Illegal Dumping of Home Appliance and Local Community

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ABSTRACT

Using the unique data of waste household electric appliances in Japan, this paper examines the effect of community characteristics on the frequency of illegal dumping. The results reveal that the frequency of illegal dumping is higher in a low-income community with a high unemployment rate. The increase in the disposal cost and the decrease in the law enforcement's ability lead to the increase in illegal dumping. The paper further evaluates the role of community participation in the prevention of illegal dumping. It is shown that the surveillance and reporting systems in cooperation with the local residents have contributed to the reduction of illegal dumping.

Key Words: Illegal Dumping, Community Characteristics, Community Participation

JEL Classification: K42, K32, R20, Q58

1. Introduction

As the cost of waste disposal increases, waste reduction and the promotion of recycling are being addressed seriously in the public policy (Porter 2002). Many countries have adopted various recycling programs, including take-back responsibility for producers (OECD 2004).

The Japanese government introduced the Law for Recycling of Specified Kinds of Home Appliances generally called Japanese Home Appliance Recycling Law, on April 1, 2001. In this new recycling program, consumers have to pay the recycling fees when they return used appliances to retailers. Due to this characteristic of a pay-after-use system, a great deal of concern has been expressed regarding the increase in illegal dumping.

Illegal dumping results in various kinds of problems. Illegally dumped debris destroys local landscapes. If the runoff from dumpsites contains toxic chemicals and contaminates water reservoirs, it can increase health risks. Local governments have to spend substantial amount of money for cleaning up contaminated sites.

Therefore, it is important to analyze the situation of illegal dumping and to find effective countermeasures against illegal dumping. However, the research on illegal dumping is very limited.[1] This is mainly due to the fact that data on illegal dumping is scarcely available. The object of this paper is to analyze the causes of illegal disposal and to evaluate the effectiveness of the countermeasures.

In order to examine the situation of illegal dumping, Japanese local governments have investigated and recorded the incidents of illegal dumping. Using this unique dataset, we initially examine the determinants of illegal dumping.

Local governments have taken various countermeasures. In several local governments, community residents get involved in monitoring and patrol activities. Using the dataset provided by the Japanese Ministry of the Environment, we will examine whether the participation of community residents contribute to the reduction of illegal dumping.

The rest of the paper is organized as follows. In the following section, we describe a brief overview of the Japanese Home Appliance Recycling Law. Section 3 explains the situation of illegal dumping of used electric appliances. Section 4 provides the data used in the analysis. We conduct two types of analysis in this paper. In Section 5, we analyze the model that explains the illegal dumping incidents per capita using

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[1] There are few empirical studies that analyze illegal dumping problem. Fullerton and Kinnaman (1996) and Kinnaman and Fullerton (2000) analyze the effect of pricing garbage by bag on illegal dumping. They suggest that some reduction of garbage was attained by increase in illegal dumping. However, they do not use the data of illegal dumping incidents. The volume of illegal dumping is estimated indirectly.

cross-sectional data. The result of this analysis reveals that the illegal dumping incidence increases as the disposal cost increases. It further shows that illegal dumping is more serious in municipalities with lower income and higher unemployment rates. In Section 6, we examine whether the participation of community residents reduces illegal dumping incidents. We show that the monitoring and patrol activities by community residents have significantly contributed to reduction of the incidents. Section 7 presents our conclusions.

2. Background

The Japanese Home Appliance Recycling Law came into effect on April 1, 2001. The law stipulates the responsibilities of consumers, retailers, and manufacturers under the new recycling program. Consumers are responsible for returning used appliances to retailers, and retailers must deliver these used appliances to the collection depots. Manufacturers have to collect used appliances from collection depots and have to recycle them at recycling plants. Manufacturers are grouped into Group A (Matsushita, Toshiba, and others) and Group B (Hitachi, Sanyo, Sharp, Sony, Fujitsu, Mitsubishi and others), and they in the same group cooperatively built and operate collection depots and recycling plants. Four appliances (televisions, refrigerators, washing machines, and air conditioners) are covered by this law.[2]

One of the unique features of the program is that consumers have to pay the recycling fees when they return used appliances to retailers. Thus, in Japan, a payment-after-use system is adopted for the collection of the recycling fees.[3] This is in contrast to Europe where Directive 2002/96/EC on waste electrical and electronic equipment (WEEE) prescribes that consumers are able to return their used appliances free of charge.[4]

Why did the Japanese government decide to adopt the payment-after-use system, which may encourage illegal dumping? There are two attractive features about the payment-after-use system. First, households had been using a large number of electric appliances prior to the implementation of the recycling law. The payment-after-use system allows the collection of recycling fees for products that were sold before the passage of the law. Second, the usages periods of electric appliances are considerably long. During the usage periods, the collection cost and recycling process might change. The payment-after-use system can reflect the change in the economic

[2] The required rates of recovery by weight are 55% for televisions, 50% for refrigerators and washing machines, and 60% for air conditioners.

