Evaluating the Impact of the Fukushima Daiichi Nuclear Power Plant Accident

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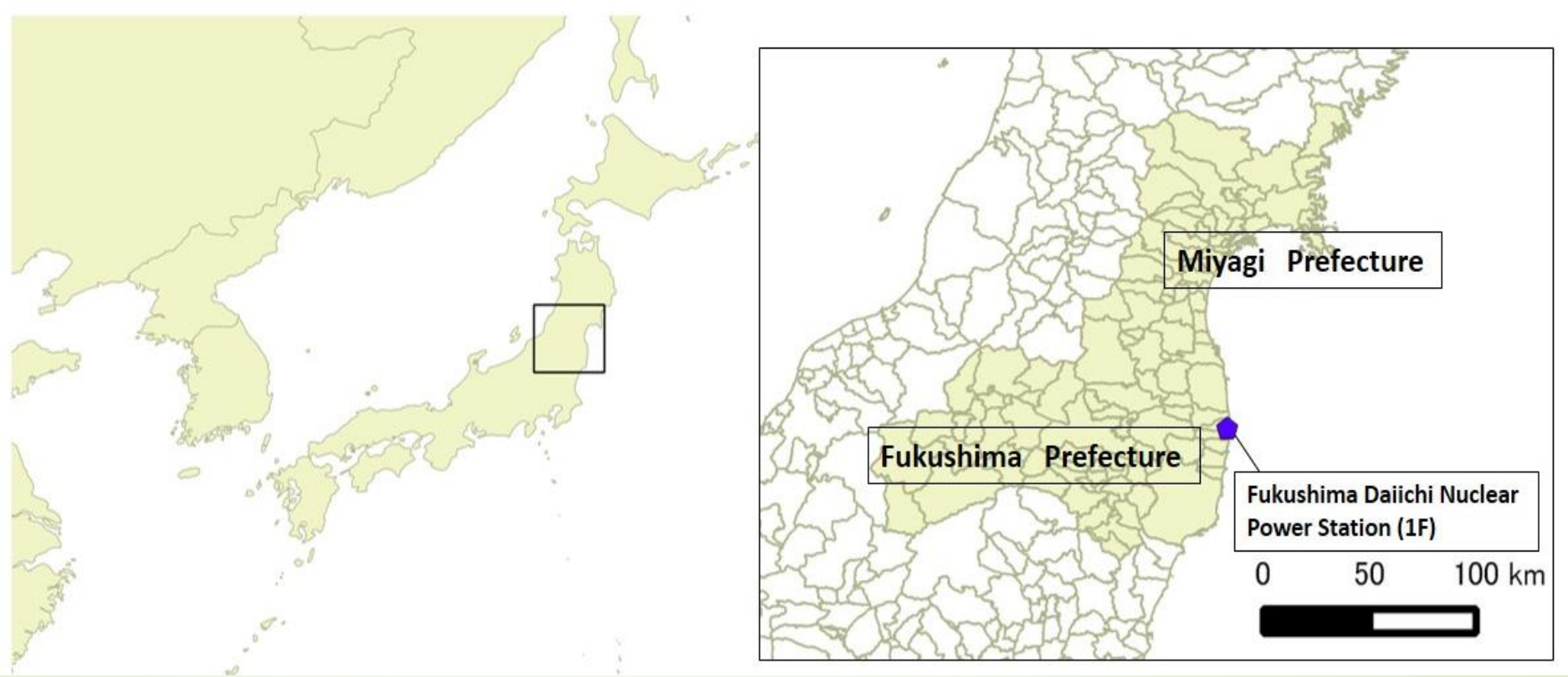
1. Introduction
Background and the aims of this paper

