The Intended and Unintended Consequences of Taxing Waste

Tommaso Colussi [1], Matteo Romagnoli [2] and Elena Villar [3]

[1]Università Cattolica del Sacro Cuore, IZA, and fRDB

[2]Università degli Studi di Milano-Bicocca

[3]Università Cattolica del Sacro Cuore

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What we do

- We estimate the economic and environmental consequences of the adoption of Pay-As-You-Throw (PAYT) taxation schemes
  - → PAYT charges households on the basis of the amount of unsorted waste they produce
- We use a newly-constructed longitudinal dataset of Italian municipalities over the 2010-2019 period
- We exploit the staggered adoption of PAYT across localities over time (stacked-by-event DiD)
- We look at a variety of outcomes:
  - Intended effects: waste outcomes (sorted, unsorted, total)
  - Unintended effects: other environmental outcomes not targeted by the policy and pro-environmental attitudes

Motivation

- Limiting the environmental impact of waste production is a key policy challenge
  - Municipal solid waste (MSW) represents the forth largest supplier to global emissions of greenhouse gases (GHGs)
  - Global MSW is 2.24 billion tonnes and it is expected to increase by **73%** in **2050**
- Several countries have promoted policies that stimulate recycling, limit the use of land-filling, and incentivize responsible consumer behavior
- A potentially effective policy tool to achieve these goals is represented by PAYT waste taxation

Contribution

- Extensive literature on the effectiveness of PAYT in reducing waste (Fullerton & Kinnaman, 1996; Bucciol et al. 2015; Valente 2022).

$\Rightarrow$ New Data, strategy, and evidence on consumption behavior!

- Crowding out intrinsic motivation of pro-environmental behavior (Benabou & Tirole, 2003)

$\Rightarrow$ Spillover effects on environmental attitudes and outcomes not directly targeted by PAYT

Outline

PAYT in Italy

Data

Identification

Empirical Analysis

Conclusions

PAYT

- Italy has recently witnessed an increase in the number of municipalities that adopt PAYT taxation schemes (*Tarip*)
- These programs establish a direct link between costs and users' behavior towards waste production
- Under PAYT, the costs of waste management are covered by:
  - Flat fee: identical for all users or determined according to specific parameters
  - Variable fee: computed according to the amount of unsorted waste presented for collection
- The production of unsorted waste is generally measured in terms of frequency (number of emptying) or mass (Kg of waste)

PAYT implementation

- Municipalities tend to follow guidelines of the European Union when deciding to adopt PAYT

1. Defining the right balance between fixed and variable fee (e.g. 40% in Treviso)
2. Measurement of waste at the individual user level (to avoid free-riding)
3. The engagement of residents to ensure a correct understanding of the policy and its environmental benefits

→ “If the environmental awareness is low, information campaigns are required""

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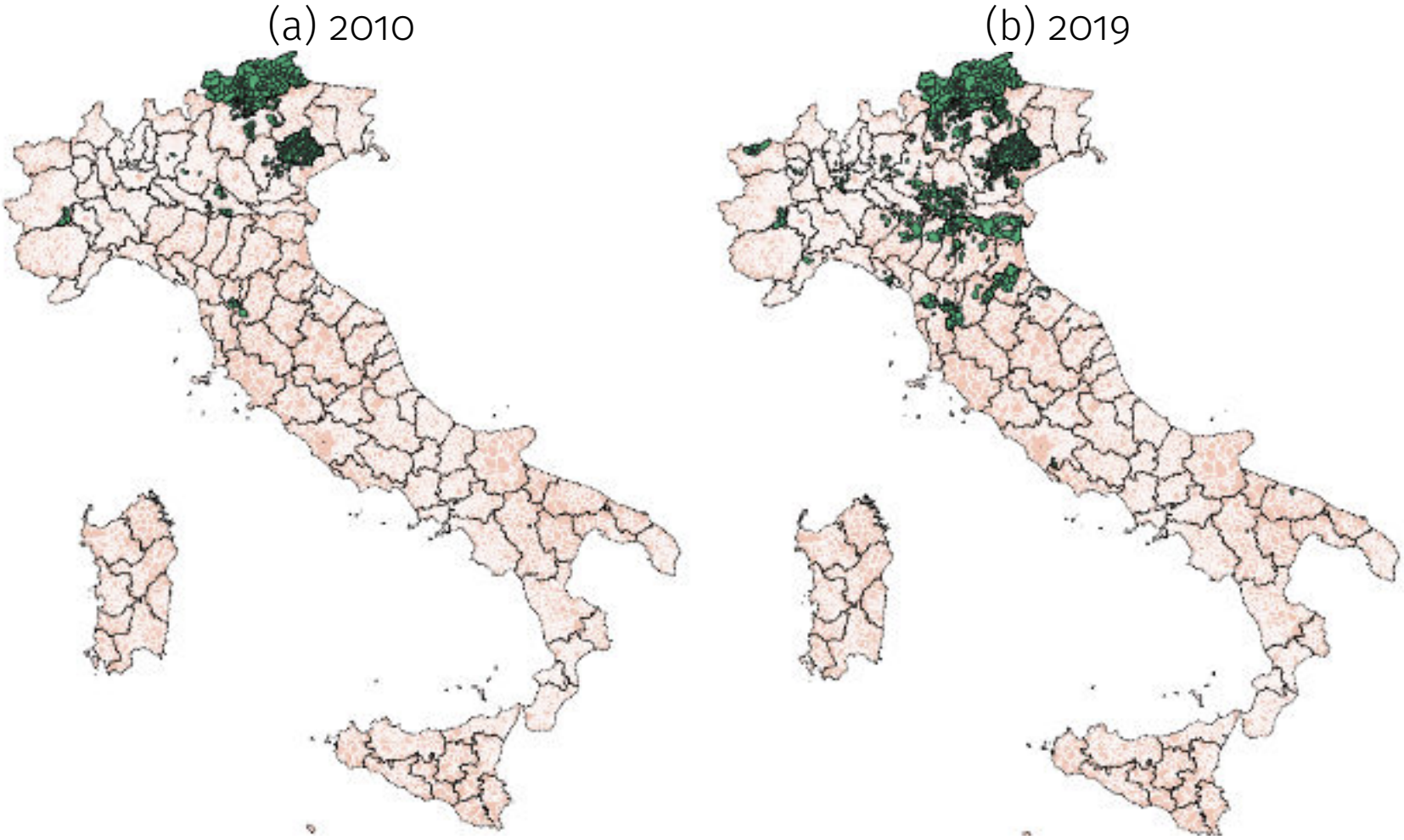
Data I

- Municipality-level dataset from **2010** to **2019**: PAYT adoption and year of policy introduction
- Waste outcomes: waste production (total, unsorted, sorted by material)
- Municipal characteristics: population size, income, extension area, household size (ISTAT)
- Household consumption: survey of consumption of Italian households (2010-2019 - ISTAT - Adele)

Data II

- Environmental outcomes
  - Number of vehicles classified by EU emission standards at the municipal level (ACI)
  - Geographical distribution and power capacity of solar panels across municipalities (GSE)
- Attitudes about the environment and climate change at the municipality level (IPSOS Polimetro)

PAYT in Italian municipalities



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Stacked-by-Event DiD

- Our design compares municipalities that are treated earlier with municipalities that are treated later:
  - We consider each year of PAYT introduction as a cohort
  - We create a separate dataset for each of the treatment cohorts
  - In each dataset: municipalities that introduce PAYT in that year are treated, while municipalities that will introduce PAYT in later years are controls – rolling control group
  - Municipalities that experience treatment in **2019** serve only as controls
  - Event-time dummies are specified relative to the specific year of PAYT introduction for each cohort

Event-Study Specification

$$Y_{mt} = \alpha_m + \nu_{pt} + \beta Treated_{mc} + \sum_{s \neq -1} \gamma_s \cdot D^s + \sum_{k \neq -1} \delta_k \cdot D^k \cdot Treated_{mc} + \varepsilon_{mt}$$

