The Determinants of the Municipality's Decision to Implement Recycling in Japan: Socio-Economic and Technological Factors

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Introduction

In Japan, a recycling-based society has been promoted owing to the shortage of landfill sites for waste disposal during the past decade. The Japanese government has encouraged reduction, reuse, and recycling of waste with the slogan "3R" under the Basic Law for Establishing a Recycling-based Society.

Along with this slogan, several recycling laws have been enacted and various policies implemented in Japan. Among them, the Containers and Packaging Recycling Law enacted in 1997 seems to be the most important, because containers and packaging waste accounts for a large share of the emitted waste with respect to cubic capacity. The types of containers and packaging designated by this law include glass containers, PET bottles, paper containers and wrapping, and plastic containers and wrapping. According to the law, municipalities are required to collect and store recyclable containers and packaging material that households have separated from solid waste.

However, the law is non-binding in nature; thus, the collection of each type of recyclable containers and packaging is done at the discretion of the municipalities. Some municipalities do not provide collection services for these recyclables.

Why do some municipalities recycle while others do not? Few studies have investigated the determinants of the municipality's decision to collect recyclables.

Objectives

To examine the factors affecting a municipality's decision to implement the collection of already sorted recyclable containers and packaging in Japan.

Our study differs from the prior studies in the following three respects:

1. we use a panel data at the municipal level, which enables us to analyze the behavioral characteristics of each municipality more accurately;
2. we investigate the municipality's decision to provide collection service for each type of recyclable containers and packaging, while the other studies looked at recyclables as a whole; and
3. we examine technological as well as socioeconomic factors. whereas other studies mainly looked at cost-benefit relations.

For further information

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Models

$$y^* = \begin{cases} B(\cdot) - C(\cdot) > 0 \rightarrow y = 1 \\ B(\cdot) - C(\cdot) < 0 \rightarrow y = 0 \end{cases}$$

where y^*: a latent variable:
If the net benefit is positive and a municipality starts collecting recyclables.

We estimate the following model, applying the random-effects probit model proposed by Guilkey and Murphy (1993):

$$y_{s,it} = \beta_s x_{s,it} + \gamma_s z_{s,it} + v_{s,i} + \lambda_{s,t} + \varepsilon_{s,it}$$

where
$y_{s,it}$: binary choice of 0 and 1 of i'th municipality, t year, and s type of container and packaging collection;
x : technology vector;
z : the demographic of the municipality;
v and λ: cross sectional invariance and time invariance, respectively;
ε : an error term

Dependent Variables

- Dummy variables: 1 if municipalities collect a certain type of presorted recyclable or collect commingled recyclables and then sort them sort them according to their type. 0 otherwise.
- 6 types of recyclables
  - *Dbottle* (glass bottles)
  - *Dmetal* (cans)
  - *Dpet* (PET bottles)
  - *Dpapercon* (paper containers and wrapping)
  - *Dplacon* (plastic containers and wrapping, excluding PET bottles and white trays)
  - *Dwhitetray* (white trays)

incombustible ↕ combustible

Independent Variables

- **Socio-economic factors**
  - Waste generation per capita per year (w)
  - Rate for under 15 years of age *(Ratio of under 15)*
  - Rate for over 65 years of age (*Ratio of over 65*)
  - Average taxable gain per capita (million yen) (*Income*)
  - Average household size (*HHsize*)
  - Population density (person per km^2) (*Popd*)
- Year dummy
- Waste technological factors
  - Landfill
    - Remaining landfill capacity per capita (m^3) (*landfillpop*)
    - A municipality possesses landfill sites? (*Dlandfill*)
    - A municipality shares landfill sites with regional affairs association? (*Dcommonlandfill*)

Ownership types of landfill sites: self or joint?