[3] Therefore, Japanese recycling program can be regarded as unit-based pricing, in which residents pay for waste management service per unit of waste discarded.

[4] This program is said to have adopted the concept of extended producer responsibility; each producer is responsible for financing the collection, treatment, recovery, and environmentally sound disposal of WEEE.

conditions and can tell the true social cost of recycling to consumers.

Most manufacturers in Japan charge identical fees for the recycling of home appliances. The recycling fees are 3,500 yen (29.2 dollars or 23.3 Euro) for air conditioners, 2,700 yen (22.5 dollars or 18.0 Euro) for televisions, 4,600 yen (38.3 dollars or 30.7 Euro) for refrigerators, and 2,400 yen (20.0 dollars or 16.0 Euro) for washing machines.[5] Consumers have to pay these recycling fees to retailers when they replace old appliances with new ones. They also have to pay transportation fees to ask the retailers to deliver used appliances to recycling plants. The transportation fees differ from retailer to retailer and depend on the size of the appliance.

Prior to the implementation of the new recycling law, municipalities (cities and villages) collected the four electric appliances under the category of “bulky garbage.”[6] Although some municipalities charged households a collection fee for the service of collecting bulky garbage, a majority of the charge were less than 1,500 yen (12.5 dollars or 10.0 Euro). When households purchased new appliances, they asked retailers to

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[5] We convert 120 yen (150 yen) into 1 dollar (1 Euro) in this paper. The company that transfers recycling of the product to another company charges a slightly higher recycling fee. Three companies charge 4,714 yen (39.3 dollar or 31.4 Euro) and one company charges 15,000 yen (125 dollar or 100 Euro) for air conditioners. Fifteen companies charge 5,569 yen (46.4 dollar or 37.1 Euro) and one company charges 5,670 yen (47.3 dollar or 37.8 Euro) for refrigerators. Five companies charge 3,444 yen (28.7 dollar or 23.0 Euro) for washing machines.

[6] In Japan, municipal solid waste is classified into household waste and business waste. Household waste can be further classified into general garbage and bulky garbage.

dispose of the used ones, for which most retailers charged between 1,000 yen (8.3 dollars or 6.7 Euro) and 2,000 yen (16.7 dollars or 13.3 Euro).[7]

In brief, the disposal fees of the four appliances have drastically increased since the implementation of the new recycling law. Overall, the disposal fees are more than doubled from the previous levels. A great deal of concern has been expressed about the increase in illegal dumping.[8] In October 2000, the central government increased the maximum penalty for the illegal dumping of municipal solid waste.[9]

In order to examine the situation, municipalities investigate the incidents of illegal dumping and report the results to the Japanese Ministry of the Environment. In Section 4, we use the dataset obtained from the Japanese Ministry of the Environment to evaluate the influence of community characteristics on illegal dumping. In order to tackle the illegal dumping problems, the municipalities introduced various countermeasures after the implementation of the recycling law. In section 5, we evaluate the effectiveness of these countermeasures.

Research on illegal dumping is extremely limited because data on the volume

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[7] See Yamaya (2000).

[8] In a survey by Japanese Ministry of the Environment, 95.1% of the local governments have expressed their concern to the central government (Japanese Ministry of the Environment 2002).

[9] At present, the maximum penalty for an individual who carries out illegal dumping is five years' imprisonment and/or a fine of ten million yen (83,333.3 dollars or 66,666.7 Euro). The maximum penalty for a company is a fine of one hundred million yen (833,333.3 dollars or 666,666.7 Euro).

or incidents of dumping are scarcely available. Sigman (1998) analyzes the frequency of used oil dumping in the United States. She shows that dumping is sensitive to the cost of legal waste management and the threat of enforcement. Although our research methodology is similar to her, there are several notable differences. First, this paper focuses on a different product, the used electric appliances. The incidents of illegal dumping of used electric appliances are identified more easily and are likely to be reported more frequently to the regulator as compared with those of used oil. Second, Sigman uses a state-level panel dataset, while we use a municipality-level panel dataset. Hence, our analysis can take into account the effects of community characteristics on illegal dumping more precisely. Finally, and most importantly, the agents who carry out illegal dumping are different in the two studies. Sigman analyzes illegal dumping carried out by commercial and industrial enterprises. On the other hand, the illegal dumping of electric appliances studied in this paper is mainly carried out by households.[10]

