue here is that there is a tradeoff between accuracy and degrees of freedom. Furthermore, states constitute multiple housing markets so these results are averages over multiple housing markets corresponding to the number of NPPs in each state. We present results for three states; Pennsylvania (PA), New York (NY), and Illinois(IL). The results using plant by year fixed effects are included in Table 4. We only present results on the maximum (absolute) value. We can see a dramatic difference in these results as compared to the national average as given in Table 3. The maximum values are now significant (at 10% or better) for all three states. Furthermore, these impacts are very similar and quite large for Ring0_2; that is, the at the maximum impact, prices within 2km of a NPPT are at least 15% less than those within 4 to 8 kms from a NPP. These maximum impacts occur at 136, 206, and 521 days after the Fukushima accident in PA, NY, and IL, respectively. The first are consistent with the maximum impact occurring within a year of the Fukushima accident.

The results for Ring2_4 are more varied. The maximum impact for PA is -11.55% and this is significant at the 10% level. The maximum impact for NY is -20.56%, is significant at the 5%

[6] The full set of results is included in the appendix; the structural characteristics are individually significant and have the expected signs.

level, and is actually larger than the impact for Ring0_2. The maximum impact for IL is small and not significant.

Note that we do not include the results for the other four states since either there are a small number of observations (MI), or the impacts are unreasonably large in magnitude (NC, NJ, and SC).

Finally, we look at individual NPPs. These might be the most accurate estimates since they correspond to a single housing market but the number of nearby transactions is limited. We include results for 3 NPPs with a reasonably large number of transactions in Table 5. What is most striking is the impact for Three Mile Island (TMI). At its largest, transaction prices within 2 kms of TMI are 41% lower and those in the 2km – 4 km ring are 25% lower than prices within 4km and 8km of TMI. These maximums occurred 141 and 158 days after The Fukushima accident and then declined to zero after 324 and 410 days. House prices within 2 km of the Limerick NPP, also in PA, declined by a maximum of 8.66% and those within 2km and 4km of Limerick were not affected by the Fukushima accident. House prices within 2 km of the McGuire NPP, in NC, declined by a maximum of 26% though the p-value is 0.149 and those within 2km and 4km of McGuire were not affected by the Fukushima accident.

VIII. Conclusion

The accident at the Fukushima nuclear power plant not only affected Japan but it shocked the world. It had a huge impact in Germany which decided to shut down all its nuclear power plants by 2020. There was not such an extreme outcome in the United States but citizens, at least initially, were clearly upset by this event. Still, one year later Americans' opinions of nuclear power returned to pre-Fukushima levels. In this paper, we test to see how the housing market reacted to the Fukushima accident and whether this was consistent with public opinion. In particular, we focus on house prices near nuclear power plants. Because the Fukushima accident was truly an information shock, a comparison of prices before and after the accident will provide an estimate of its causal impact on the housing market. And since the Fukushima accident did not change the actual risk of nuclear power plants in the U.S., any impact on prices reflects household updates of this risk based on this exogenous information.

We have data on transactions for single-family homes in 2009-2013 that are within 50 miles of 29 NPPs in seven states in the U.S. Our results provide evidence that the impact on house prices was very local (within 0-4 kms of a NPP) and of a limited duration (around 6 – 12 months). This is consistent with polls taken in the U.S. that showed a significant drop in those who approved of building more NPPs soon after the Fukushima accident but a significant majority in favor of using nuclear power one year after the event.

Following Fink and Stratmann (2015), we first estimate a hedonic house price model at the national level. While we do find a negative impact on house prices, we find relatively stronger evidence of a negative impact of the Fukushima accident on house prices when we disaggregate the impact to the state and individual NPP level. This shows that aggregation can mask important heterogeneity of results.

One complication of this analysis is that the Fukushima accident occurred during a time of major turmoil in the U.S. housing market. As Figure 3 shows, national house prices actually where as their lowest level at the time of the crisis. Hence it is unclear if these results would generalize to other periods that corresponded to different points of the housing cycle.

References

Bauer, Thomas K., Sebastian Braun, and Michael Kvasnicka. 2015. "Distant Event, Local Effects? Fukushima and the German Housing Market," unpublished mimeo.

Fink, A. and T. Stratmann. 2015. "U.S. Housing Prices and the Fukushima Nuclear Accident," *Journal of Economic Behavior & Organization* 117: 309–326.