- Fukushima Daiichi Power Plant Accident (Fukushima DPPA) caused tremendous damage to not only Tohoku region but also …
- Quantitative assessment of the impact caused by Fukushima DPPA
  - Fukushima DPPA solely from earthquake and tsunami
  - Changes of the impact as time goes by
  - Damages differ from place to place according to spatial conditions
- Devising a desirable quantitative method that enables an accurate evaluation of the impact of the Fukushima DPPA
  - Is hedonic price approach applicable?
  - Problems w.r.t. spatial autocorrelation and choice of variables

1. Introduction
Locations of interest



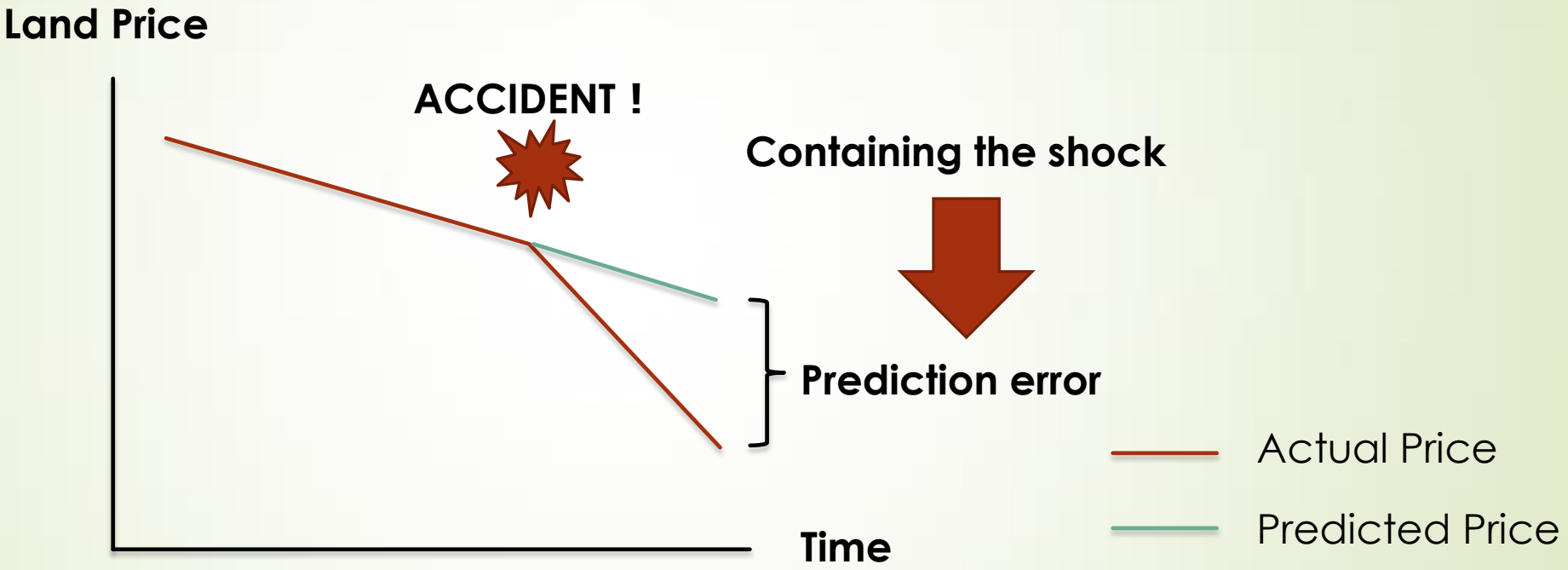
2. Earlier literature

- Few researches on the economic evaluation of the impact of nuclear power plant accidents
- On Three Mile Island accident:
  - Nelson（1981）, Gamble and Downing（1982）
- On Fukushima DPPA:
  - Kato and Ueta（2012）
- Each of them used hedonic price approach
- Ignoring the spatial autocorrelation problem

3. Method
Comparison of methods

	Hedonic Approach	Spatial Hedonic Approach	Our Method
Time trend	Ignoring	Ignoring	Taking into consideration the trend of land price
Spatial autocorrelation	Ignoring	Creating spatial weight matrix arbitrarily	Estimating spatial weight matrix
Choice of variables	Using explanatory variables arbitrarily	Using explanatory variables arbitrarily	Using explanatory variables that clearly reflect the impact