3. Illegal Dumping of Electric Appliances

Since 2001, the Japanese Ministry of the Environment has been conducting surveys that

[10] Mitsubishi Research Institute (2005) conducted the survey to several municipalities and asked them who carry out illegal dumping.

ask municipalities questions regarding the number of incidents of illegal electric appliance dumping. The report of the survey provides data on televisions, refrigerators, washing machines, and air conditioners that are dumped illegally in each municipality.[11]

As a proxy of the frequency of illegal dumping at household-level, we divide the number of illegal dumping incidents of four electric appliances from 2001 to 2003 by the number of residents.

There are 47 prefectures in Japan, each comprising municipalities (cities and villages). There were a total of 3,213 municipalities in Japan as of April 1, 2003. Unfortunately, several municipalities did not maintain a record of the illegal dumping incidents. As a result, the number of observations included in our dataset is reduced to 2,978.

Figure 1 shows the geographical distribution of the frequency of illegal dumping summed at the prefecture level. The figure suggests two characteristics of the data. First, the frequency of illegal dumping is larger in the prefectures along the Pacific coast, where the population densities are high. This result would imply that a used appliance might not be transported over a long distance until it is illegally dumped. Second, the frequency of illegal dumping increased between 2001 and 2003 in the

[11] The report only provides the summary statistics. We requested the Ministry of the Environment of Japan for offering municipality-level data on illegal dumping.

average prefecture. However, the change in the number of illegal dumping varies among prefectures. In some prefectures, such as Ishikawa Prefecture, the frequency of illegal dumping actually decreased.

Table 1 reports the descriptive statistics of illegal dumping. This table shows that, on an average, 1.396 incidents of illegal dumping are reported per 1,000 residents in a municipality. The variation in the frequency of incidents is large. In some municipalities, illegal dumping incidents are simply not found. The highest number of incidents in a municipality is 103.333 incidents per 1,000 residents.

Among the four appliances that are dumped, televisions constituted the largest group. The average frequency of dumping televisions is 0.744. Thus, television dumping incidents account for more than half of the dumping incidents of all the four electric appliances. This result is reasonable when one considers that most Japanese households own only one refrigerator and one washing machine, while some Japanese households own two or three televisions.[12] Moreover, it is considerably easier to dump televisions than other appliances because televisions are usually smaller and lighter than the other three appliances.

[12] We provide the relevant statistics in the next section.

4. Data

4.1. Explanatory Variable

To investigate the determinants of illegal dumping, we use the frequency of it as a dependent variable and explain its variation by variables that can be summarized into three categories: the expected number of used electric appliances, the cost of legal disposal, and the cost of illegal dumping. We will discuss the variables in three categories below.

4.2. Expected Number of Used Electric Appliances

It is ideal to use the number of appliances that are expected to be removed in each municipality as a control variable. Unfortunately, the data on the number of waste electric appliances is not available. We assume that the lifespan of electric appliances is roughly the same across municipalities and then use the number of electric appliances possessed in each municipality as a control variable.

The Statistics Bureau of Japan undertakes the National Survey of Family Income and Expenditure every five years. In this survey, the number of major durable goods that households possess is estimated. All four electric appliances (televisions, refrigerators, washing machines, and air conditioners) are included in this survey. We employed the 1999 survey data to represent the potential for generating used electric appliances. The summary of this survey is reported in Table 1 along with the descriptive statistics of other covariates.

Unfortunately, the survey is conducted at the prefectural level. To take into account the difference in the number of used electric appliances at the municipality level, we include income variable. The households in high-income municipalities will possess more electric appliances and will purchase new ones more frequently. Thus, it is expected that the generation of used electric appliances is higher in municipalities with a high-income population.[13]

4.3. Cost of Legal Disposal

Households take used electric appliances to a retailer or ask the retailer to collect them. They pay recycling and transportation fees to the retailer. The retailer has to take the used appliances to the collection depot. As we explained in the previous section, most manufacturers charge identical recycling fees. In contrast, the transportation fee varies among retailers. Unfortunately, the data on transportation fees is not available. We estimate the distance from each municipality to the nearest collection depot and use it as

[13] The source of income data is Kojin Shotoku Shihyo (Nihon Marketing Kyoiku Center 2000).

a proxy for the transportation fee. The longer the distance to the nearest depot is, the higher the transportation cost will be. Hence, we expect that the frequency of dumping will increase as the distance increases.