Kawaguchi, Daiji and Norifumi Yukutake. 2014. "Estimating the Residential Land Damage of the Fukushima Accident," Discussion Paper Series #2014-18, Department of Economics, Hitotsubashi University.

Other related papers to review:

Clark, D.E., Michelbrink, L., Allison, T., and Metz, W.C., 1997. "Nuclear Power Plants and Residential Housing Prices," *Growth and Change* 28: 496–519.

Davis, L. W. (2011). "The effect of power plants on local housing values and rents," *The Review of Economics and Statistics*, 93(4): 1391–1402.

Figlio, David N., and Maurice E. Lucas. 2004. "What's in a Grade? School Report Cards and the Housing Market," *American Economic Review* 94(3): 591-604.

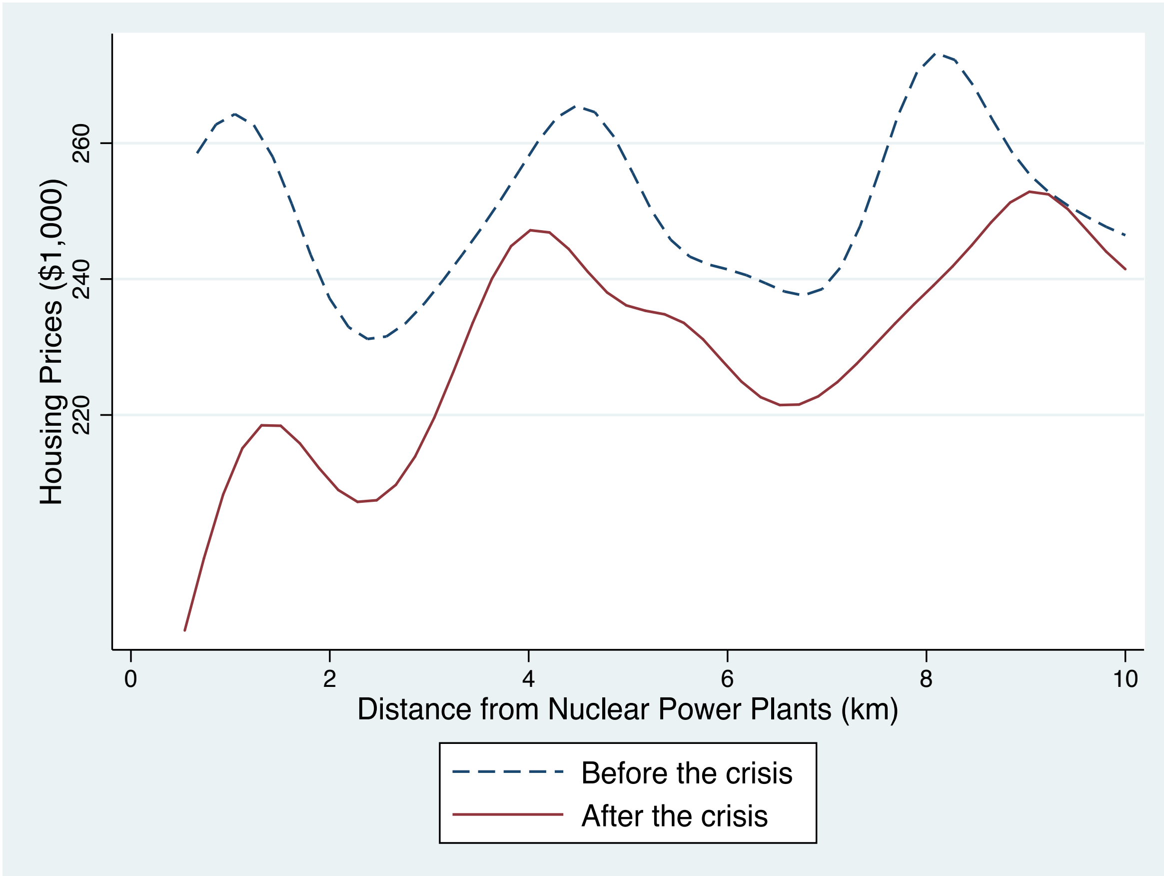
Folland, S., and Hough, R., 2000. "Externalities of Nuclear Power Plants: Further Evidence," *Journal of Regional Science* 40: 735–753.

Gamble, H. B. and Downing, R. H. (1982). "Effects of nuclear power plants on residential property values," *Journal of Regional Science*, 22(4): 457–478.