- Y_{mt} outcome of interest
- α_m municipality fixed effects
- $Treated_{mc}$ indicator for PAYT in cohort c
- D^s relative event-time dummies
- ν_{pt} province-by-year fixed effects
- ε_{mt} errors clustered at the municipality level
- δ_k's: change in outcomes of treated municipalities k years before/after treatment, relative to pre-treatment year, compared to the change in outcomes of not-yet-treated

post

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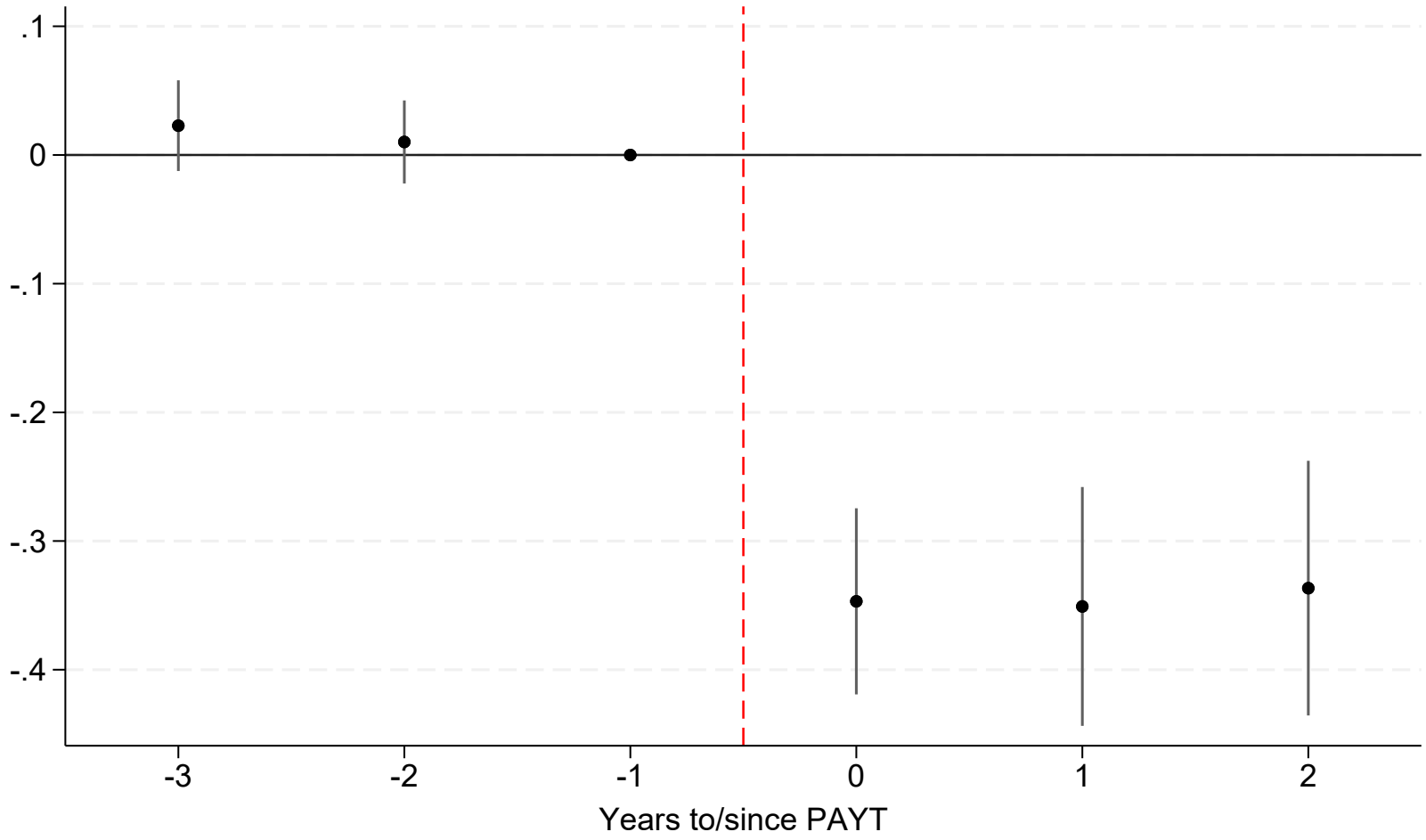
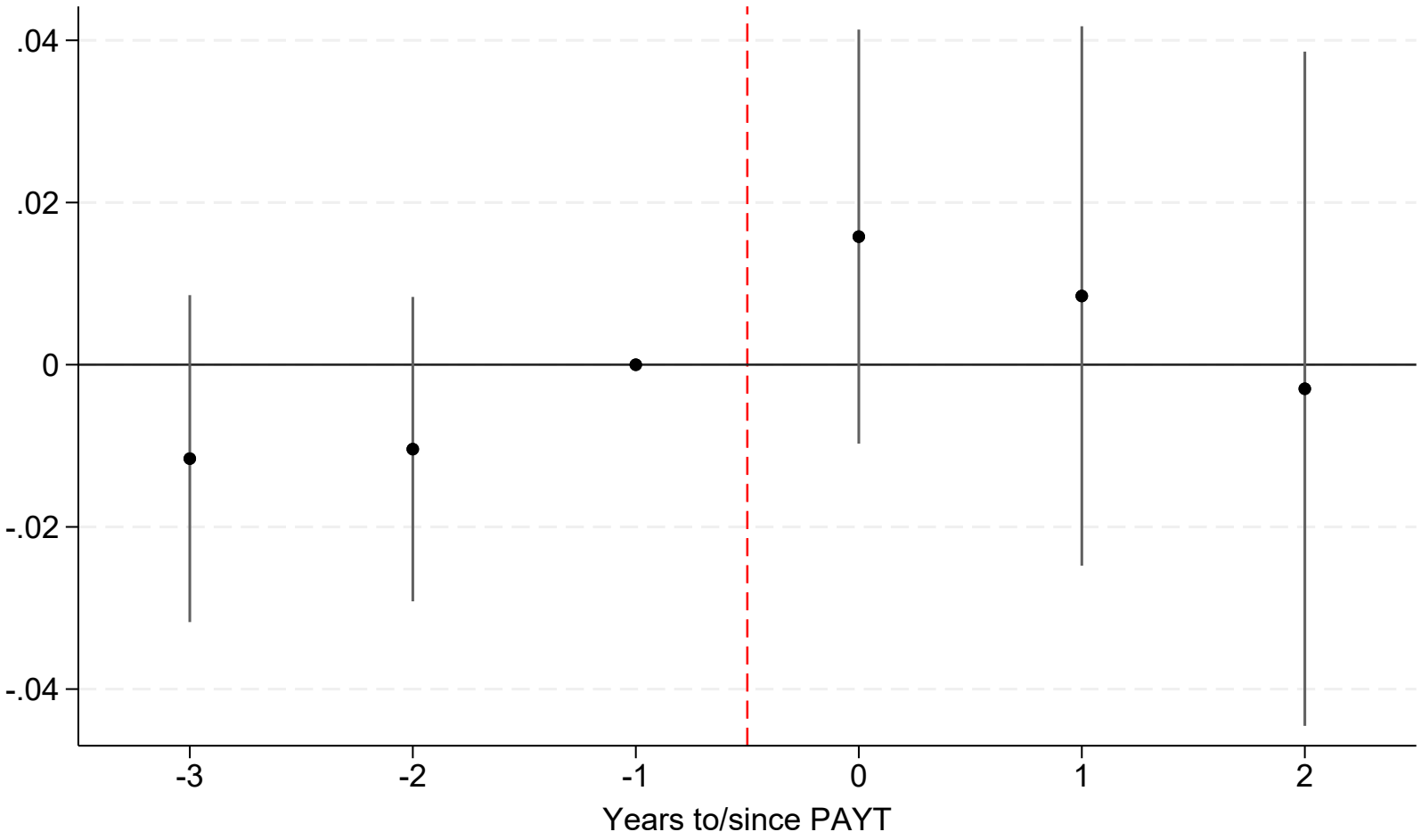
The Intended Consequences of PAYT - Waste I

