Waste to the Bottom:
Developing States' Leverage in the Global Waste Trade

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29 January 2023

Abstract

In the global waste trade, importers buy foreign-origin waste and scrap. After recycling waste products into raw materials destined for new goods, the leftovers are just trash – imported negative externalities that can overwhelm low-capacity developing states. Yet there is power in piles of foreign garbage, especially as modern waste management systems are designed around trade. When a waste product's imports concentrate in fewer states, those states gain market power to extract compensation while still accommodating domestic demand. To support the theory, I introduce a list of 179 internationally traded waste products (HS 6-digit), as well as novel data on product-level tariffs and the international distribution of waste imports (1995-2020). I show the theory in action as, since China's shocking 2017 ban on imports of 26 waste products, states on the receiving end of diverted imports have exercised their newfound power to use tariffs in service of environmental protection.

Word Count: 11,732

Acknowledgements: Sincere thanks to In Song Kim, Jean-Baptiste Velut, Stephen Chaudoin, Stephen Weymouth, Iain Osgood, Clint Peinhardt, and audiences at the International Political Economy Society (2021), the "Wastelands" conference of the European Association for American Studies (2022), and Yale University (2023). For excellent research assistance, I thank Luca Messerschmidt, Vepa Rejepov, AJ Torok, Anthony Calacino, Devika Kumar, student researchers at the University of Texas at Austins Innovations for Peace and Development lab, and student researchers at Sorbonne Nouvelle. For financial support, I thank the UT Austin Vice President for Research, the Dr. Ccile DeWitt-Morette France-UT Endowed Excellence Fund, the Georgetown University McDonough School of Business, and Sorbonne Nouvelle. All errors are my own.

1 Garbage Introduction

In the global waste trade, exporters collect post-consumer materials and post-industrial byproducts and offer them for sale on international markets. Importers buy containers and trucks of waste products, because they can process the waste to recover valuable raw materials. Globally, 40% of raw materials are sourced from waste products.[1] While the waste trade goes both ways, industrializing developing states are especially hungry for raw materials. Based on novel data introduced in this article, the trade overall has netted out to at least 980 million tons of waste products exported from OECD states and imported into non-OECD states since 1995.

What sets waste products apart from other traded goods is that a waste product by definition requires processing to recover a primary good, so every waste product carries a leftover component known as end-of-life (EOL) waste with no further reuse value.[2] The upshot of the waste trade is that voluntary transactions between exporters and importers in commercial markets redistribute EOL waste from one national jurisdiction to another. So, developing states end up as de facto importers of negative externalities in the form of physical, even smelly, foreign-origin garbage. Low-capacity developing states struggle to implement domestic, behind-the-border regulations to mitigate negative externalities, much less those that result from economic integration (Dolak and Prakash, 2022; Rudra, Alkon and Joshi, 2018; Ward and Cao, 2012). While commercial markets for waste products help meet demand for raw materials in developing states, waste products' imported leftovers manifest a race to the bottom (Rudra, 2008).

I argue that developing states can and do can abate the waste trade race to the bottom by repurposing trade protection in service of environmental protection. Developing states have a ready, flexible, even old-fashioned trade policy lever at hand – the product-level tariff (Kim, Liao and Imai, 2020). A higher tariff makes it more expensive to import a waste product, which can improve environmental protection in two ways: first, by generating more compensation from those commercial market actors responsible for importing negative externalities, and second, by discouraging imports by those who now find it too expensive. The aim is to raise the tariff just high enough to mitigate imported negative externalities, while also accommodating domestic demand for a waste product's raw materials. Conceptually, the tariff can serve as an environmental Pigouvian "sin" tax that just happens to be levied at the border (Wiseman and Ellig, 2007). Developing states can and do use tariffs as leverage in shaping the distribution of the physically big, environmentally overwhelming, costly leftovers of the global waste trade.

[1] As of 2023. Bureau of International Recycling `https://www.bir.org/the-industry`

[2] While primary goods may also contain EOL waste, the incidence of EOL waste is predictable, visible, and salient for the subset of waste products.