Nelson, J.P., 1981. "Three Mile Island and Residential Property Prices: Empirical Analysis and Policy Implications," *Land Economics* 57: 363–372.

Smith, V.K., and Michaels, R.G., 1987. "How Did Households Interpret Chernobyl?: A Bayesian Analysis of Risk Perceptions," *Economics Letters* 23, 359–364.

Figure 1



Notes: The sample includes housing sale prices in one year before and after the crisis.

Figure 2

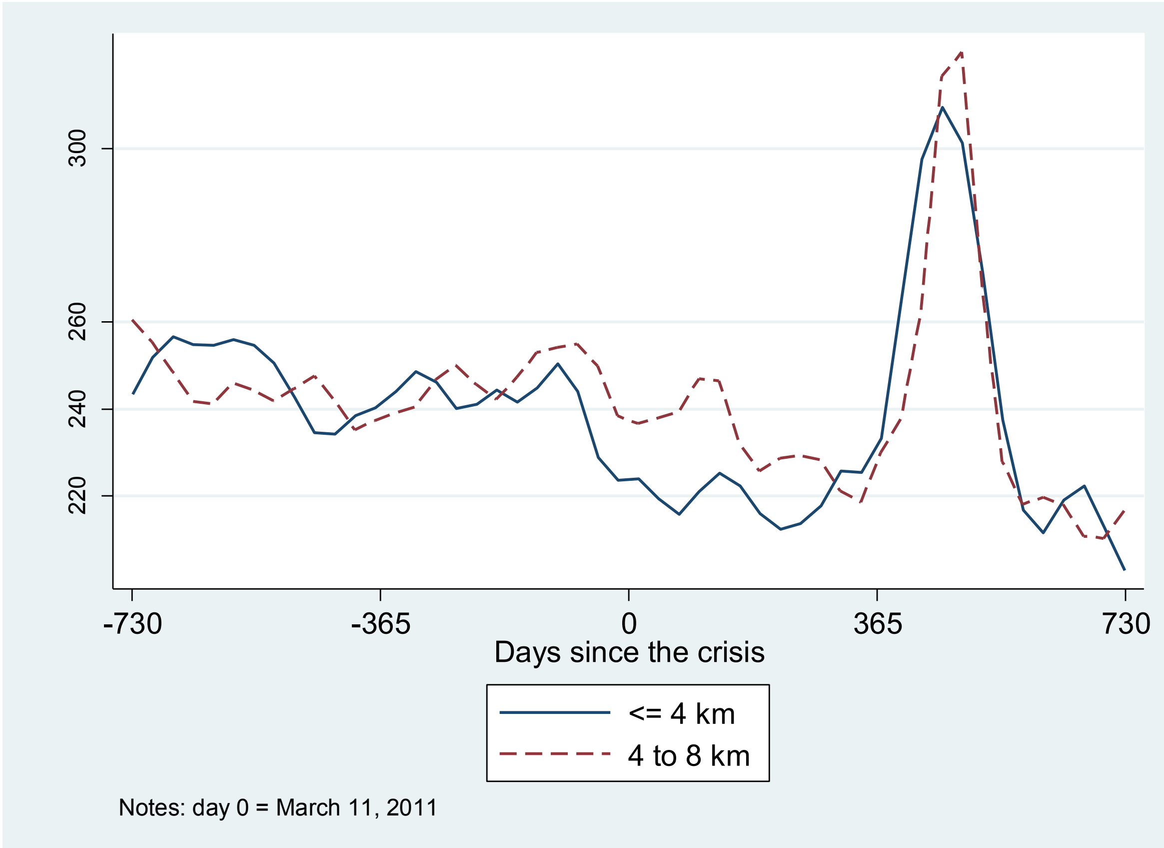

300
260
240
220
-730
-365
0
365
730
Days since the crisis
<= 4 km
4 to 8 km
Notes: day 0 = March 11, 2011

