International Conference on Policy Modeling (EcoMod2004)
Paris, June 30-July 2, 2004

An Empirical Study on the Nuisance Facilities Impact on the Property Value: The Case of Waste Treatment Facilities in Japan

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ABSTRACT: Waste treatment sites are difficult facilities to site because of a local residents' opposition. While these facilities bring public interests to the wide area, the nuisance is concentrated to the narrow area around the site. The inequity will reflect on the property value. Through the empirical study on the metropolitan area in Japan, this assumption was corroborated in some regions. Especially in the outskirts of the metropolitan, the average rate and the volatility of the annual property value change are significantly lower around waste facilities. As a result the tail of the distribution of the future property value become thin, the option value of the property relatively decline.

1. INTRODUCTION

Waste treatment site is a typical one of the NIMBY (not in my back yard) facilities. Nowadays it is difficult to site because of a local residents' opposition, and many disputes have occurred throughout Japan (Ohashi 1996). The reason of the oppositions is nuisances which are concentrated to the narrow area around the site. In Japan, the environmental risk of toxic chemicals has been focused as an important nuisance in recent years. Especially DIOXIN with the incineration of wastes has been the strongest reason to oppose to such facilities.

Although the environmental risk is an important problem, the actual risk with the waste treatment facilities under the environmental regulation would be low enough to prevent the health impacts. Since many people still do not want such facilities around them, the negative effect to the property value will be brought about by the only facts that such facilities are hated. It should be called 'Stigma' effect and it is one of the externalities. In the Appraisal Institute in US the methods to evaluate 'Stigma' have been discussed, and some guides are proposed (Mundy 1992, Roddewing 1996). In the study of Greenberg and Hughes (1993) nearly 20% of tax assessors in New Jersey towns with hazardous waste sites report that proximity to such a site has lowered the appreciation of property value, deterred land uses, and affected land use plans within one-fourth mile of the site.

The major methods to evaluate the facilities' effect to the property value are CVM (Contingent Valuation Method) and Hedonic approach. Although there are many CVM studies which obtained significant results (Smith and Desvousges 1986, Groothuis and Miller 1994, Ciccheti and Sepetys 1995, Groothuis and Van Houtven 1998, etc.), they would been lacking in objectivity because they based on the supposed market. So the objective approach should be more persuasive. There are also many Hedonic studies using the real market data, but some results are not significant. Zeiss and Atwater (1989) reviewed 10 studies which analyzed the effect of waste treatment facilities to the property value, and they pointed that only 3 studies obtained significant results. One of the reasons they indicated is imperfect information in the real estate market.

Hedonic approach catches the change of the expected value of the future rent. The summation of them is the present land price. In contradiction to that I focused on the probability distribution of the future land price in this study. The summation (integration) of the product of the future land price as a stochastic variable and the probability (probability density) is the present land price. Even though there is no change in the present land price as an expected value, the expectation of the capital gain can change if the distribution form has changed. So I have tried to observe the externality with waste treatment facilities as the change of the distribution of the future land price.

2. THE STOCHASTIC MODEL OF THE FUTURE LAND PRICE

Suppose that the present land price is S, and on the next period the price becomes Su at probability p and Sd at probability $1-p$. In case u, d and p do not depend on the period, the future land price follows the binominal process as Fig.1.

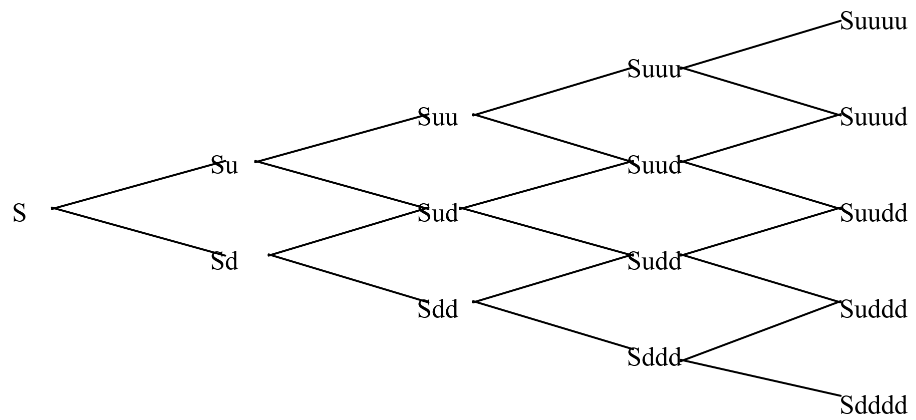

Fig.1. the binominal process of the land price

The future land price S_T is defined as a stochastic variable by equation (1). Here n is the number of periods to the future, and S_n is the number of times to rise and a stochastic variable which follows the binominal distribution.