Moreover, piles of developed states' imported garbage in developing states makes it easier for developing states to raise tariffs, even and especially when those piles grow bigger. The more that demand for a waste product's raw materials is concentrated in developing states, the more dependent its commercial market is on developing states' willingness to serve as repositories for the leftovers. If we think of a "market" for a waste product's imported negative externalities, developing states can name their price when they are the only "buyers" available. Moreover, if and when the number of developing states willing to "buy" imported negative externalities decreases, then remaining states gain power to raise tariffs higher while still accommodating domestic demand for raw materials. This is exactly what happened in the wake of China's sensational "National Sword" policy – a "Ban on the Entry of Foreign Garbage" – when in 2017 it shocked global markets by banning imports of 26 specific waste products. Exporters raced to the bottom, diverting exports (including those en route) intended for Chinese buyers to importers in other developing states – and the attached EOL waste once destined for China has ended up in those developing states' territories. I show that developing states awash in imports of those 26 waste products are raising tariffs and reshaping the global distribution of garbage, even years after the initial "China garbage shock."[3]

A theory of developing states' leverage in the global waste trade is far from esoteric. One takeaway is that developing states can use decisions over economic openness to alleviate consequences of low state capacity. Another is that trade protection can be repurposed as a tool to mitigate foreign-origin negative externalities, so long as the negative externalities respect national borders. These takeaways open up a research agenda on the other ways in which trade policy might be repurposed in service of outcomes other than protection of import-competing interests (Holtmaat, Adolph and Prakash, 2020). Furthermore, with developing state demand for raw materials in mind, contemporary waste management systems in developed states the world over have been designed around export.[4] As a result, developed states are using capitalist markets as a byway to mitigate their domestically-produced negative externalities. If and when the structure and operation of markets confers power on developing states, it is developed states that need to adjust. As one example, Mesa, Arizona contracts with waste management service providers-cum-exporters to collect the contents of households' blue recycling bins. In a January 2022 mailer, Mesa introduced a new recycling program tagline: "When in Doubt, Keep it Out."[5] In the fine print, Mesa explains that recyclability is endogenous: service providers "ultimately determine what

[3]The enormous "China shock" literature has looked at the political-economic consequences of China's entry to global markets (Autor, Dorn and Hanson, 2016). The "China garbage shock" affords the opportunity to see consequences when China exits.

[4]The major trade association in the US "aggressively advocates initiatives that promote free and fair trade of recycled commodities," and its European counterpart calls for "open and fair competition" to ensure "a genuine international recycling market." Sources: "ISRI: International Trade," `https://www.isri.org/advocacy-compliance/international-trade` and "EuRIC: Position Papers." `https://www.euric-aisbl.eu/position-papers`. As of 2023.

[5]Appendix A.

items can and cannot be accepted," they are only "willing to accept and recycle items with a strong market value," and finding markets in recent years "has been difficult." When developing states' trade policies squeeze exporters' profit margins too far, Mesa can no longer rely on commercial markets to do its dirty work. Although, having my parents drop their empty glass pickle jar in the trash instead does not seem a sustainable solution, in any sense of the word.

In providing support for the theory, I introduce a novel list of 179 internationally traded (HS 6-digit) waste products, which more than doubles previously best-available data cataloguing waste products. I also introduce newly assembled data on product-level import tariffs for up to 137 non-OECD states from 1995-2020.[6] The next section uses these data to illustrate how the waste trade redistributes physical negative externalities. Section 3 draws insights from a variety of literatures on the political-economic consequences of the waste trade. Section 4 presents the theory. Section 5 describes the empirical approach and reports results from regression analysis and a differences-in-differences research design leveraging China's 2017 import ban on 26 waste products. I end with rubbish conclusions.