Figure 3 – National House Price Index

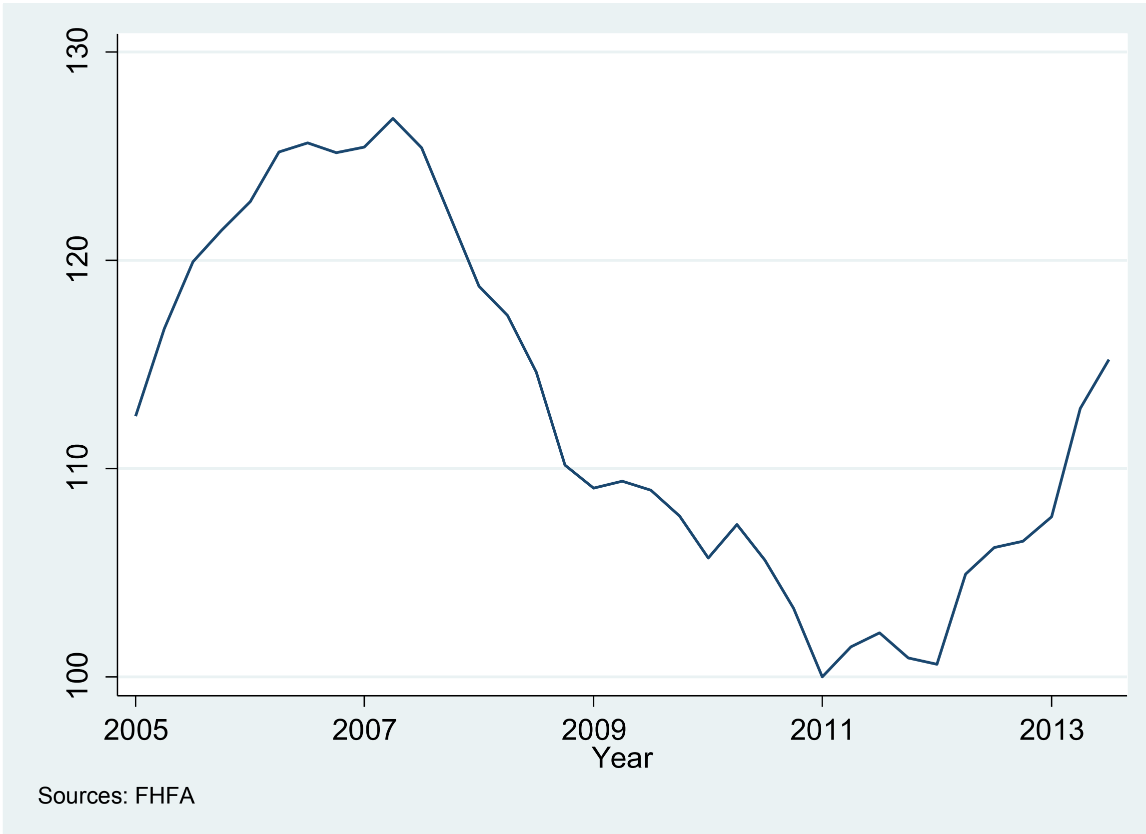


Table 1 – Summary Statistics

Distance from Nuclear Power Plant	Number	Mean	Std Dev	Max	Min	p10	p90
<4 km							
Real Sales Price (Jan 2011 $1000s)	2273	231.51	148.31	1444.29	12.13	90.93	386.93
Year Built	1929	1985.02	25.76	2013	1900	1951	2010
Living Space (Square Feet)	1879	1998.33	978.39	7638.00	500.00	1014.00	3254.00
Number of Full Baths	1005	2.04	0.85	6	1	1	3
Lot Size (Acres)	2259	0.48	0.68	6.13	0.02	0.09	1.00
4-8km							
Real Sales Price (Jan 2011 $1000s)	7608	239.82	170.00	1660.71	10.60	83.59	413.84
Year Built	5998	1985.30	28.61	2013	1900	1950	2011
Living Sq Ft	5951	2111.29	912.92	7993.00	540.00	1153.00	3242.00
Full Baths	4250	1.93	0.77	6	1	1	3
Acres	7859	0.48	0.75	6.54	0.01	0.09	1.00
8-12km							
Real Sales Price (Jan 2011 $1000s)	11778	259.21	228.70	1870.34	10.70	87.06	452.92
Year Built	9464	1988.97	26.25	2013	1900	1954	2011
Living Sq Ft	9447	2189.87	932.90	7957.00	576.00	1196.00	3376.00
Full Baths	7273	2.03	0.75	7	1	1	3
Acres	11867	0.49	0.74	6.55	0.01	0.09	1.00
Total							
Real Sales Price (Jan 2011 $1000s)	21659	249.49	202.53	1870.34	10.60	86.09	431.15
Year Built	17391	1987.27	27.10	2013	1900	1951	2011
Living Sq Ft	17277	2141.97	933.15	7993.00	500.00	1160.00	3323.00
Full Baths	12528	2.00	0.77	7	1	1	3
Acres	21985	0.49	0.74	6.55	0.01	0.09	1.00