We used Logistica Truck II to estimate the distances. It is the software popularly used among Japanese transportation companies and shows the shortest path to the destination. It includes the road map inside and simulates the distance between two locations. Both Group A manufacturers and Group B manufacturers have 190 collection depots. For each group, we estimated the distance between a municipality and all 190 collection depots.[14] Then we found the nearest collection depot for each municipality. For the municipalities that have collection depot within their boundary, we assume the distance is zero.[15] The average distance to the nearest collection depot of Group A is 25.267 km and that of Group B is 23.914 km.

The financial burden of the legal disposal cost depends on the income level of the household. For high-income households, the financial burden is not significant. For low-income households, the financial burden is high. Income increase reduces illegal dumping in this respect, while it increases the expected number of used appliance as

[14] We use the location of the town hall as the starting point in this distance estimation.
[15] The distance of zero does not accurately reflect transportation costs of 190 municipalities which have the collection depot within their boundaries. However, the basic findings of our analysis still remain the same even if these 190 municipalities are removed from the dataset.

examined in the previous section. The net impact of income increase on illegal dumping incident is thus an empirical question.

Retailers can refuse to collect certain products, such as a product that was manufactured by liquidated companies. Some municipalities collect these orphan products as a public service. The provision of the public collection service reduces the disposal cost. We include a dummy variable for the availability of the public collection service. This data is taken from the survey by the Ministry of the Environment.

4.4. Expected Cost of Illegal Dumping

The expected cost of illegal dumping depends on the detection probability of illegal dumping and the application of the penalty. The penalty is basically determined by national law and is uniform across the municipalities. In the remaining analysis, we will only focus on the difference in the detection probability.

To measure the general enforcement level of a municipality, we use the arrest rate of the criminal offences. The source of the data is Keisatsu Hakusho (National Police Agency 2000). It may be costly to conduct illegal dumping in the community with a high arrest rate. We expect a minus sign for the coefficient.

The local labor market condition often influences the incident of crime. While considering this issue, we include the unemployment rate in the analysis. We expect that an increase in the unemployment rate will lead to an increase in illegal dumping. We use the unemployment data obtained from the population census.

4.5. Community Participation

The previous studies examine whether environmental outcomes are influenced by collective action of community residents. They argue that communities protect local environment when their residents take a collective action against polluting facilities.

Hamilton (1995) examined whether the share of the minority population in a local community influenced the environmental outcome in the United States. He concluded that the capacity expansion decision of commercial hazardous facilities is not explained by the share of the minority population, but by the estimated voting rate. Hence, he argued that collective action explains the relationship between race and environmental conditions.

Pargal and Mani (2000) examined the effects of community action on the location choice of industrial plaints in India. They argue that the residents in the states with high political participation are more likely to organize to pressure the plants to improve environmental conditions. Their results show that the voting rate influences the location decision of the industrial plants.

Earnhart (2004) studied the compliance level of municipal wastewater treatment facilities in Kansas, the United States. He found that community characteristics influenced the compliance level even after he controlled for enforcement by the government.

All of the above studies suggest that community characteristics may affect the level of point-source pollution through collective action. However, it is unclear if the characteristics can contribute to prevent mobile-source pollution such as illegal dumping. We assume that community residents act like a member of a vigilance committee in order to protect their property from illegal dumping.[16]

In order to examine the impact of community participations, we include two kinds of variables in the analysis. The first variable is a proxy of collective action. The residents in the community that has a strong collective action may watch their neighborhood cooperatively. Following Hamilton (1995), Brooks and Sethi (1997), and Pargal and Mani (2000), we include voter turnout. It is expected that a higher voter turnout leads to the higher collective action, and thus results in a lower frequency of illegal dumping. We use the data on the proportion of the voting-age population that

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[16] In fact, such neighborhood watch program is considered as the oldest and most effective crime prevention program. For example, National Sheriffs' Association of the United States has sponsored the program since 1972 .

voted in the 1998 House of Councilors' Election; this data is sourced from the Network Democracy Forum (2002).

The second kinds of variables are community support variables. People tend to dump their used appliance at the site where a used appliance has already been dumped before. Therefore, it is important to find dumping incidents at an early stage. Municipalities ask various organizations to assist their monitoring and patrol programs. These organizations include local residents, the post office, taxi companies, and the police. The Japanese Ministry of the Environment conducted a survey on the community support programs. Table 2 summarizes the results of this survey.