Figure: log Unsorted Waste pc



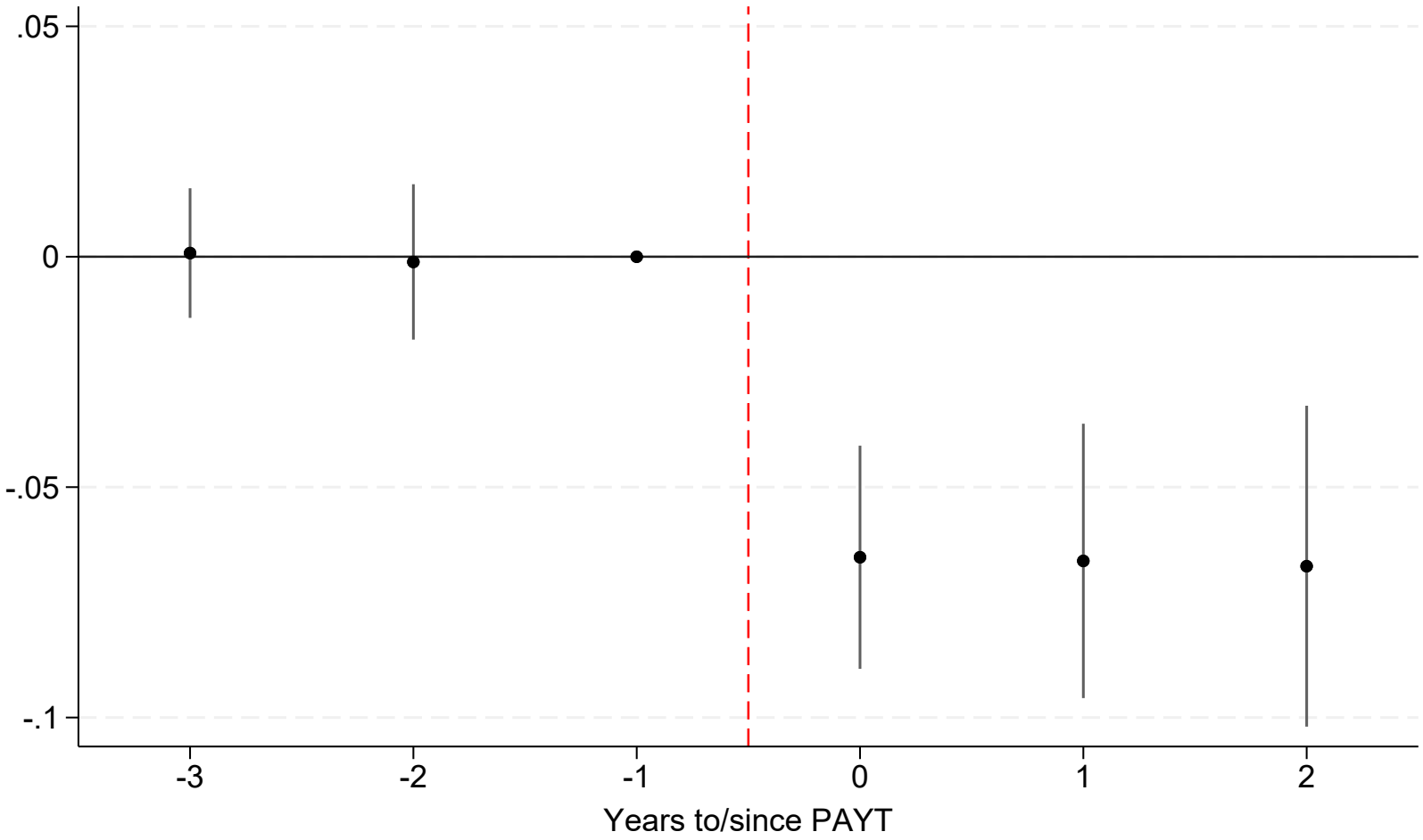
The Intended Consequences of PAYT - Waste II

Figure: log Sorted Waste pc



The Intended Consequences of PAYT - Waste III

Figure: log Total Waste pc



The Consequences of PAYT on Waste - Summary

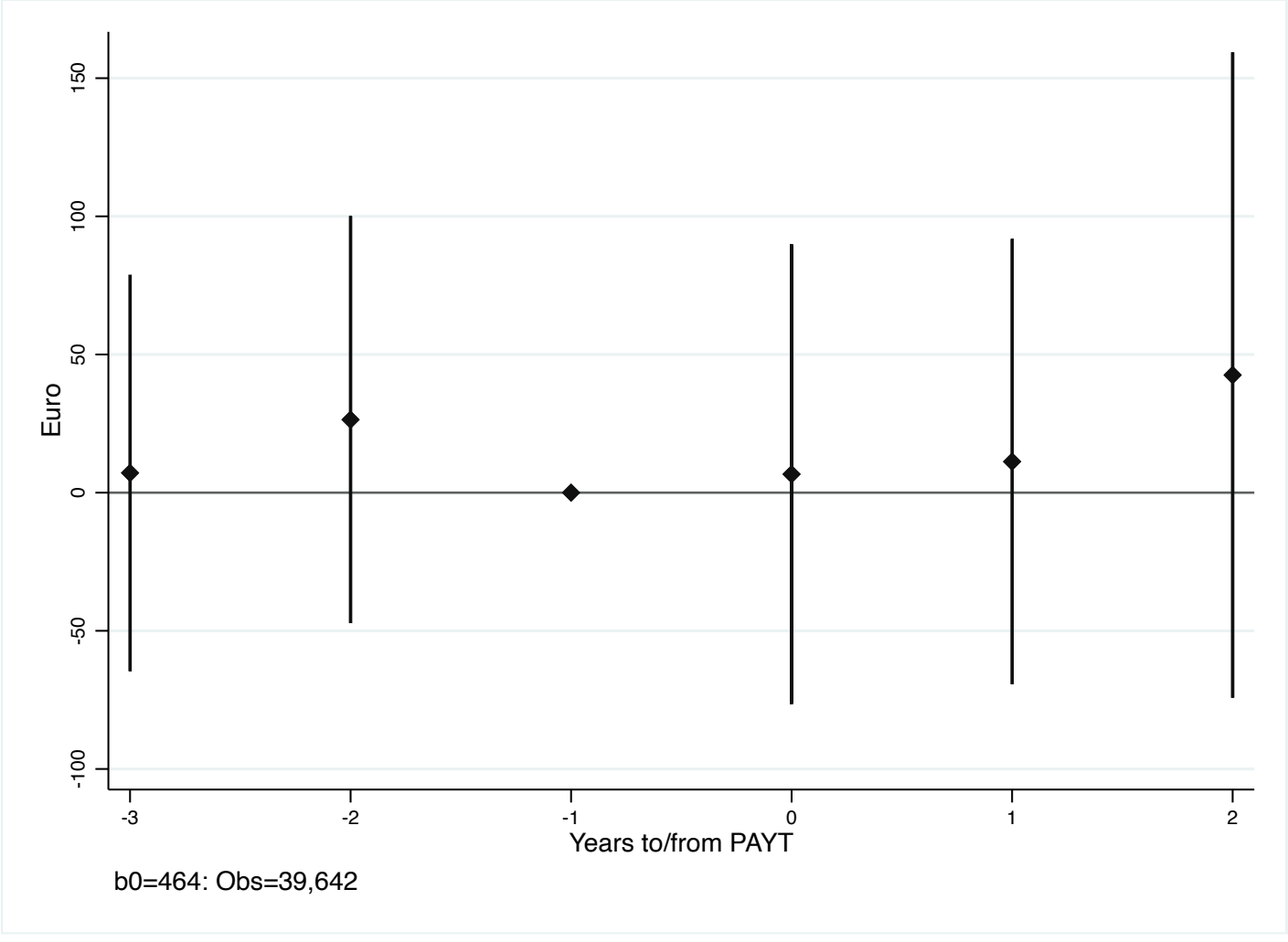
- Following the adoption of PAYT, unsorted waste decreases by around 40%
- No effect on sorted waste and total waste decreases by about 8%

→ Highly heterogeneous effects hetero

- What are the channels? Waste avoidance or decrease in consumption?