Table 2: Number of Observations in Each Ring x Month Interaction

	Months Before Fukushima		Months After Fukushima	
	Ring0_4	Ring4_8	Ring0_4	Ring4_8
Interaction Terms	(1)	(2)	(3)	(4)
Within ring × month 1	77	262	81	393
Within ring × month 2	65	228	98	320
Within ring × month 3	83	325	99	357
Within ring × month 4	115	318	79	367
Within ring × month 5	89	300	90	405
Within ring × month 6	111	305	115	349
Within ring × month 7	91	312	97	316
Within ring × month 8	90	306	99	313
Within ring × month 9	159	465	82	292
Within ring × month 10	115	475	72	272
Within ring × month 11	121	439	108	257
Within ring × month 12	79	276	84	238

Table 3: Regression Results.
Dependent Variable: Natural Log of House Price

	Fixed Effects (interacted with year)	
	State	Plant
Ring0_2 × cubic in time	(1)	(2)
Time × e^{02}	-0.164	-0.121
	(0.117)	(0.109)
$Time^2$ × e^{05}	0.699	0.582
	(0.494)	(0.449)
$Time^3$ × e^{08}	-0.650	-0.558
	(0.500)	(0.452)
Maximum Effect	-0.111	-0.071
p-value	0.103	0.183
Maximum Days	148	127
Impact (%)	-10.48	-6.86
Ring2_4 × cubic in time		
Time × e^{02}	-0.071	-0.053
	(0.045)	(0.044)
$Time^2$ × e^{05}	0.376*	0.358
	(0.187)	(0.180)
$Time^3$ × e^{08}	-0.405*	-0.410*
	(0.203)	(0.198)
Maximum Effect	-0.039	-0.022
p-value	0.134	0.220
Maximum Days	117	87
Impact (%)	-3.79	-2.15
N	20,206	20,206

Notes: The sample includes all houses that were sold in two years before and after the Fukushima crisis within 8 km of nuclear power plants. The number of zip codes is 115. The standard errors are clustered at the city level and included in parenthesis below the point estimates. The regression also includes month dummies, and structural characteristics. *** p<0.01, ** p<0.05, * p<0.1

Table 4: Regression Results for States
Dependent Variable: Natural Log of House Price

	State		
	PA	NY	IL
Ring0_2 × cubic in time	(1)	(2)	(3)
Maximum Effect	-0.188**	-0.168***	-0.186*
p-value	0.016	0.007	0.074
Maximum Days	136	206	521
Impact (%)	-17.1	-15.46	-17.01
Ring2_4 × cubic in time			
Maximum Effect	-0.123*	-0.23**	-0.030
p-value	0.074	0.014	0.240
Maximum Days	165	169	525
Impact (%)	-11.55	-20.56	-2.93
Number of Obs	5,882	1,744	1,598
Number of NNPs	3	5	6

Notes: The sample includes all houses that were sold in one year before and after the Fukushima crisis within 8 km of nuclear power plants. The standard errors are clustered at the zip code level. The regression also includes month dummies, and structural characteristics.
*** p<0.01, ** p<0.05, * p<0.1

Table 5: Regression Results for Individual NNPs
Dependent Variable: Natural Log of House Price

	Plant		
	Limerick, PA	Three Mile Island, PA	McGuire, NC
Ring0_2 × cubic in time	(1)	(2)	(3)
Maximum Effect	-0.091***	-0.531***	-0.300
p-value	0.000	0.000	0.149
Maximum Days	104	141	289
Impact (%)	-8.66	-41.21	-25.92
Ring2_4 × cubic in time			
Maximum Effect	-0.008	-.0290**	-0.005
p-value	.	0.032	.
Maximum Days	-124	158	-31
Impact (%)	-0.75	-25.17	-0.500
Number of Obs	3,792	1,291	2,955

Notes: The sample includes all houses that were sold in one year before and after the Fukushima crisis within 8 km of nuclear power plants. The standard errors are clustered at the zip code level. The regression also includes month dummies, and structural characteristics. *** p<0.01, ** p<0.05, * p<0.1