5. Determinants of Illegal Dumping

5.1. Empirical Model

The number of the illegal dumping incidents is zero in many municipalities. Therefore, we employ Tobit model for the evaluation of the determinants of illegal dumping:

$$y_i = \alpha + \boldsymbol{\beta}\mathbf{X}_i + u_i \qquad \text{if } RHS > 0$$

$$y_i = 0 \qquad \text{otherwise.}$$

y_i is the number of illegal appliance dumping incidents per 1,000 residents.[17] Since

[17] We initially employed simple Tobit models. We then found that the size of the residual decreases as the municipality population increases. To resolve this

most explanatory variables of $\mathbf{X}_i$ are the data of the single year, we apply the dumping incidents in 2003 for explained variable.[18]

5.2. Results

Group A's designated collection depot is often located in the municipality where Group B's designated collection depot is located. To avoid a multicolinearity problem, we ran two separate models: one with the distance to the Groupd A's nearest collection depot included as an explanatory variable, another with the distance to the Groupd B's nearest collection depot included as an explanatory variable. Although the parameter values are slightly different, we obtain very similar results in two models. To shorten the paper, we only report the result of Group A in Table 3.

The first column shows the result when the total number of illegal dumping incidents of all four electric appliances is taken as a dependent variable. The remaining four columns show the results when the dumping incident of the specified electric appliance is taken as a dependent variable.

All coefficients for transportation cost variables take positive signs and it is statistically significant when refrigerator and washing machine are used for a dependent

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heterogeneity problem, we corrected the covariance matrix by utilizing population as a weighting variable.

[18] We use 2003 data since the number of the data is the largest.

variable. This implies that the frequency of illegal dumping increases as the transportation cost increases. The frequency of illegal dumping is lower in municipalities where public collection services are provided. The collection services in these municipalities are likely to reduce the disposal cost for household. The results of transportation cost and public collection support the economic theory discussed in the previous literature: the frequency of illegal dumping incident increases as the legal disposal cost rises.

The increase in income has a negative impact on the number of illegal dumping incidents in the four models. As discussed earlier, the income increase produces two counter effects. While wealthy households may generate more used electric appliances, they may dispose of them appropriately. The result suggests that the latter factor is significant.

The clearance rate influences the frequency of illegal dumping. The minus sign for the coefficient of this variable supports our expectation. Municipalities with a high clearance rate have a high enforcement level. Therefore, the cost of carrying out illegal dumping may be high in such municipalities. We find that the frequency of illegal dumping is lower in such municipalities. We also find that an increase in the unemployment rate has a positive impact on illegal dumping. Illegal dumping occurs in municipalities with a higher unemployment rate.

If voter turnout measures the level of collective action, then we expect that a higher voter turnout results in a lower frequency of illegal dumping. However, based on the estimation result, the contribution of voter turnout to the reduction of illegal dumping is modest. In contrast, the coefficients for resident support are statistically significant in the three models. Further, the sizes of the coefficients are large. The results imply that the participation of community residents is important for the prevention of illegal dumping.

6. Effectiveness of Community Support Programs

6.1. Empirical Model

The analysis in the previous section ignores the endogeneity of community support programs against illegal dumping. The municipalities with higher frequency of illegal dumping are more likely to ask their residents to assist monitoring and patrol activities. Therefore, we may have overestimated the effectiveness of community support programs in the previous section.

In this section, we examine whether community support curbs the increase in illegal dumping. In Section 2, we showed that the frequency of illegal dumping increased between 2001 and 2003 on average. If community support program is effective, the municipality that adopts the program experiences the lower growth of illegal dumping.

We want to evaluate the effectiveness of community support programs by the maximum likelihood technique. Let Δy_i denote the change in the illegal dumping incidents per 1,000 residents between 2001 and 2003. Z_i^{2001} is the dummy variable that takes 1 if a specific support program was available in 2001. $\mathbf{X}_i^{2001}$ is the vector of other community characteristics. Then we want to maximize the likelihood function of $\ln L(\beta) = \sum_i f\left(\Delta y_i \middle| Z_i^{2001}, \mathbf{X}_i^{2001}, \boldsymbol{\beta}\right)$. Here, $f(\cdot)$ is the probability density function that the change in the illegal dumping incidents becomes Δy_i. $\boldsymbol{\beta}$ denotes the vector of the parameters.