$$S_T = S \cdot u^{S_n} \cdot d^{n-S_n} \tag{1}$$

And the stochastic variable $\widetilde{S}_n$ given with equation (2) converges on the standard normal distribution.

$$\widetilde{S}_n = \frac{S_n - np}{\sqrt{np(1-p)}} \tag{2}$$
$$E[S_n] = np$$
$$V[S_n] = np(1-p)$$

Then equation (3) is given with equation (1) and (2). This means that the stochastic variable $\log S_T$ follows the normal distribution whose average is $\log S + n\left(p \log u + (1-p)\log d\right)$ and variance is $np(1-p)(\log u - \log d)^2$.

$$\log S_T = \log S + n\left(p \log u + (1-p)\log d\right) + \sqrt{np(1-p)} \cdot (\log u - \log d) \cdot \widetilde{S}_n \tag{3}$$

Therefore S_T follows the logarithmic normal distribution. This probability density function is as equation (4). S_T is shown as x in it.

$$f(x) = \frac{1}{\sqrt{2\pi}\sigma x} \exp\left(-\frac{(\log x - \mu)^2}{2\sigma^2}\right) \tag{4}$$
$$\sigma = \sqrt{np(1-p)} \cdot (\log u - \log d)$$
$$\mu = \log S + n\left(p \log u + (1-p)\log d\right)$$

σ and μ are needed to get the concrete form of equation (4). Then equation (3) is modified to equation (5).

$$\log\left(\frac{S_T}{S}\right) = n\left(p \log u + (1-p)\log d\right) + \sqrt{np(1-p)} \cdot (\log u - \log d) \cdot \widetilde{S}_n \tag{5}$$

The left side of equation (5) is the land price change rate based on the continuous compound. Equations (4) and (5) mean that the land price change rate follows the normal distribution whose average is $\mu - \log S$ and variance is σ^2 as shown in expression (6).

$$\log\left(\frac{S_T}{S}\right) \sim N\left(\mu - \log S, \sigma^2\right) \tag{6}$$

Here suppose the arbitration between the land and the risk-free property. Then equation (7) is given writing the yield of the risk-free property as r, and the term to the final period as T. The right side of equation (7) is the expected value of S_T following the logarithmic normal distribution as equation (4).

$$Se^{rT} = e^{\mu + \frac{\sigma^2}{2}} \tag{7}$$

Then equation (7) is modified to equation (8), and expression (9) is given with equation (6) and (8). Expression (9) shows that the concrete form of the future land price distribution is defined by the variance of the change rate of it. This variance is what is called volatility of the land price.

$$\mu = \log S + rT - \frac{\sigma^2}{2} \tag{8}$$

$$\log\left(\frac{S_T}{S}\right) \sim N\left(rT - \frac{\sigma^2}{2}, \sigma^2\right) \tag{9}$$

3. THE EMPILICAL ANALYSIS

Outline

In this study one strong assumption is adopted. It is that the equivalent areas at the potential of urbanization have equivalent potentials for the property value change. As mentioned above, the land price change rate follows the normal distribution, and the future land price follows the logarithmic normal distribution whose concrete form is defined by the land price volatility. So the externality with waste treatment facilities should be observed as the difference in the average and the variance of the land price change rate among the equivalent urbanization areas. The procedures of the analysis were follows:

1) Classification of the Tokyo metropolitan areas in Japan to the equivalent groups at the potential of urbanization.
2) Statistical test for the average and the variance of the land price change rate in each group according to the existence of waste treatment facilities.
3) Analysis of the future land price distribution applying equation (4) and expression (9).