  - Types of incineration facilities
    - Stoker furnaces (*Dstoker*)
    - Fluidized bed furnaces (*Dfluide*)
    - Waste power generation (D_{EPG})
    - Percentage of waste generation collected by entities directly run by municipalities (*Ratio of public sector*)

importance of combustion efficiency

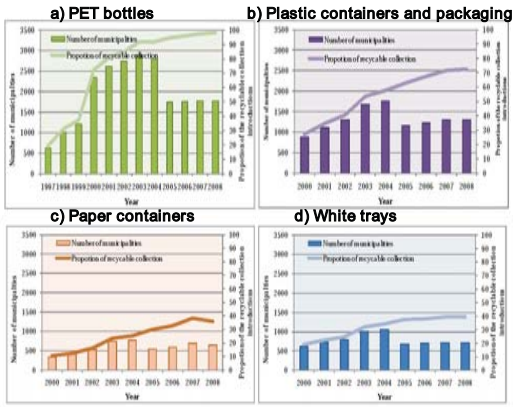
  - RDF (Refuse Derived Fuel) facilities (D_{RDF})

Plastics and paper are required

Data

- Balanced panel
- 2000 - 2002 (Three years) (To avoid the influence of large-scale merging of municipalities in 2003)
- 2508 municipalities

Figure 1. The ratio of the number of municipalities that have introduced collection or separation of a) PET bottles; b) plastic containers and packaging; c) paper containers; and d) white trays per year.



Sources: Ministry of the Environment (2006)

Results

Table 1. Estimation results of Random effects probit model

Variables	(1) *Dbottle*	(2) *Dmetal*	(3) *Dpet*	(4) *Dplacon*	(5) *Dpapercon*	(6) *Dwhitetray*
D_{EPG}	0.656**	0.129	0.932**	-0.486	-0.116	-0.495
Dstoker	-0.154	-0.155**	-0.0513	-0.532**	-0.433**	0.028
Dfluide	0.490*	0.374***	0.830**	-0.311	-0.1	-0.0315
D_{RDF}	0.651	0.327*	-0.652	-5.846***	-3.758	-1.003
Ratio of public sector	-0.740***	-0.516***	-1.268***	-0.697***	-0.859***	-0.398
ln (w)	-0.528**	-0.0293	-0.39	-0.358*	-0.055	0.087
ln (*landfillpop*)	0.0410*	0.121***	0.0821**	0.074***	0.006	0.039
Dcommonlandfill	-0.458*	-1.122***	-1.809***	-1.200***	-0.706***	-1.050***
Dlandfill	0.633**	0.618***	1.424***	1.213***	0.622**	0.889**
ln (*Income*)	0.503	-0.193	2.607***	3.078***	1.551***	1.281**
ln (*Popd*)	0.102	0.162***	0.172	0.091	0.004	0.011
ln (*HHsize*)	-0.537	-0.0203	-3.651***	-0.122	-1.738***	-1.956**
Ratio of under 15	-0.074	-0.0558***	-0.016	0.0804	0.101*	-0.038
Ratio of over 65	-0.0319	-0.0213***	-0.0208	0.038	0.046*	0.00037
Year 00 (benchmark)	-	-	-	-	-	-
Year 01	0.431***	-0.066	1.007***	0.872***	0.0974	0.590***
Year 02	0.852***	-0.0363	1.763***	1.842***	0.777***	1.061***
Constant	2.666	3.215***	-3.376	-7.819***	-8.995***	-9.337***

Discussion and Conclusions

Whether or not municipalities recycle containers and packaging is likely to depend on if they own incineration facilities, and how scarce the remaining landfill capacity is.

- Random effects probit vs. Pooled probit
  - ➢The Log Likelihood tests showed that the random-effects probit model was more effective.
  - ➢We could control unobservable and time-invariant individual effects by municipalities, which provided an accurate estimation using the available panel data.
- **Incineration and power generation**
  - ➢Municipalities using waste power generation did not show a high probability of collecting and separating recyclable containers.
  - ➢Municipalities with stoker furnaces were less likely to collect and separate recyclable containers and packaging with higher combustibility.
- **RDF (Refuse Derived Fuel)**
  - ➢Municipalities having RDF facilities showed a lower possibility of collecting and separating plastic containers. This seems to be because plastic containers are particularly suitable materials for RDF, and municipalities would rather use them to maintain their RDF facilities than collect and separate them.
- **Landfill**
  - ➢Municipalities that had their own landfill sites showed a higher probability of collection and separation than those that did not possess landfills.
  - ➢Municipalities that shared landfills with other municipalities showed a lower probability of collection and separation.
  - ➢The scarcity signal of remaining landfill capacity could encourage municipalities with their own landfill sites to reduce landfill waste by keeping recyclables out of landfills. However, even with the scarcity signal, municipalities sharing landfills with other regional association might take no countermeasures.

Reference: Guilkey D.K and Murphy J.L (1993) "Estimation and Testing in The Random Effects Probit Model," *Journal of Econometrics, 59(3), 301-317.*