The range of Δy_i depends on the initial level of illegal dumping. Suppose that the number of illegal dumping incidents per 1,000 residents in 2001 is 3. Then, $\Delta y_i \geq -3$, since the number of illegal dumping incidents cannot be minus. To take the range of the illegal dumping reduction into account, we estimate the following likelihood function:

$$\ln L(\beta) = \sum_i I_0 \cdot F\left(0 \middle| Z_i^{2001}, \mathbf{X}_i^{2001}, \boldsymbol{\beta}\right) + \sum_i I_1 \cdot f\left(\Delta y_i \middle| Z_i^{2001}, \mathbf{X}_i^{2001}, \boldsymbol{\beta}\right).$$

I_0 and I_1 are the index variables. I_0 (I_1) takes 1 if the number of illegal dumping is

0 (positive) and takes 0 if the number of illegal dumping is positive (zero). The first term on the right hand side of the equation corresponds to the case when the number of illegal dumping incidents in 2003 is zero. $F(\cdot)$ is the cumulative density function and measures the probability that the number of illegal dumping incidents in 2003 becomes non-positive. In contrast, the second term corresponds to the case when the number of illegal dumping incidents becomes positive.

Since the likelihood function is a complicated form, we only include four control variables in the estimation; income, transportation cost, clearance rate, and unemployment rate.

6.2. Results

Results are shown in Table 4. The coefficient for voter turnout takes negative sign and it is statistically significant. If this variable represents the level of collective action as noted in the previous section, then the result implies that collective action curbs the increase in illegal dumping.

We find that the growth of illegal dumping is lower in the community where community support program was available in 2001. It implies that the surveillance and report systems established in cooperation with the local residents and post offices and/or taxi companies contribute to the reduction of illegal dumping.

The coefficient for the income variable is positive in this model. This is in contrast with Table 3, where we observed a minus sign for the variable. The growth of illegal dumping is higher in high-income communities, but its absolute frequency is lower.

The signs for clearance and unemployment rates are the same as those in Table 3. Therefore, the situation of illegal dumping has been further aggravated in the municipality whose enforcement's ability is weak.

7. Conclusions

In this study, we have used unique dataset and have analyzed the relationship between illegal dumping and community characteristics. We find that the frequency of illegal dumping is well explained by socioeconomic conditions of the community. The frequency of illegal dumping increases as the disposal cost and decreases as the cost of illegal dumping rises.

The previous papers suggest that community action functions as an informal regulation against polluting facilities when formal regulation is weak. The result of our study shows that this is also significant for the prevention of illegal dumping.

Introducing active community participation can be helpful policy instruments especially when formal regulation is difficult and costly.

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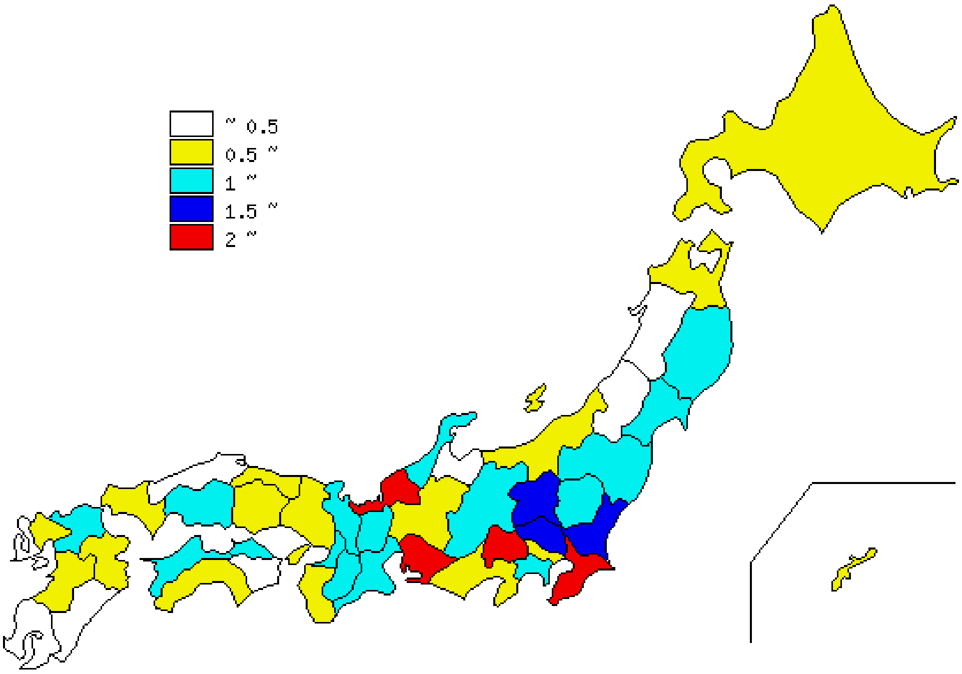