2 Garbage Data

Exporting firms accumulate waste products from municipalities' household recycling and waste management systems, industrial producers of primary products, secondary scrapyards that collect post-industrial and post-consumer waste, and other direct and indirect sources. The non-zero end-of-life (EOL) waste component of these products needs to be processed out before the recyclable component can be used as an input in downstream production processes. Unfortunately, especially in light of its normative salience, the global waste trade is poorly measured (O'Neill, 2019). A growing literature makes clear the shortcomings in tracking waste shipments and ensuing opportunities for evasion and illegality (Favarin and Aziani, 2020; Liddick, 2009). Scholars and advocacy groups are innovating methodological solutions to the tracking problem; for example, Biotto et al. (2009) develop remote sensing to identify illegal landfills, and the Basel Action Network uses GPS trackers to follow electronic waste (e-waste) to incorrect and often illegal destinations.[7] Yet, a scalable technological solution is difficult to imagine in an issue area that is rife with incentives for political actors to obfuscate.

2.1 Garbage Measurement

The most successful global governance effort in this space is the Basel Convention on Trade in Hazardous Waste and its Disposal, with the core function of providing repositories for various member

[6] I also demonstrate the continued usefulness of the product-level tariff alongside national-level waste import non-tariff barriers (NTBs), based on a newly-assembled dataset of over 1200 NTBs (1995-2020).

[7] "E-Trash Transparency Project," with the MIT Sensable lab. `https://www.ban.org/trash-transparency`.

state self-reporting on waste shipments (Yang, 2020). However, the Basel Convention's limitations mean it has not resolved the measurement problem, much less the problem of setting or enforcing harmonized regulations (Puckett et al., 2005; Clapp, 1994; Kummer, 1992). First, while the Basel Convention was signed in 1989 and quickly reached near-universal coverage, the United States is not a member.[8] Second, the Basel Convention facilitates a program of technical work with regard to "toxic, poisonous, explosive, corrosive, flammable, ecotoxic, and infectious wastes," but radioactive waste is excluded.[9] Third, the Basel Convention is designed around member state autonomy in defining hazardous waste and even waste itself (Pongracz and Pohjola, 2004). Given that the Basel Convention delegates definitions to member states, it does not link its technical advice to specific traded products.[10] The measurement problem in documenting the international distribution of EOL waste extends even to identifying what counts as a waste product.

Since 1988, the statistical infrastructure of the World Customs Organization's Harmonized Commodity Description and Coding System has been the world's means of defining traded goods. Harmonized System (HS) codes are hierarchical and move from categories (2- and 4-digit) to a specific waste product with a 6-digit HS code.[11] To use the core metaphor from James Scott's *Seeing Like a State*, HS codes are the means by which states "see" traded products (Scott, 1998). This article introduces a list of 179 traded waste products at the HS 6-digit level, which more than doubles the previously best-available list of the OECD Trade in Waste and Scrap database.[12] To be classified as a waste product, the definition includes the term *waste* or *scrap*; it is a residual or byproduct from primary production processes; and/or the product is a one-time primary good intended to be processed into inputs for further use. Waste products are of eight different types, based on their source: animal, chemical, metal, mineral, paper, plastic, textile, and vegetable.[13]

Whether an international regulatory body "sees" and measures something is endogenous to politics (Buthe and Mattli, 2014). E-waste is notoriously under-measured (Ilankoon et al., 2018). The World Customs Organization acknowledges that e-waste has been relegated to not-elsewhere-specified HS codes, despite it being an an "example of a product class which presents significant policy concerns as well as a high value of trade." Its first guidance on e-waste "to assist countries in their work under the Basel Convention" appeared only in the 2022 HS revision. Plastic waste has also been poorly "seen" (Lebreton

[8] Fiji, Haiti, and several small island nations are the only other non-members. Membership in the subsequent 1998 Rotterdam Convention on pesticides and industrial chemicals and the 2001 Stockholm Convention on persistent organic pollutants is in the dozens.

[9] A set of African nations formed the 1998 Bamako Convention that prohibits hazardous – including radioactive – waste imports into member-states; however, there are serious concerns over compliance (Okafor-Yarwood and Adewumi, 2020).

[10] Neither does the European Union, which has built on the Basel Convention in providing technical guidance.

[11] Product codes beyond 6-digits are not globally harmonized.

[12] HS codes are updated on a five-year cycle; the number in use in the period varies from 129 (1992 revision) to 144 (2002 revision). The previously best-available OECD list is of 63 waste products (Kellenberg, 2012). The OECD list's coding decisions are explicit; it misses 17 of the 26 waste products China banned in 2017.