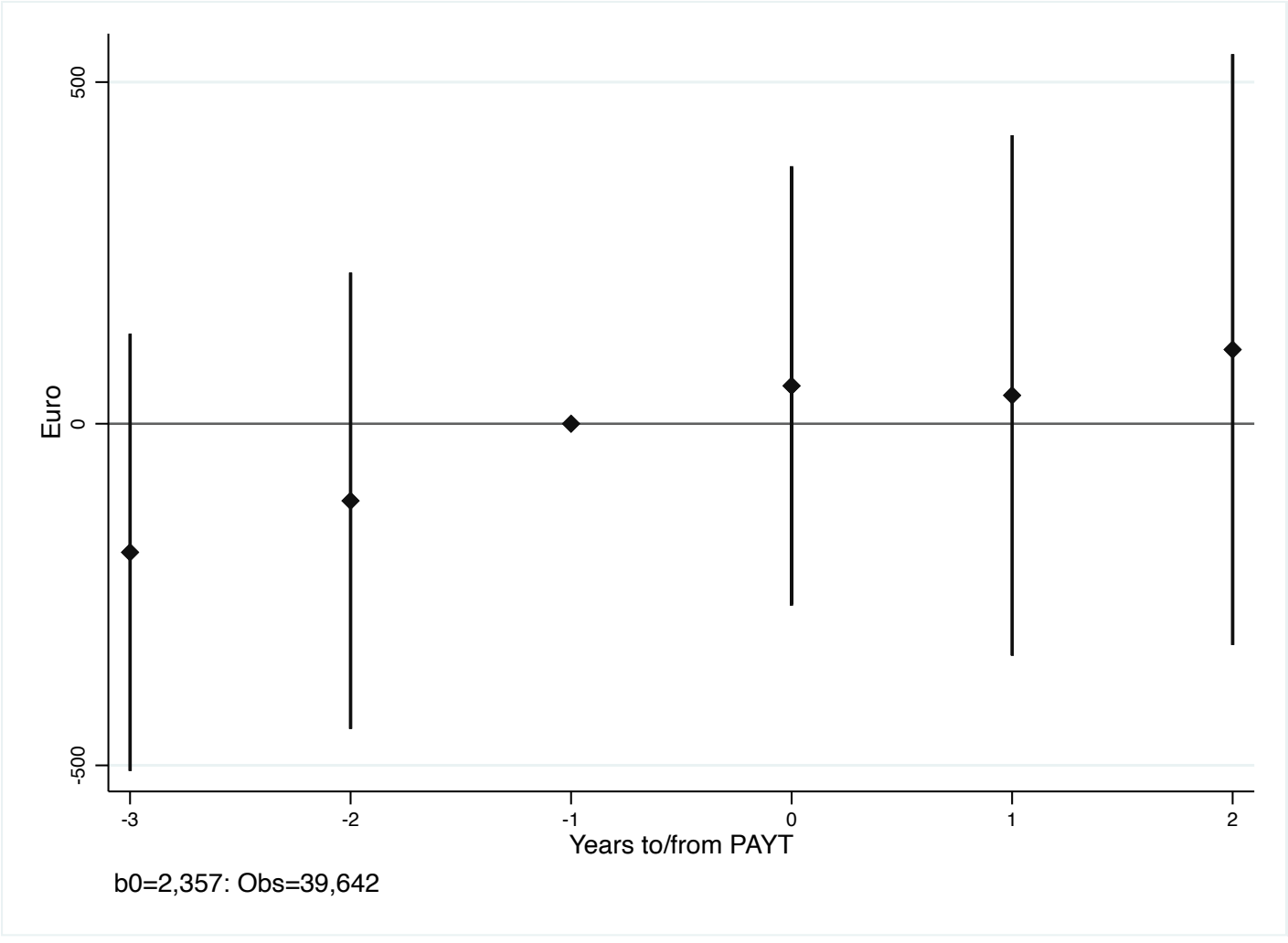
Does PAYT affect consumption?

Figure: Food expenditure



Does PAYT affect consumption?

