The Double-Edged "Operation National Sword": How Did China's Waste Import Ban Affect Global Plastic Recycling Innovation?

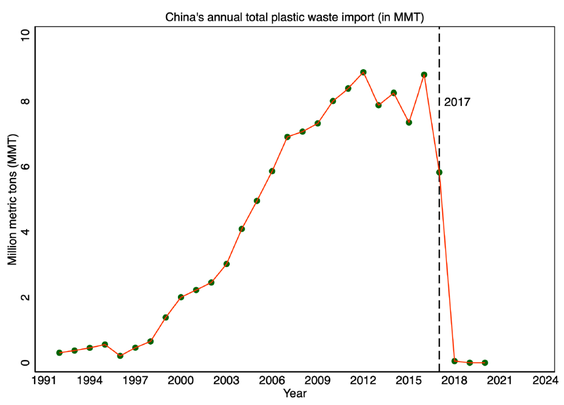
Ruiqing Miao (Auburn University; miaorong@auburn.edu)

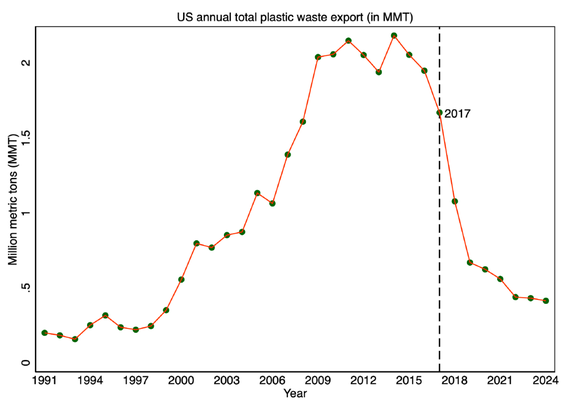
Abstract

China's 2018 "Operation National Sword" ban disrupted global plastic-waste trade and altered incentives to innovate. Using patent data in the United States, I study the impact of this ban on recycling innovation through difference-in-differences analysis. Preliminary U.S. evidence suggests an approximately 40% increase in plastic-recycling innovation during 2018–2023 relative to a no-ban counterfactual. Ongoing work investigates cross-country responses, the direction of innovation, and global recycling outcomes.

Introduction

- About 400 million metric tons of plastic produced in 2022 globally (~ 50kg/person)
- Only 9% of plastics are recycled globally.
- China imported about 45% of the world's traded plastic waste during 1992–2017.
- On January 1, 2018, China restricted plastic-waste imports, disrupting global recycling markets.





Research questions

- How did innovation in recycling respond to this policy shock?
- Did the response differ across countries? If yes, in what way?
- To what extent, if any, did the response improve waste recycling?

Methods

- DID with year and waste-type fixed effects:

$$y_{it} = \alpha + \beta \cdot \text{Treated}_i \cdot \text{Post}_t + \lambda_i + \gamma_t + \epsilon_{it},$$

where y_{it} is number of patents for waste type i filed in year t.

- Use event study to evaluate the pre-trends:

$$y_{it} = \alpha + \sum_{k=K_{\min}}^{K_{\max}} \beta_k \cdot \text{Treated}_i \cdot \mathbf{1}[t - 2018 = k] + \lambda_i + \gamma_t + \varepsilon_{it},$$

where K_{min} and K_{max} are earliest and latest relative year to 2018.