3. Method
Overview of our method



- Divide prediction error by the land price one year before and define it as prediction error rate

3. Method
Overview of our method 2

- Regress prediction error rate on four shocks of this disaster

- OLS
  - Under some assumptions, OLS gives consistent estimators
  - But the land price data are not randomly collected

- FGLS
  - Need to know the variance-covariance matrix of error terms
  - Use the residuals we've acquired by time series analysis
  - FGLS gives the most efficient estimators

3. Method
Virtues of our method

- Avoiding overestimation
  - The land prices of Fukushima and Miyagi prefecture have been declining
  - Unless taking this into account, the impact of this disaster would be overestimated
- Less arbitrariness
  - Solving the spatial autocorrelation problem by creating the variance-covariance matrix by doing time series analysis
  - Less arbitrary than making a spatial weight matrix
  - Few discretions of choosing variables, different from hedonic price approach

4. Data
Land price data

- Time series land price data from 1992 to 2013 are from two official land price publications
  - Implemented by the central government and the prefectural governments
  - designed to complement each other
  - provide the land prices assessed by specialists, real estate appraisers
  - Those prices are the probable values of points that would be formed in assumed transactions without any extraordinary incentives

- There are 565 points without missing values from 1992 to 2013 and we choose them for analysis

4. Data
Data other than land price

- Air dose rates
  - Results of the survey by the Ministry of Education, Culture, Sports, Science and Technology's…
- Distance from Fukushima DPP
  - We measured the distance using GIS software
- Tsunami
  - We used GIS data By Tani (2012)
- Earthquake
  - Seismic intensity by the Japan Meteorological Agency (2011)
- Reconstruction grants
  - The total amount of the first to fourth rounds of funding for the municipality that includes the point, i.e., sample, we are studying