[13] Appendix D.

and et al., 2018), although the Basel Convention succeeded in adopting amendments on hazardous plastics in 2019, and the United Nations agreed in 2022 to negotiate a legally binding agreement on plastic waste pollution.[14] Further, the Harmonized System does not "see" trade in services, which means there is no regularized documentation of transactions in which firms import the service of foreign waste storage (or export waste at a negative price). Trade-in-services scandals between OECD-origin firms and Tonga, Western Samoa, Nigeria, and Guinea-Bissau motivated the Basel Convention, but Basel has struggled to get member buy-in to a ban on hazardous waste shipments intended for final disposal in non-OECD states (O'Neill, 2019; McKee, 1996).

In terms of research design, the population of interest is the set of traded products on which standard trade policy tools like the tariff can be applied. This means waste products with HS codes – including any additional waste products coded in the future, if and when political will brings about measurement. I see it as crucial to advance the research agenda on the political economy of the global waste trade now, starting with the data that states have endogenously chosen to collect. I say this for scholarly and normative reasons, given the waste trade's serious consequences for localized and global welfare.

2.2 Garbage Trends

Deriving inputs from waste products is not inferior or exploitative in itself (Gregson et al., 2015). However, a key normative concern is that the global waste trade facilitates net transfers of negative externalities from the territories of developed to developing states. Figure 1 provides evidence that the baskets of waste products imported into developing states have characteristics consistent with more, and more consequential, negative externalities, compared to those imported into OECD states.[15] First, the volume of the annual import surplus in non-OECD states (left panel) is always higher than that in OECD states (right), and it has more than doubled in the study period while remaining relatively flat in OECD states.[16] Import surpluses are measured in millions of (metric) tons, because the physicality of waste products is the means by which their EOL waste components are delivered. However, waste products vary in the weight of their EOL content. In fact, the distinction between the recyclable and the EOL component of a waste product at a given point in time is endogenous not just to technology, but to the costs of virgin materials, to other standard supply and demand dynamics, and broadly to the

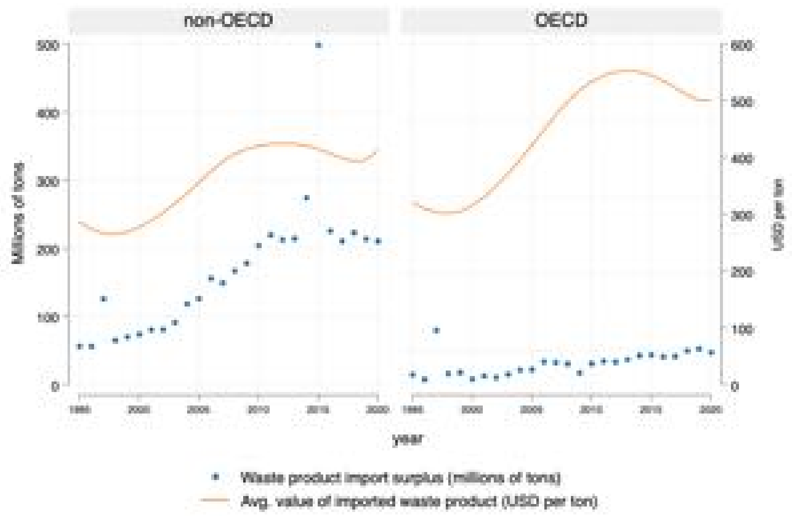
[14] Still, in the first negotiating meeting, the US and Saudi Arabia rejected the principle of harmonized plastics standards, consistent with the interests of their oil industries. Valerie Volcovici. "Countries split on plastics treaty focus as UN talks close." Reuters: 2 December 2022.

[15] Note that normative concerns are supported even by the list of waste products resulting from endogenous choices over observation. Trade data from CEPII/COMPUSTAT, 202201 (Gaulier and Zignago, 2010).