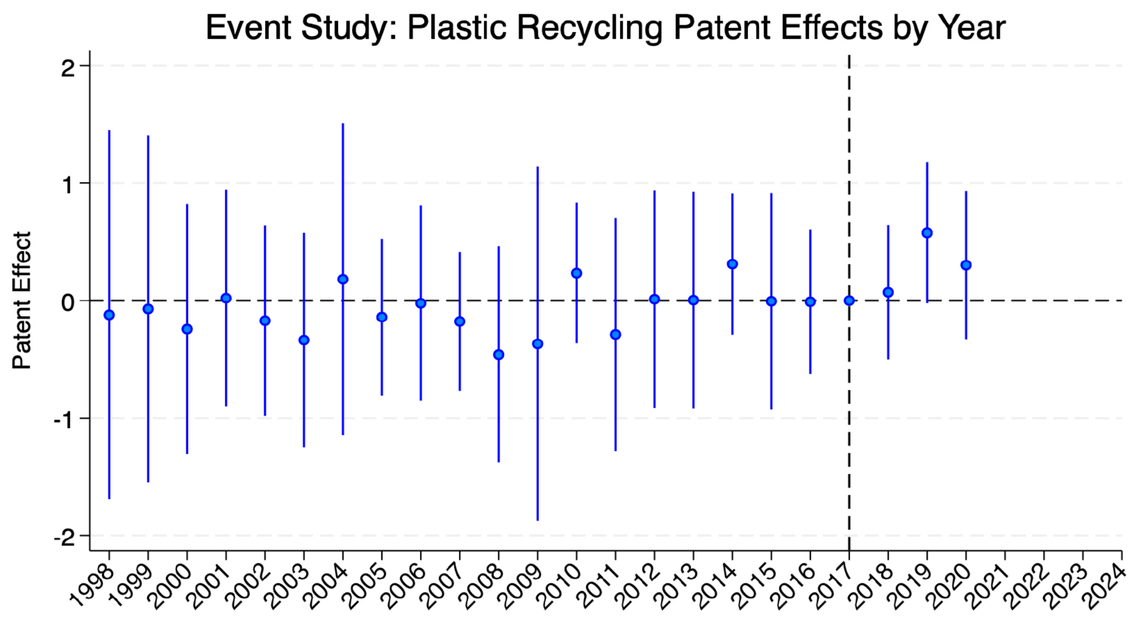
Data

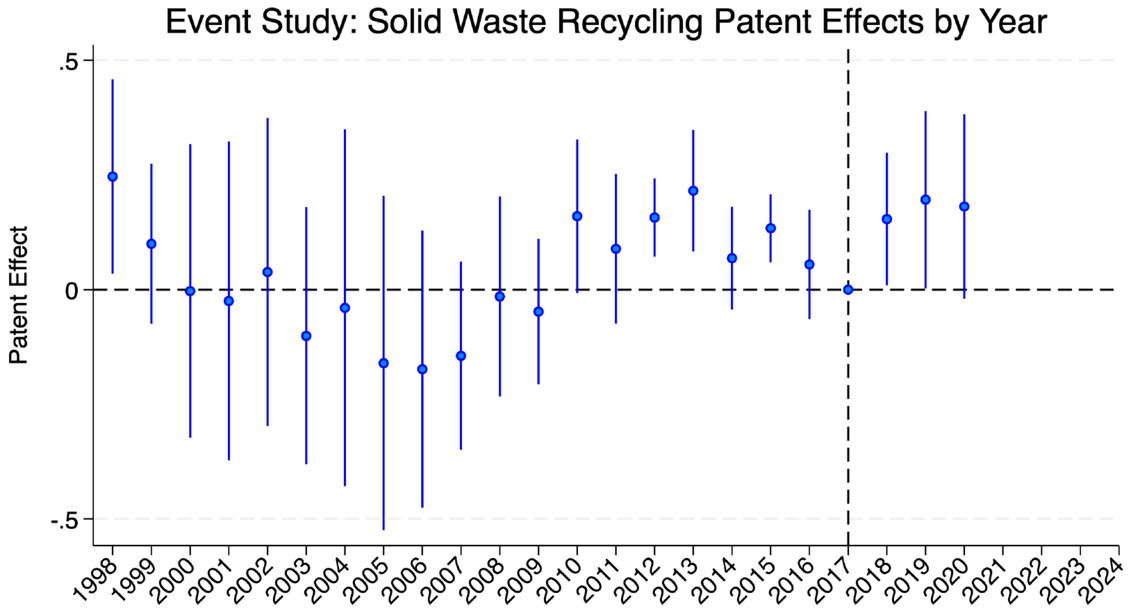
- US Patent count: Google Patents and Patentsview
- US waste trade data: trade volume at 6-digit Harmonized System (HS) code level from United Nations Comtrade Database
- Link the two datasets by identifying patents related to waste specified by HS code
- Treatment group: 4 types of waste banned in 2018
  - HS391510 (Polymers of ethylene)
  - HS391520 (Polymers of styrene)
  - HS391530 (Polymers of vinyl chloride)
  - HS391590 (other plastic waste)
- Control group: 8 types of waste not banned in 2018, and with stable trade after 2018
  - HS252530 (Mica waste)
  - HS271091 (Waste oils containing PCBs)
  - HS411520 (Composition leather)
  - HS711291 (Gold scrap)
  - HS711299 (Other precious metal scrap, excl. gold)
  - HS720429 (Ferrous alloy steel scrap, excl. stainless)
  - HS810330 (Tantalum scrap)
  - HS811020 (Antimony scrap)

Results

Table 1. Waste Import Ban and Patent Outcomes

	Plastic Patents (asinh)			Solid Waste Patents (asinh)		
	(1)	(2)	(3)	(4)	(5)	(6)
Treatment × Post	1.567**	0.360**	0.399**	0.457	0.252**	0.252**
	(0.709)	(0.130)	(0.147)	(0.246)	(0.095)	(0.101)
Commodity Fixed Effects		✓	✓		✓	✓
Year Fixed Effects			✓			✓
Observations	276	276	276	360	360	360
R-squared	0.0556	0.0185	0.2723	0.0032	0.1595	0.6931





Preliminary conclusions

- US plastic waste recycling innovation responded positively to China's import ban (~ 40% increase).
- So did US solid waste recycling innovation (~ 25% increase).

Ongoing work

- How did Chinese innovation in recycling respond to the ban?
- Did US and China respond differently? If yes, In what way?
- Conduct a global analysis on the innovation impact using country-level exposure of China's import ban.
- How did the innovations in recycling affect the prices of waste?

Support: NSF • Alabama Agricultural Experiment Station • USDA-NIFA Hatch project