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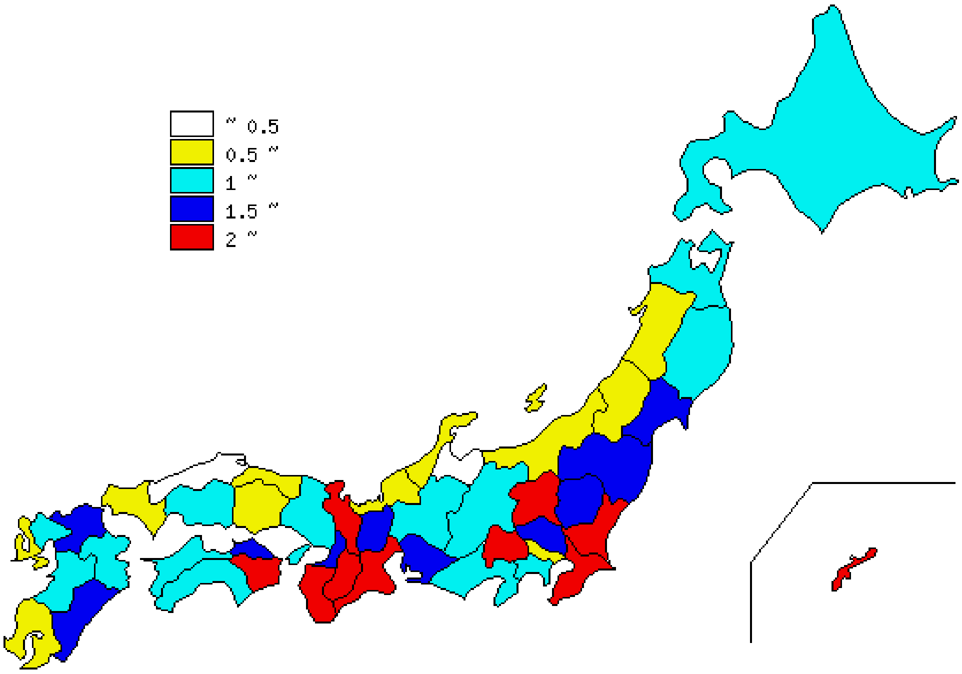

Year 2003

Figure 1. Nubmer of Illegal Dumping Incidents per 1,000 Residents

Table 1.
Descriptive Statistics

	Units	Data Level	Year	Mean	Std[a]	Min	Max
Number of illegal dumping incidents per 1000 residents							
All Four Appliances	Cases	Municipality	2001-03	1.396	2.794	0	103.333
Air Conditioner	Cases	Municipality	2001-03	0.099	0.310	0	12.4242
Television	Cases	Municipality	2001-03	0.744	1.363	0	47.7778
Refrigerator	Cases	Municipality	2001-03	0.300	0.793	0	34.0776
Washing Machine	Cases	Municipality	2001-03	0.253	0.723	0	33.3333
Number of appliances owned per 1000 residents							
All Four Appliances	Units	Prefecture	1999	6679.865	1014.776	4345.000	8528.000
Air Conditioner	Units	Prefecture	1999	1856.323	781.984	109.000	2971.000
Television	Units	Prefecture	1999	2367.553	281.985	1454.000	2978.000
Refrigerator	Units	Prefecture	1999	1333.374	107.571	1144.000	1542.000
Washing Machine	Units	Prefecture	1999	1122.615	57.114	1031.000	1265.000
Income	Million Yen	Municipality	2002	3.112	0.439	2.239	8.002
Unemployment Rate	%	Municipality	2000	3.838	1.569	0.000	15.782
Arrest Rate	%	Prefecture	2000	27.558	8.122	14.400	48.800
Voter Turnout	%	Municipality	1998	66.574	9.430	35.480	98.150
Group A	Km	Municipality	2005	25.267	17.988	0	141.902
Group B	Km	Municipality	2005	23.914	16.705	0	140.454

Note. [a]: Standard deviation

Table 2.