Classification of the Tokyo metropolitan areas

In this study the unit of area is the lattice which is about 1km square. Tokyo metropolitan areas are covered with 6,143 lattices. But the areas where the large-scale developments had been carrying out were excluded, 5,432 lattices ware used in analysis. The data which indicate the potential of urbanization are as in Table 1. The land price indicator of each lattice was calculated by expression (10). $p(x, y)$ in it was estimated by the Delaunay Triangle Interpolation proposed by Kago and Takatsuji (2002).

$$\iint p(x, y)dxdy \tag{10}$$

Table 1. the data for the analysis

DATA	YEAR
land use	1989
waste treatment facilities	1990
national census	1990
statistics of industries	1991
land use regulations	1989
land use plans	1989
accessibility to the center of Tokyo	1989
land price	1990～2000

By the principle factor analysis for the data of Table 1, 4 independent variables were composed. The cumulative contribution rate of them was about 80%. Then the lattices were classified by the cluster analysis with the 4 independent variables. As the result shown in Table2, the 8 classes ware obtained, and 4 classes of them included the lattices which waste treatment facilities existed in. The geographical distributions of the lattices were presented in from Fig.2 to Fig.5.

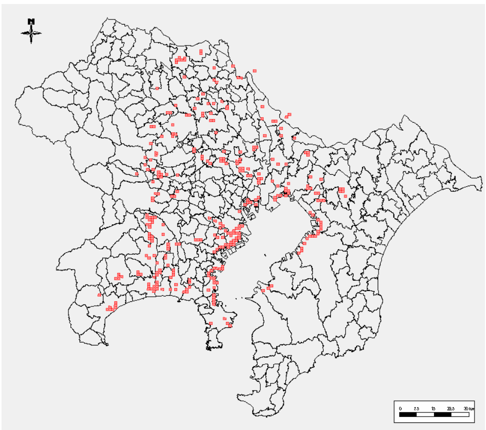

Fig.2 class B

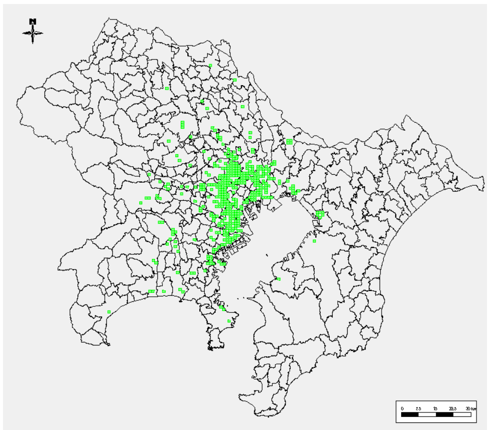

Fig.3 class D

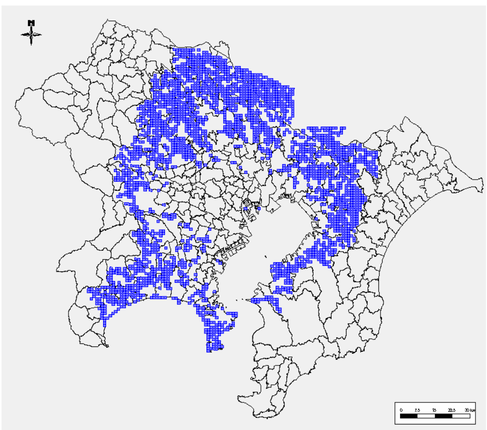

Fig.4 class F

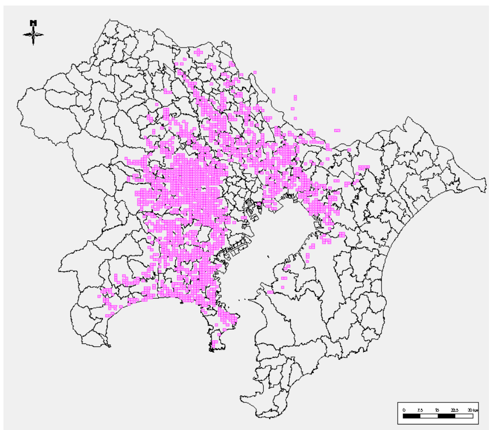

Fig.5 class H

Table 2. the classify by the potential of urbanization

class	the number of lattices	waste facilities exist in	feature of the class
A	16	0	
B	312	15	industrial distinct
C	73	0	
D	418	5	residential distinct in the center of Tokyo
E	37	0	
F	2708	64	outskirts of Tokyo
G	6	0	
H	1862	37	residential distinct in the suburbs of Tokyo
total	5432	121	