[16] An unprecedented amount of trade in ship salvage (HS 890800) accounts for the very high weight of non-OECD states' import surplus in 2015.

political-economic determinants of the extent to which capitalist, commercial markets are accepted as a mechanism to redistribute negative externalities for that particular waste product at that time. Thus, only in combination with price trends can we infer that non-OECD states receive net flows of waste imports' more serious negative externalities. Assuming that market actors internalize at least some costs, higher negative externality baskets should sell at a lower average price. Not only have non-OECD baskets cleared at lower prices across the period, but the price has increased by a factor of only 1.3 despite doubling in volume. This is against a backdrop of increasing demand for waste products overall, suggested by rapid price growth for baskets imported into OECD states despite little change in volume.

Figure 1: Trends suggest a net transfer from OECD to non-OECD states of high-negative externality waste products.

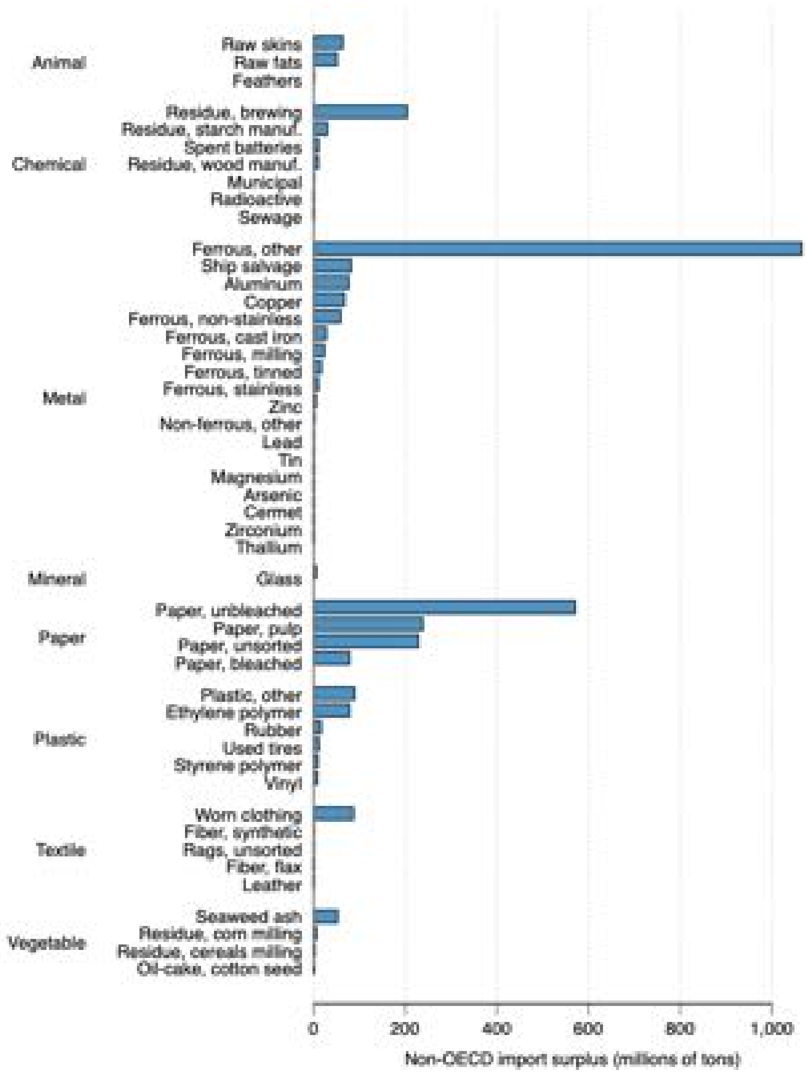


Waste products vary in the downstream applications of their constituent raw materials and the potential for harm from their EOL components, reinforcing that tradeoffs around market openness operate at the product-level (Kim, Liao and Imai, 2020). Figure 2 summarizes the 89 waste products for which non-OECD states have a net import surplus across the study period, categorized by waste type; similar products are combined for presentation.[17] Non-OECD states are net importers of a number of metals and other industrial scrap and byproducts, consistent with the waste trade accommodating unmet demand for raw materials important for industrialization. They are also net importers of all post-consumer paper and plastic waste products, which reflects the structure of global recycling systems and the importance of these materials to manufacturing processes concentrated in developing states. A number of waste products can be sold in a mixed form, meaning that a different HS code applies when the exporter offshores the sorting process. Exporters accept lower prices for mixed waste; for example, the average price per ton paid by importers of "Ferrous, other" (HS 720449) is one-third that of the 14 pre-