Community Support Programs (N = 2911[a])

Supporter	Percentage of municipalities with community support	
	Year 2001	Year 2003
Resident	27.55%	31.60%
Post Office and Taxi Companies	23.15%	40.43%
Police	14.36%	16.45%

Note. a. The data of illegal dumping incidents of 2,911 municipalities are available both in 2001 and 2003. Therefore, we use the data of 2,911 municipalities for the time series comparison.

Table 3.

Determinants of Illegal Dumping of Appliances: Group A Result (N = 2978)

Variables	All Four Appliances	Air Conditioner	Television	Refrigerator	Washing Machine
Constant	2.2596***	−0.1614*	2.5666***	−0.0169	0.1082
	(0.5350)	(0.0864)	(0.3301)	(0.1873)	(0.2140)
Expected Number of Used Electric Appliances					
Number of Appliances [a]	8.27E-05**	1.08E-04***	−1.68E-04**	2.62E-04***	3.95E-04***
	(3.51E-05)	(8.94E-06)	(6.79E-05)	(8.41E-05)	(1.39E-04)
Income	−0.2652***	−0.0040	−0.2296***	0.0315***	−0.0028
	(0.0568)	(0.0108)	(0.0300)	(0.0157)	(0.0142)
Disposal Cost					
Transportation Cost[a]	0.0068**	0.0000	0.0018	0.0014**	0.0011**
	(0.0025)	(0.0005)	(0.0013)	(0.0006)	(0.0006)
Public Collection	−0.1161*	−0.0702***	−0.0590*	−0.0113	−0.0014
	(0.0631)	(0.0115)	(0.0323)	(0.0158)	(0.0149)
Expected Cost of Illegal Dumping					
Clearance Rate	−0.0487***	−0.0061***	−0.0194***	−0.0143***	−0.0124***
	(0.0041)	(0.0008)	(0.0021)	(0.0010)	(0.0010)
Unemployment Rate	0.1931***	0.0653***	0.0098	0.0717***	0.0494***
	(0.0230)	(0.0042)	(0.0133)	(0.0064)	(0.0057)
Community Participation					
Voter Turnout	−0.0033	−0.0013	−0.0038	−0.0022	−0.0039***
	(0.0052)	(0.0010)	(0.0027)	(0.0013)	(0.0013)
Resident Support	−0.1398**	−0.0106	0.0022	−0.0746***	−0.0599***
	(0.0639)	(0.0117)	(0.0333)	(0.0161)	(0.0152)
Post Office and Taxi	0.0062	0.0221*	0.0050	0.0027	-0.0002
Companies Support	(0.0608)	(0.0113)	(0.0317)	(0.0154)	(0.0145)
Police Support	0.0937	0.0385**	0.0311	0.0119	0.0030
	(0.0764)	(0.0138)	(0.0397)	(0.0191)	(0.0180)

Table 3.

Continued

Sigma	1.4648***	0.2624***	0.7617***	0.3672***	0.3447***
	(0.0194)	(0.0038)	(0.0102)	(0.0050)	(0.0047)
Log Likelihood	−5287.9140	−511.7011	−3401.7000	−1339.5070	−1169.9890

Note. The numbers in parentheses indicate standard errors.

* Significant at the 10% level ** Significant at the 5% level *** Significant at the 1% level

a E-07 = A × 0.0000001, A E-08 = A × 0.00000001.

Table 4.

Effectiveness of Community Support Programs: Group A Result (N = 2911[a])

Variables	Resident Support	Post Office and Taxi Companies Support	Police Support
Community Participation			
Voter Turnout	−0.003***	−0.003***	−0.003***
	(0.001)	(0.001)	(0.001)
Community Support Programs	−0.090***	−0.224***	−0.166
	(0.031)	(0.023)	(0.141)
Other Community Characteristics			
INCOME	0.117***	0.140***	0.116***
	(0.019)	(0.019)	(0.018)
Transportation Cost [b]	−3.703E-04***	−2.902E-04***	−3.759E-04***
	(1.051E-04)	(1.040E-04)	(1.050E-04)
Clearance Rate	−0.004***	−0.004***	−0.004***
	(0.002)	(0.002)	(0.002)
Unemployment Rate	0.072***	0.078***	0.072***
	(0.007)	(0.007)	(0.007)
Log likelihood	−7925.126	−7911.529	−7925.920

Note. The numbers in parentheses indicate standard errors

* Significant at the 10% level ** Significant at the 5% level *** Significant at the 1% level

a. The data of illegal dumping incidents of 2,911 municipalities are available both in 2001 and 2003.

b E-07 = A × 0.0000001, A E-08 = A × 0.00000001.