

# Estimating the impact of waste pricing programs on waste reduction

- Using MTE analysis

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## 1. Introduction

Solid waste disposal is social and environmental problems. More and more solid waste is thrown away and the amount of solid waste is expected to increase to 3.40 billion tons by 2050 due to increased consumption associated with economic growth. Moreover, the solid waste disposal is a fiscal burden of local community (Kaza et al., 2018).

Corresponding to these issues, this paper investigates the waste reducing effect of the Pay-As-You-Throw program (PAYT) that requires households to pay for non-recyclable waste and has been implemented to reduce the non-recyclable waste and the fiscal burden of governments.

Although the waste reduction effect of PAYT has been observed in many existing studies (e.g., Usui and Takeuchi, 2014), it has not yet been investigated whether the waste reduction effect of PAYT can be observed in municipalities that have not yet implemented PAYT. Given that those municipalities that have already adopted PAYT should have self-selected into PAYT in anticipation of its effect, it is natural to imagine that the effect of PAYT on municipalities that have adopted PAYT is not the same as on those that have not. In this sense, the effect of PAYT on waste reduction depends on self-selection into the adoption of PAYT, and the propensity to self-select will cause the heterogeneity in the effect of PAYT.

## 2. Data and Method

To address heterogeneity in treatment effects due to differences in the propensity to self-selection, we estimate the waste reducing effect of PAYT using the estimation of the marginal treatment effect (MTE) analysis. The MTE is an estimate that can be interpreted as the average treatment effect for the subject who is indifference for the treatment with a given propensity score (Brinch et al., 2017) and is estimated using an instrumental variable (IV) that affects the selection of treatment, not the outcome. Since municipalities where the adoption of PAYT is expected to have the greatest benefit should have the high propensity score for the treatment, estimating the MTE for each propensity score tells us whether the estimated effect on such municipalities has external validity for the municipalities with different propensity scores.

To estimate the MTE of PAYT on the amount of waste, we use the fiscal indices of local governments as IVs, exploiting the fact that the fiscal situation of each local government should

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affect the adoption of PAYT due to the revenue from PAYT, but should not directly affect household waste generation. It is known from the literature on fiscal stress labeling that residents' behavior does not change when the fiscal situation of the municipality deteriorates unless such fiscal situation is clearly and explicitly published (e.g., Thompson, 2016), while waste management costs represent a significant financial burden for the municipality. In this sense, controlling for covariates such as income level, and fiscal stress label, the fiscal situation of municipalities should satisfy the exclusion restriction on waste volume. Moreover, given that PAYT generates revenue from waste pricing and reduces waste management costs by reducing waste, municipalities with weak fiscal positions should have a high propensity to adopt PAYT.

For the estimation, we use the panel data of 1694 municipalities in Japan from 2008 to 2019.

### **3. Result of the analysis**

Our MTE analysis shows that there is large heterogeneity in the treatment effect for municipalities with different propensity scores, and that the waste reduction effect on non-recyclable waste is relatively small for municipalities that are reluctant to adopt PAYT, although the result shows that the adoption of PAYT reduces non-recyclable and total waste and increases recyclable waste in most municipalities.

In addition, we derive the waste reduction effect of PAYT in terms of several estimates such as average treatment effect (ATE), ATE on the treated (ATT), and ATE on the untreated (ATUT) from MTE. We also find that while the estimated effects are qualitatively the same across all estimands, the effect of PAYT is larger in terms of ATT than ATUT, i.e. the effect is larger in municipalities that have already introduced PAYT than in those that have not.

### **4. Conclusion**

Our estimation shows that the expected waste reduction effect of PAYT is not as large for the municipalities that have not yet adopted PAYT as for the municipalities that have adopted PAYT, even though PAYT has reduced the total amount of waste and the revenue from PAYT is expected. This result suggests that there is a self-selection bias to adopt PAYT, which brings the heterogeneous effect of PAYT on waste reduction along with the reluctance to adopt PAYT.

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