[17]For deficit waste products, see Appendix C.4.

sorted ferrous metal waste products. Consistent with the net transfer of negative externalities implied by Figure 1, non-OECD states are net importers of all waste products sold as mixed. Indeed, an estimated 20 million informal workers – "waste pickers" – sort waste worldwide.[18] Several waste products in Figure 2 are eyebrow-raising; still, they are in demand and traded at positive prices (which are observable given their HS codes). Overall, Figure 2 reinforces that the waste trade is not unidirectional, but also that many of the waste products that are net-imported into developing states pass a "smell test" suggesting high EOL waste.

Figure 2: This figure summarizes waste products for which non-OECD states are net importers in the study period (1995-2020).



[18] "Bureau of International Recycling: The Industry." `https://www.bir.org/the-industry` As of 2023.

3 Garbage Literature

The political upshot of developed-to-developing state transfers of negative externalities via the waste trade is that commercial markets provide outs for developed states to relocate "not in my backyard" (NIMBY) problems to developing states' "backyards" (Foster and Warren, 2022). International relations scholars have paid little direct attention to the global waste trade and its theoretical implications.[19] Instead, fellow travelers in social sciences have made inroads into understanding the waste trade's material and non-material dimensions. On the material dimension, Kellenberg (2012) moves from the concept of "pollution havens," when the production of goods with harmful byproducts is moved to low-regulation jurisdictions, to "waste havens," when the byproducts themselves are exported. A variety of studies link waste imports to worsened environmental quality and human health (Heacock and et al., 2016; Ederington, Levinson and Minier, 2005; Cole, 2004), although well-identified tests of causal effects are as yet scarce (Jayachandran, 2022). On the non-material dimension, scholars engage critically with the power relations embedded in global recycling markets (Theis, 2020; Cotta, 2020; Schmidt, 2006; Sanchez, 1994). Liboiron (2021) argues that foreign-origin pollution is "an enactment of ongoing colonial relations," particularly when one nation's waste management transforms Indigenous Land "into a Resource for waste disposal."[20] Okafor-Yarwood and Adewumi (2020) argue that imported pollution is best thought of as a form of environmental racism. Waste imports carry multifaceted harms, for social justice (Rathore, 2020); rural and urban communities (Mihai et al., 2022; Grant and Oteng-Ababio, 2012); municipal budgets (Kaza et al., 2018); and so on. Evidence from a variety of national settings establishes agency on the part of communities exposed to harms. Of note, waste pickers have been powerful organizers (Amuzu, 2018; **?**). Still, the myriad harms of imported negative externalities in developing states illustrate a weakness in the "circular economy" model that sees the waste trade as a means of closing the loop from responsible resource usage, to recycling, to reuse (WTO, 2011).[21]

In international environmental politics, the primary struggle has been for states to find ways to combine global governance and domestic institutions to limit exposure to negative externalities produced outside of the state's jurisdiction (Dolak and Prakash, 2022; Perlman, 2020; Spilker, 2013; Cao, 2009). In stark contrast, waste imports are physical, so states can regulate negative externalities when they arrive packed inside containers and trucks. Thus, the regulator's starting point has much more in common with other forms of negative externalities that arrive in a physical form, such as trade in illicit substances (Kim and Tajima, 2022). Even that analogy is strained, however, given non-harmonized definitions of which waste is illicit (Higashida, 2020). What deserves scholarly attention is how a developing state can

[19] On lacunae in international relations, see Colgan (2019).

[20] p 6, 40. See also Liboiron (2021) on the ethics of capitalizing Land and Resource.

[21] Although, after reviewing a whopping 114 definitions of the "circular economy," Kirchherr, Reike and Hekkert (2017) expect that its vagaries "may eventually result in a collapse of the concept."

unilaterally intervene at the border, in pursuit of its own optimal tradeoffs between the environmental and economic consequences of imports of a given waste product.