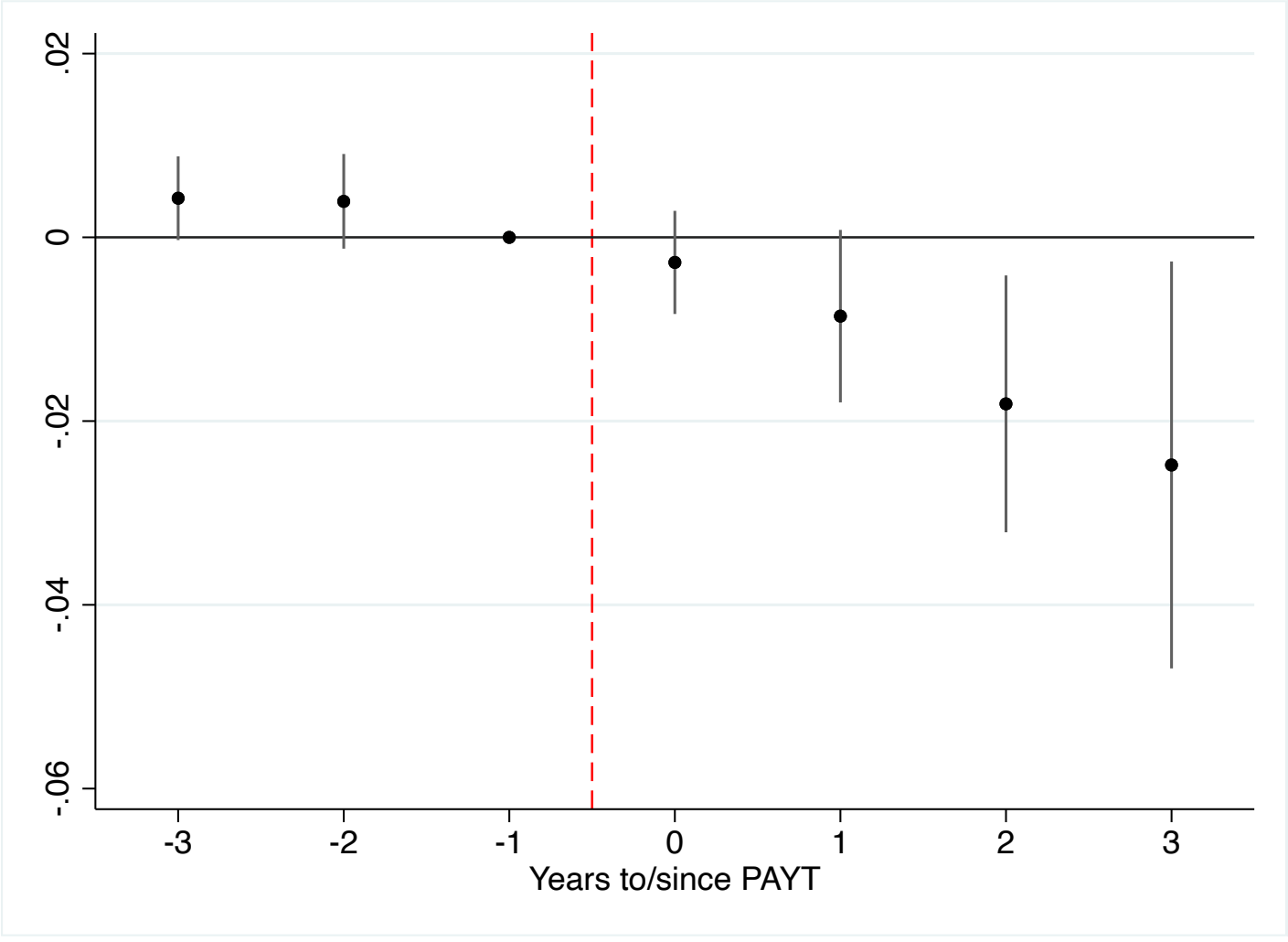
Figure: Non-Food expenditure



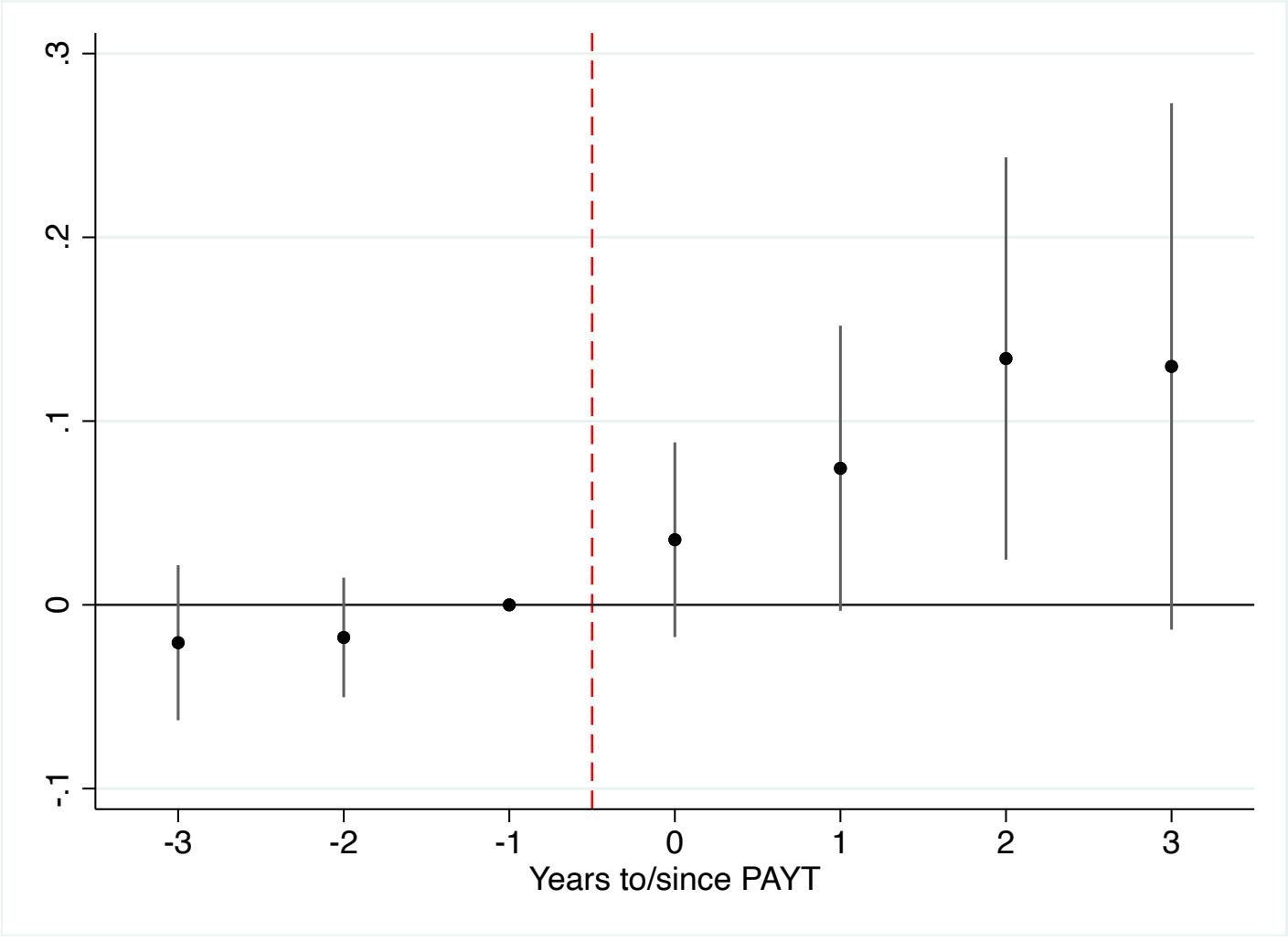
The Unintended Consequences of PAYT

- Does PAYT adoption affect other environmental behavior?
- We look at a different set of environmental outcomes:
  1. Polluting and Electric/Hybrid Cars
  2. Solar panels
- To understand the mechanisms we further analyse survey data and attitudes towards the environment.

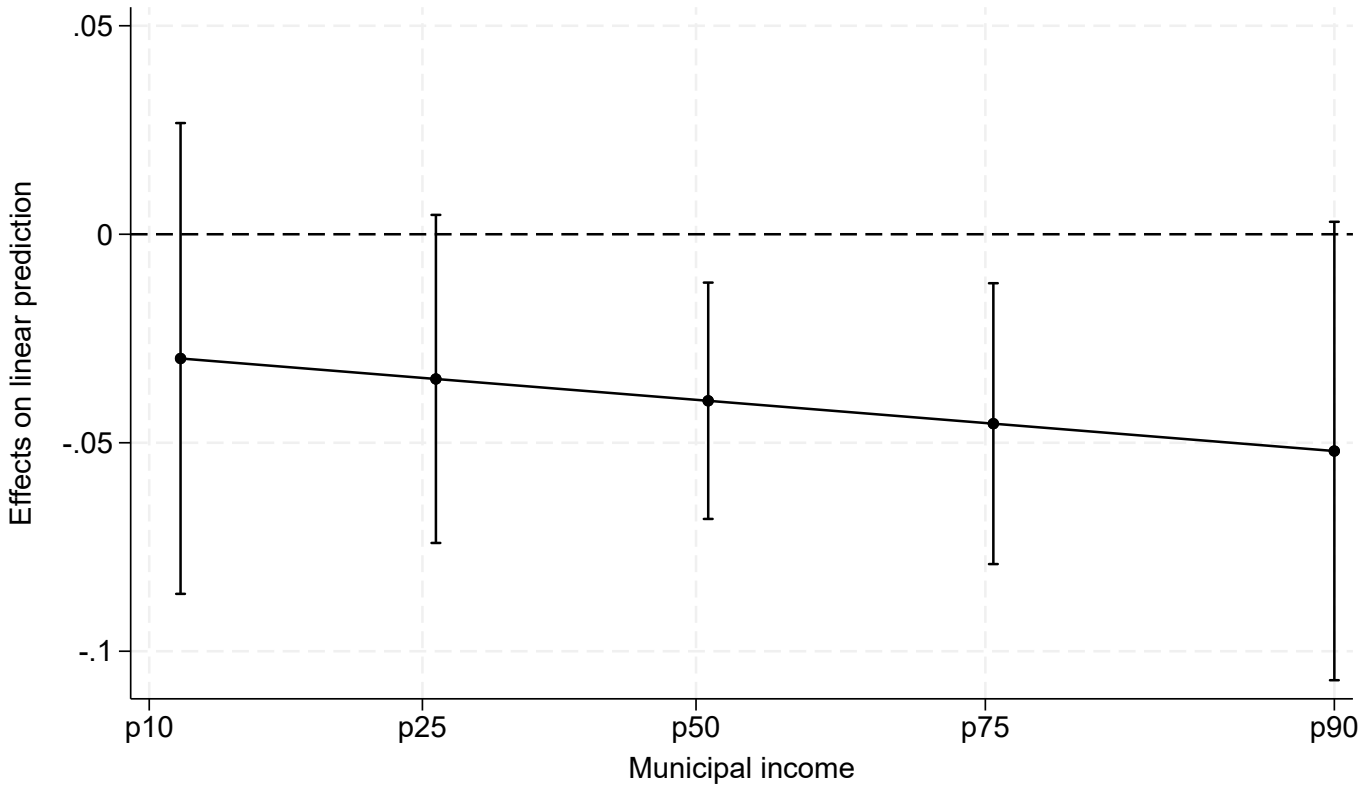
PAYT and % High Polluting Cars (Euro 0,1,and 2)



PAYT and % Electric Cars



PAYT and % High Polluting Cars - Heterogeneity



PAYT and Solar Energy Production

	Number		Power	
	(1)	(2)	(3)	(4)
Treated	0.0901***	0.0899***	0.2427***	0.1464**
	(0.0272)	(0.0258)	(0.0759)	(0.0700)
Province FE	Yes	Yes	Yes	Yes
Controls	No	Yes	No	Yes
Observations	7,386	7,386	7,386	7,386

Mechanims? PAYT and Environmental Attitudes

	(1) Environment	(2) Crime	(3) Traffic	(4) Politics	(5) Transports
PAYT	0.0653**	0.0106	-0.0788	-0.0363	-0.0159
	(0.0270)	(0.0425)	(0.0521)	(0.0373)	(0.0232)
Baseline	0.0259***	0.0527***	0.2488***	0.1050***	0.0451***
	(0.0095)	(0.0149)	(0.0183)	(0.0131)	(0.0082)
Observations	1,063	1,063	1,063	1,063	1,063

Robustness Checks

- We check the robustness of our findings to different estimators that account for variation in treatment timing
- We include municipality characteristics measured at baseline
- We check for changes in the composition of treated and controls
- We use Conley standard errors
- We test for pre-treatment differences in trends, as by Rambachan and Roth (2020)

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- As found by the existing literature, PAYT are effective tools in reducing unsorted waste
  - → Not due to a reduction in consumption
- This policy has positive spillover effects on other environmental behavior
- Likely mechanism: increased environmental concern/attitudes
- But how these attitudes translate into behavior is highly heterogeneous:
  - Low-income municipalities reduce their waste production (income effect)
  - High-income municipalities also replace their polluting car or invest in renewable energy