5. Results and discussion

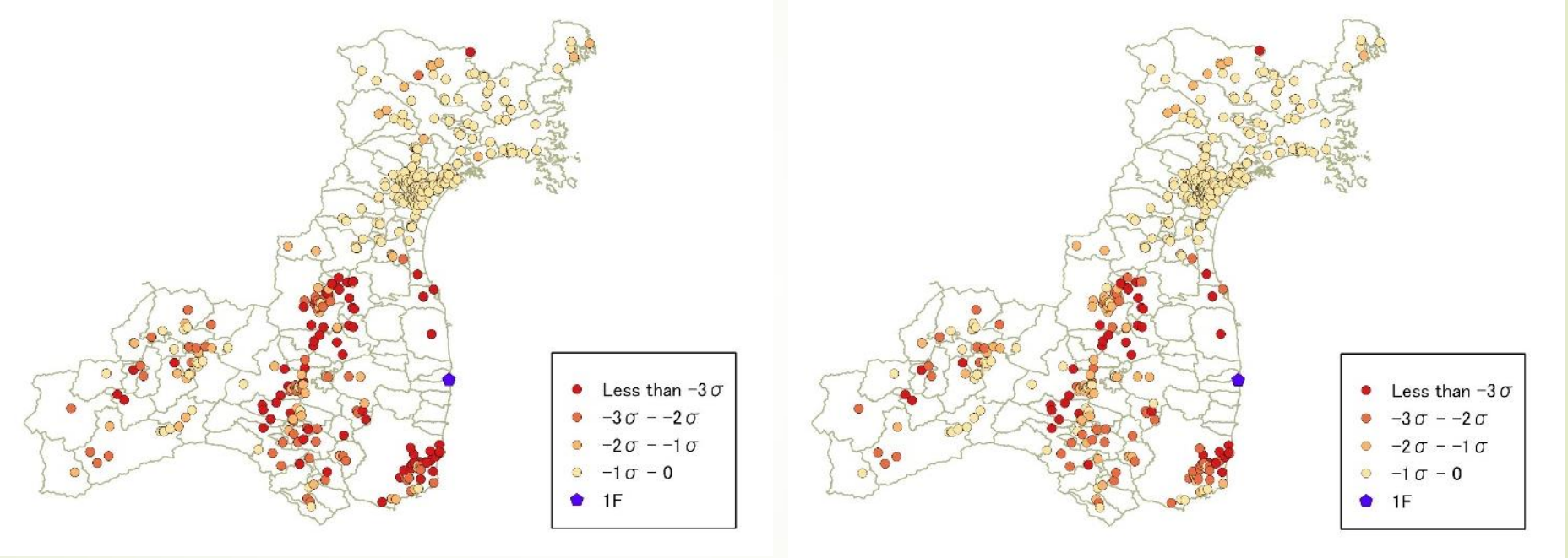
	Prediction error rates				
Variable	The first period		The second period		
	OLS	FGLS	OLS	FGLS	VIF
Air dose rates					
≤0.1	Reference category	Reference category	Reference category	Reference category	
(0.1, 0.2]	-0.0107*** (0.0023)	-0.0104*** (0.0031)	-0.0219*** (0.0049)	-0.0207*** (0.0031)	1.9532
(0.2, 0.3]	-0.0162** (0.0054)	-0.0162** (0.0055)	-0.0339*** (0.0073)	-0.0344*** (0.0055)	1.4443
(0.3, 0.4]	-0.0374*** (0.0049)	-0.0363*** (0.0056)	-0.0558*** (0.0067)	-0.0521*** (0.0056)	1.3772
(0.4, 0.5]	-0.0448*** (0.0051)	-0.0443*** (0.0053)	-0.0626*** (0.0068)	-0.0620*** (0.0053)	1.4245
(0.5, 0.6]	-0.0422*** (0.0069)	-0.0416*** (0.0056)	-0.0628*** (0.0083)	-0.0614*** (0.0055)	1.3524
(0.6, 0.7]	-0.0298*** (0.0049)	-0.0296*** (0.0082)	-0.0521*** (0.0073)	-0.0509*** (0.0082)	1.1508
(0.7, 0.8]	-0.0259*** (0.0045)	-0.0255** (0.0082)	-0.0495*** (0.0081)	-0.0482*** (0.0082)	1.1538
>0.8	-0.0335*** (0.0045)	-0.0331** (0.0101)	-0.0613*** (0.0080)	-0.0595*** (0.0101)	1.1058
Inverse of distance from Fukushima DPP	-1.1771*** (0.2395)	-1.0817*** (0.2580)	-1.7311*** (0.4123)	-1.4170*** (0.2574)	1.8900

NOTE: Standard errors are in parenthesis. ***: Significance level below 0.1%; **: 1% significance; *: 5% significance.

5. Results and discussion

- Eight dummy variables of air dose rates
  - Radioactive contamination reduces the land prices
  - Its coefficients are bigger in absolute value in the second period
- Inverse of the distance from Fukushima DPP
  - Only being closer to Fukushima DPP reduces the land prices
  - Psychological anxiety also negatively affects the land prices
  - Its coefficient slightly increases in the second period

5. Results and discussion
Fukushima DPP deviation



- This figure shows how the land prices deviate from the predicted value in sigma unit due to Fukushima DPPA
- 83 points with extreme fluctuations of less than -3σ in the first period
- 48 points with extreme fluctuations of less than -3σ in the second period even though the variances of predicted values get larger

6. Conclusion

- Two channels of negative effect on land prices in two years
  - Radioactive contamination
  - Factors other than radioactive contamination
- Decontamination to reduce air dose rate would not suffice to offset the impact of Fukushima DPPA
- The effect of Radioactive contamination gets roughly doubled in the second period
- Fukushima DPP deviation
  - 83 points with extreme fluctuations of less than -3σ in the first period
  - 48 points with extreme fluctuations of less than -3σ in the second period

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Thank you for your attention!