Statistical tests for the average and the variance of the land price change rate

For each lattice in the 4 classes, B, D, F and H, the annual change rates of the land price were calculated from 1990 to 2000. The average and the standard deviation of them were compared between the lattices which waste treatment facilities (WTF) existed in and the ones which have no WTF for each class. The results of the statistical tests for the average are Table 3 and the ones for the standard deviation are Table 4. The T-test was applied to the average, and the Wald-Wolfowitz test was applied to the standard deviation. The latter is one of the non-parametric tests.

Table 3. the average of the annual change rates of the land price

class	average		standard deviation		t-value
	no WTF	WTF exist	no WTF	WTF exist	
B	-0.0514	-0.0443	0.03589	0.03681	-0.748
D	-0.1026	-0.0994	0.03283	0.01516	-0.215
F	-0.0275	-0.0341	0.03954	0.02770	1.836*
H	-0.0541	-0.0550	0.02851	0.02799	0.193

* Statistically significant at 10%

Table 4. the standard deviation of the annual change rates of the land price

class	average		standard deviation		statistic
	no WTF	WTF exist	no WTF	WTF exist	
B	0.0953	0.1013	0.03589	0.03681	0.910
D	0.1128	0.1125	0.05484	0.04441	0.261
F	0.1235	0.1126	0.07233	0.07789	-2.186**
H	0.0801	0.0735	0.04392	0.03317	0.881

** Statistically significant at 5%

For both of the average and the standard deviation, the significant differences were found in the class F. As for the average of the annual change rate, WTF made it lower. And as for the standard deviation of it, WTF made it smaller. They would be observation of the externality with WTF. As shown in Table 2, the lattices of the class F locate in the outskirts of Tokyo. Because in such areas people have a wide range of choice for living place and so on, the externality with WTF would reflect to the property value sensitively.

Analysis of the future land price distribution

In case the future land value follows the logarithmic normal distribution presented in equation (4), the expected value of the capital gain V is given by equation (11) when the land was acquired at K. Here suppose $r = 0$ and ignore that V should be discounted to the present value. V means the present value of the right to buy the land at K in the future. The right is called call-option.

$$V = \int_K^{\infty} (x - K) \frac{1}{\sqrt{2\pi}\sigma x} \exp\left(-\frac{(\log x - \mu)^2}{2\sigma^2} \right) dx \tag{11}$$

Applying σ of the class F in Table 4, the distribution of V is drawn as Fig.6. Here $S = 100$ and $T = 1$ are supposed. This means that waste treatment facilities would restraint the possibility of the rise of the property value even though the potentials of urbanization were equivalent. That is to say, waste treatment facilities can decline the option value of the property around them.

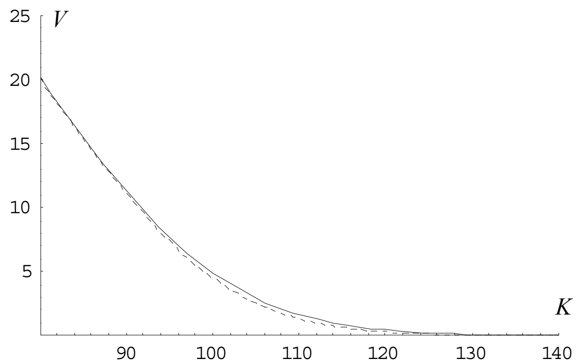

Fig.6. the distribution of the option value
* the solid line is for no WTF, and dotted line is for WTF exist

4. CONCLUSIONS

In this study I have tried to observe the externality with waste treatment facilities as the change of the distribution of the future land price. Through the empirical study on the metropolitan area in Japan, following two conclusions were obtained.

1) Especially in the outskirts of the metropolitan, the average rate and the volatility of the annual property value change are significantly lower around waste facilities.
2) As a result the tail of the distribution of the future property value become thin, the option value of the property relatively decline.

NOTICE

This study was sponsored by the Reitaku Institute of Political Economics and Social Studies in 2003 and the Hiroike Educational Institution Fund in 2004.

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