Policy implications

- PAYT reduces unsorted waste and thus pollution
- Is it a costly measure? We find no effect on municipal finance...
- ...or citizen punish the mayors who adopted it
- Then why only 9% of Italian municipalities adopted it?
- Main obstacles are:
  1. Infrastructure: collection of waste must be adapted
  2. Enforcement: measures preventing *leakage*
  3. Data privacy and confidentiality: measures to protect privacy in case of user identification

Estimating Equation

$$Y_{mt} = \alpha_m + \nu_{pt} + \beta Treated_{mc} + \delta Treated_{mc} \cdot Post_{mt} + \sum_{s \neq -1} \gamma_s \cdot D^s + \varepsilon_{mt}$$

- Y_{mt} outcome of interest
- $Treated_{mc}$ indicator for PAYT in cohort c, not collinear with α_m
- $Post_{mt}$ indicator for the years in which PAYT is in place
- D^s relative event-time dummies
- ν_{pt} year-by-province fixed effects

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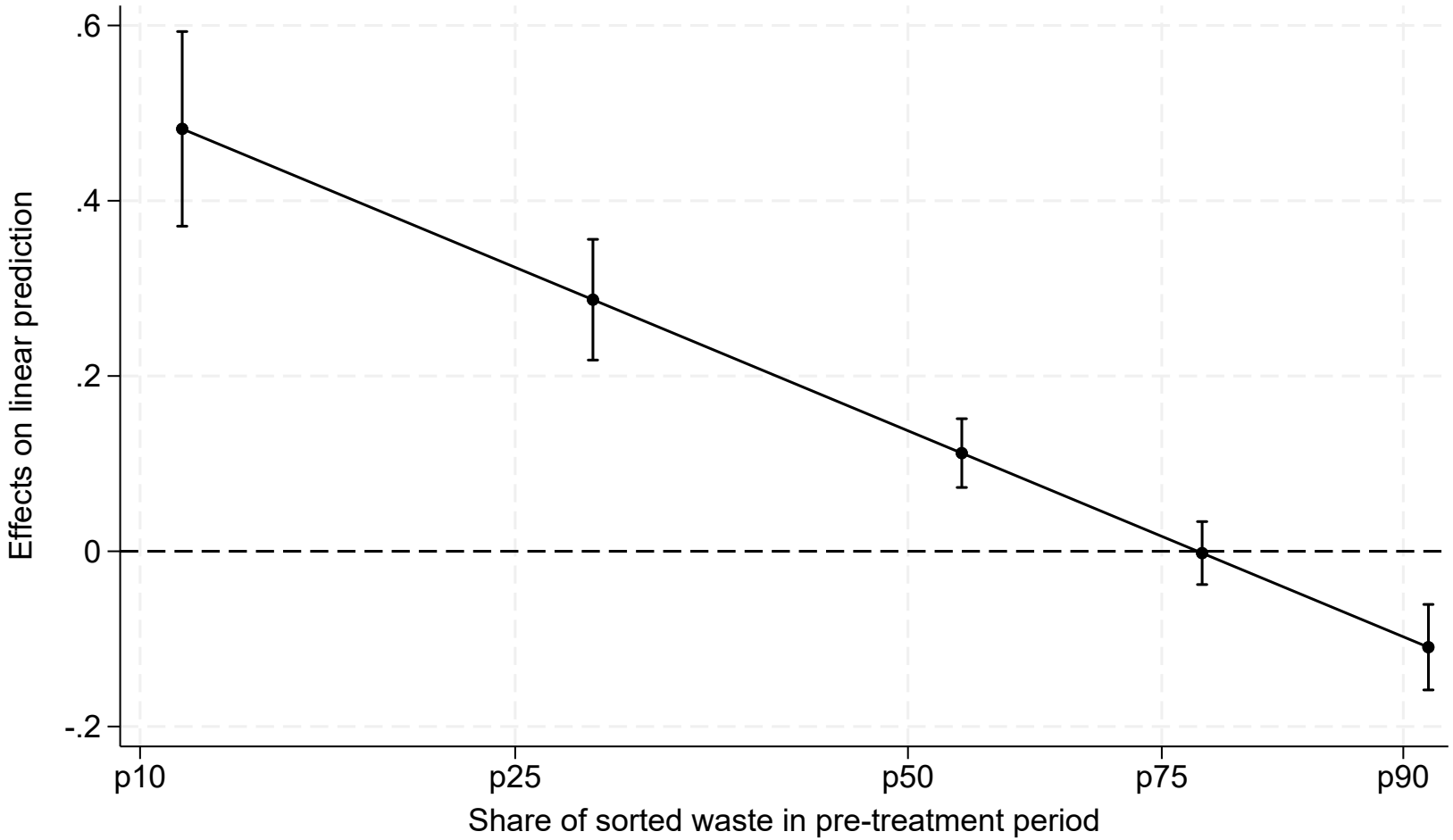
Heterogeneous Effects of PAYT on Waste Outcomes I

Figure: Sorted Waste and %Sorted



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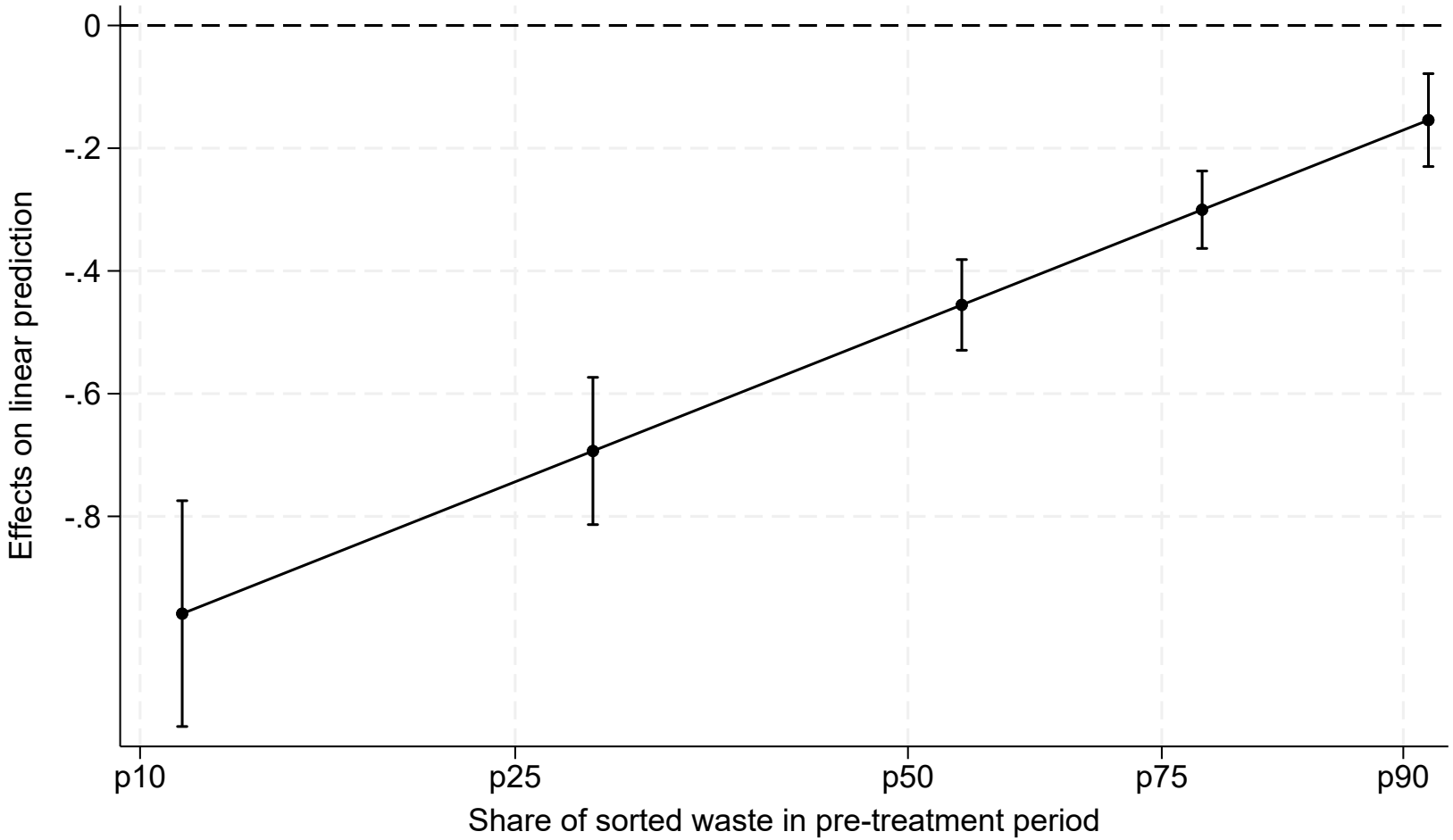
Heterogeneous Effects of PAYT on Waste Outcomes I