The Environmental Kuznets Curve literature posits an inverse U-shaped relationship between environmental harm and development level. The pattern is that at lower levels of GDP per capita, pollution is accepted as a correlate of industrialization and low state capacity. At higher levels of GDP per capita, pollution is decreasing, in concert with changes in the composition of the economy and increased state capacity. While this pattern has been observed in a variety of settings, there is little support for its implied mechanisms (Aklin, 2016; Stern, 2004). Applied to the waste trade, the data do suggest an inverse U-shaped relationship between the waste import surplus (as a proxy for pollution) and GDP per capita.[22] Theoretically, this pattern locates the politics of protectionist waste trade policy in developing states, as they are the ones facing a salient tradeoff between mitigating waste imports' negative externalities and accommodating domestic demand for raw materials sourced from those imports.

Typically, trade policy outcomes trace back to import-competing interests pitted against those that engage in and benefit from the tradeable sector. At the firm level, domestic import-competing interests seek protection if and when it is a useful tool to increase their competitiveness. However, explanations based on protection from import competition are somewhat out of place in the waste trade. Waste products are byproducts, so import competition is reasonably a second-order worry for domestic producers of waste products, although it would be relevant for domestic producers of virgin alternatives. Still, international markets for waste products have arisen as raw material needs outstrip domestic supplies of raw materials, from whatever source (O'Neill, 2019). I propose that trade protection around waste product imports requires a reconceptualization of protectionism to mean protection from imported negative externalities. At the same time, the old-fashioned protectionist trade policy instrument of the tariff is well-suited to be repurposed to trade off environmental harm against economic goals.

4 Garbage Power

A Pigouvian tax, or a "sin tax," is a form of taxation used to reduce the negative externalities caused by socially and thus politically undesirable activities (Pigou and Aslanbeigui, 1920). A higher tax on the activity increases the cost of engaging in it, which has the dual effects of reducing production of negative externalities and extracting more compensation from those that still engage in the activity. A Pigouvian tax can be applied domestically or at a border (Wiseman and Ellig, 2007).[23] Think of tariffs on waste products as Pigouvian "sin tariffs": a higher import tariff increases the costs to bring-

[22] Appendix C.5.

[23] A Pigouvian tariff that increases costs to a mix of international actors is a politically useful complement to or even substitute for a domestic tax that would generate only domestic losers.

ing the negative externality-laden good across the border, with the dual effects of reducing importation and increasing compensation from those that still import. The humble product-level tariff is incremental, adjustable, and takes low state capacity to implement, especially compared to behind-the-border regulatory efforts (Gulotty, 2020; Perlman, 2020; Ward and Cao, 2012, e.g.). Ideally, the government can set the tariff just high enough to compensate for the negative externalities caused by the imported waste product, but no higher; otherwise, too little of the waste product and its valuable constituent raw materials will be imported.[24]

When setting a Pigouvian tariff on a waste product, states face what I will shorthand as an environmental-economic tradeoff between prioritizing the welfare consequences of that product's negative externalities and the welfare benefits of its recycled raw materials. I conceptualize that tradeoff and attendant observable implications before theorizing the conditions under which economic constraints weaken.

On the environmental dimension, it is easiest for the importer to put a waste product's EOL waste in the bin and leave it at the curb. Should it do so, its private transaction creates a new burden for the local waste management system that is increasingly overstretched when bins are filled with foreigners' garbage, too (Kaza et al., 2018). From a social welfare point of view, actors participating in voluntary transactions would ideally internalize the costs of negative externalities resulting from EOL waste. However, low-capacity developing states struggle to set and enforce domestic environmental regulations in general (Prakash and Potoski, 2014), including those that would shift the waste management burden to importers and/or have the effect of passing through its costs to exporters (Boudier and Bensebaa, 2011; Helm, 2008). Moreover, even if market actors were to internalize the costs of best-practices EOL waste management, the garbage remains in a political jurisdiction different from the one in which it was generated. That physical presence, and its associated sights, smells, and exploitative overtones, have public "bad" qualities of non-rivalry and non-excludability without a behind-the-border technological solution. But with a higher Pigouvian tariff, developing states can pursue their goals on the environmental dimension by distorting prices in the marketplace in which the responsible voluntary transactions occur. All else equal, the greater the expected harms of a waste import's negative externalities, the higher the import tariff on the waste product.