Figure: UnSorted Waste and %Sorted



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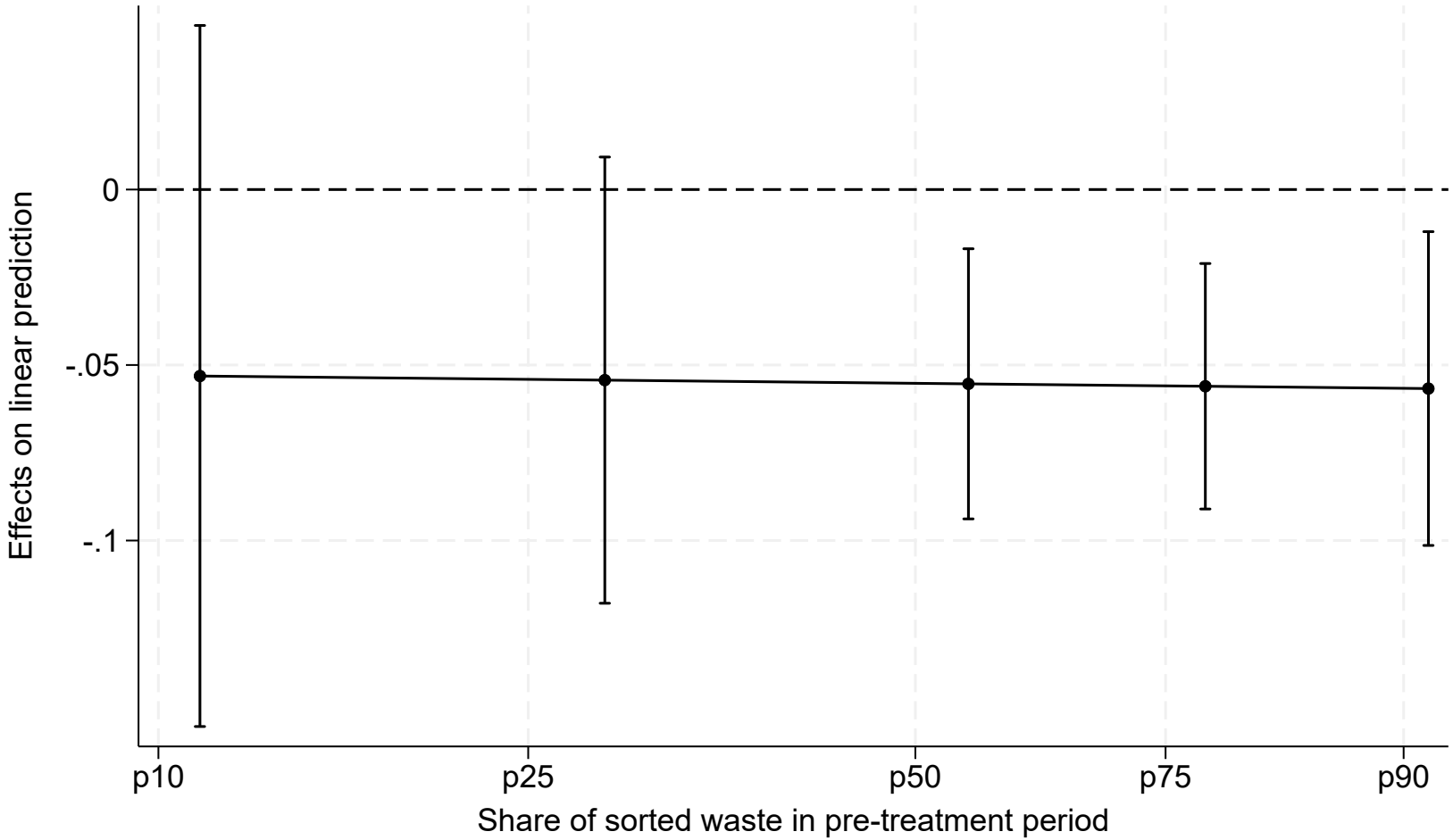
Heterogeneous Effects of PAYT on Waste Outcomes I

Figure: Total Waste and %Sorted



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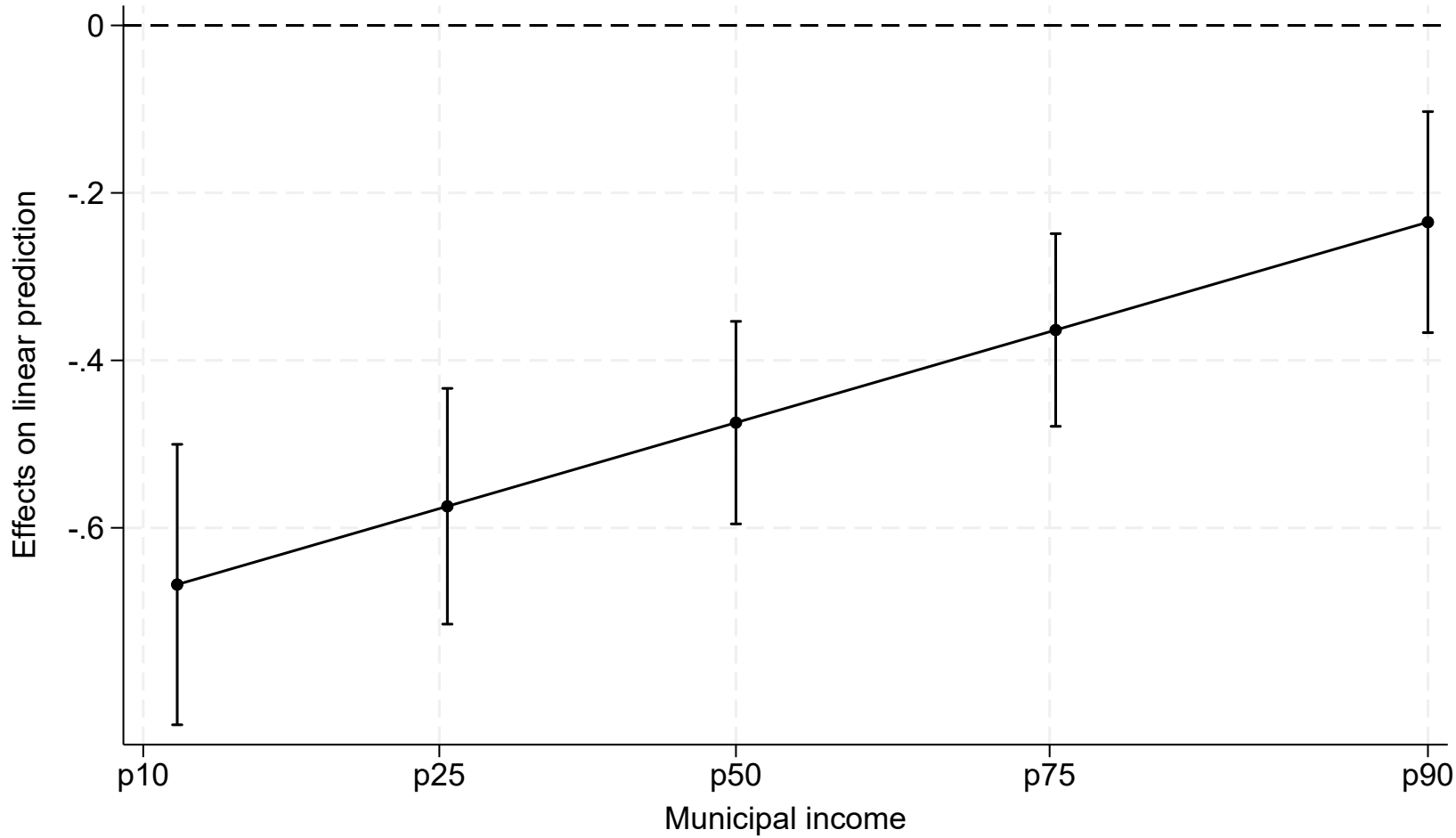
Heterogeneous Effects of PAYT on Waste Outcomes II

Figure: Unsorted Waste and Income



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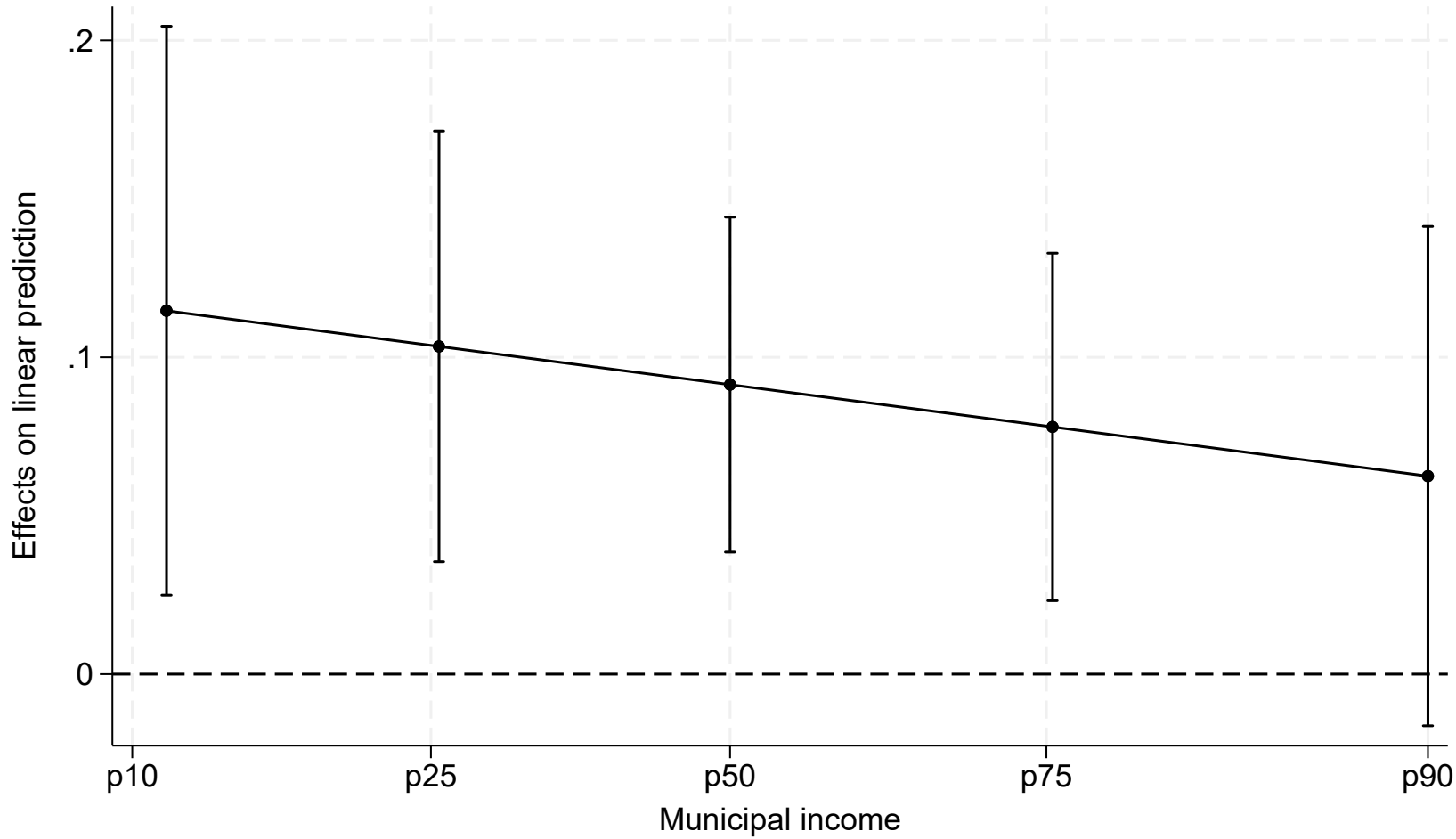
Heterogeneous Effects of PAYT on Waste Outcomes II

Figure: Sorted Waste and Income



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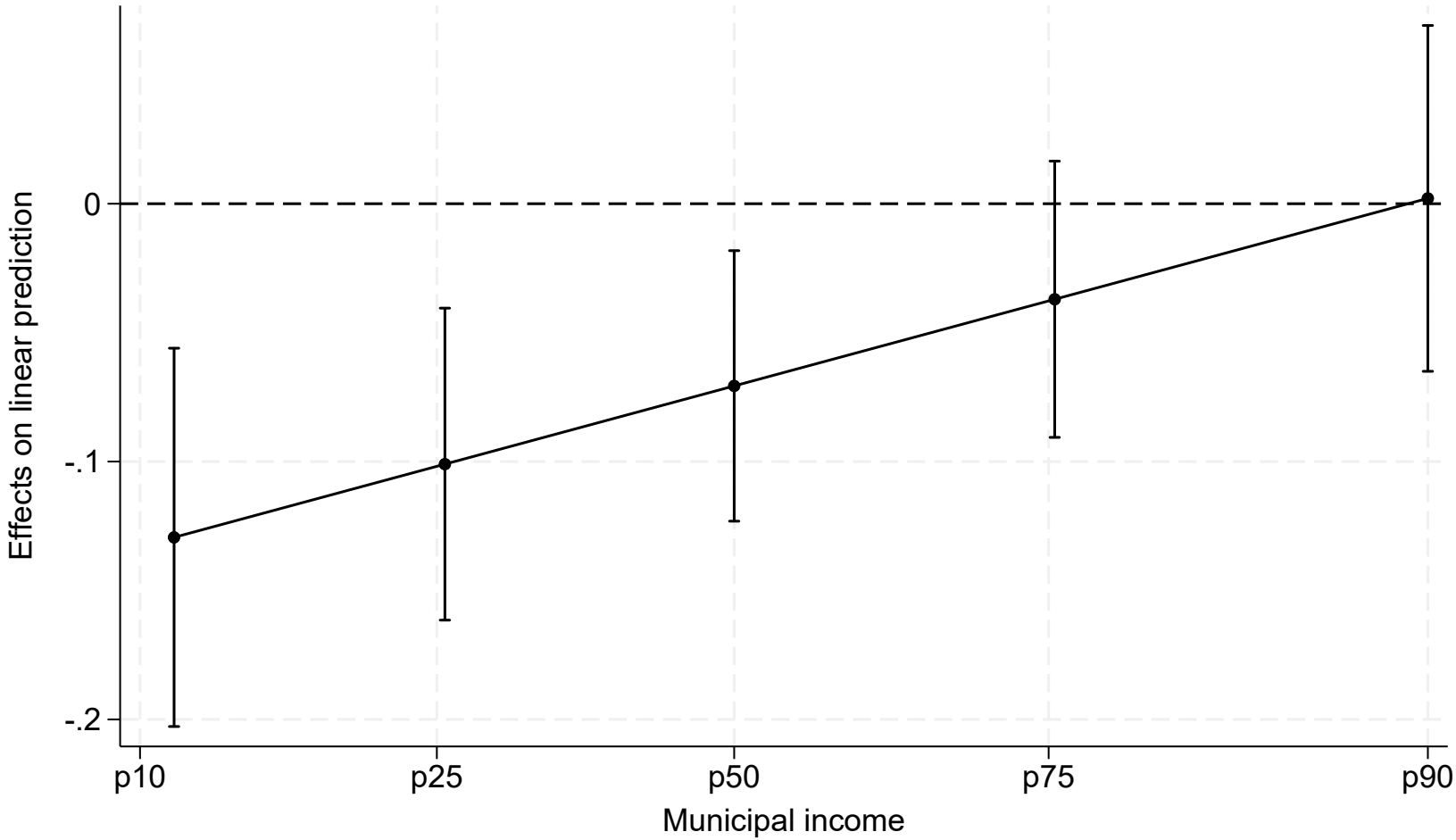
Heterogeneous Effects of PAYT on Waste Outcomes II

Figure: Total Waste and Income



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