It is methodologically fraught and perhaps counterproductive to judge which harm to whom or what is worse. Instead, to operationalize this hypothesis I maintain that mixed waste products carry higher average negative externalities than unmixed products, because mixed waste is more suffocating for the developing state than unmixed waste.[25] First, it is reasonable to presume that negative externalities

[24] I leave for future research the possibility of achieving the same goal with a trade policy tool other than the tariff.

[25] One *LA Times* expose ran under the headline, "Your Trash is Suffocating this Indonesian Village." Bengali, Shashank.

are increasing in the volume of EOL waste. Second, the sorting process itself can generate significant direct harms for waste pickers. For example, ship salvage (HS 890800) contains hazardous materials mixed with recyclables in a physically dangerous form; the International Labor Organization identifies ship-breaking as "among the most dangerous of occupations" especially in workplace fatalities.[26] At a societal level, harms to waste pickers increase production of public "bads" via social and moral negative externalities. Third, among waste products, mixed products have proven particularly important in facilitating "home style" politics (Fenno, 1977). When in 2019 the Philippines sent back to Canada 69 containers of what was discovered to be mixed illicit and licit waste, then-president Duterte told Canada, "Your garbage is on the way. Prepare a grand reception. Eat it if you want to" (Liebman, 2021). In a 2021 press conference in front of bales of imported waste, celebrating the return of over 300 illicitly mixed containers to the US, France, UK, and Canada, the Malaysian Minister of Environment promised Malaysia will not "become the garbage dump of the world."[27] Opportunities for "home style" politics emerge even when mixed waste is legal – Bloomberg reporters described the wafting "stench of curdled milk" and the sight of "maggot-infested rubbish" at the Malaysian press conference.[28] For all these reasons, I test the following hypothesis:

Hypothesis 1 *All else equal, developing states set higher import tariffs on waste products sold in mixed form than other waste products.*

On the economic dimension of the environmental-economic tradeoff, a developing state needs to avoid setting the Pigouvian tariff too high, lest too few waste products be imported into the domestic market. Too-few imports would have knock-on costs throughout the economy, for direct importers, downstream customers of recovered raw materials, and opportunities for developmental spillovers.[29] Given that waste products are a source of a great variety of raw materials destined for different purposes, and they are traded in different markets at different prices, the economic dimension of the environmental-economic tradeoff should operate at the product-level. Empirically, this means that meaningful variation in product-level tariffs should be unaccounted for by mechanisms connecting trade policy and development at the national level (Nooruddin and Simmons, 2009, e.g.). A further observable implication is that meaningful variation in the product-level tariff should be unaccounted for by membership in the Basel Convention and other national-level policies that serve as non-tariff barriers (NTBs) on waste imports.

25 October 2019. LA Times.

[26] Ninety percent of ship-breaking is carried out in Bangladesh, China, India, Pakistan, and Turkey. "Ship-breaking: A Hazardous Work." ILO: 23 March 2015.

[27] "Malaysia sends back over 300 containers of illicit plastic waste." 6 April 2021: Reuters `https://www.reuters.com/article/us-malaysia-environment-plastic-idUSKBN2BT1YT`.

[28] The (curdled) milk and maggots constitute EOL waste mixed in with the recyclable materials. Koh, Ann and Anuradha Raghu. 11 July 2019. "The World's 2-Billion-Ton Trash Problem Just Got More Alarming." Bloomberg.

[29] If recycled materials are used as inputs in exports, too few waste product imports would have further consequences for accruing foreign exchange.

All else equal, the greater the domestic demand for raw materials sourced from a given waste product, the lower the import tariff on the product.

Product-level domestic demand is endogenous to the product-level tariff in ways that the methodological hack of lagging demand measures can scarcely address. Without pretending to have solved the problem, I devise two differently-flawed measures for domestic demand, based on the argument that they are substantially (though not fully) driven by decisions taken outside of the developing state in question.[30] First, I create an indicator variable for the 89 waste products that are net-imported into non-OECD states in the study period, expecting that they should be in relatively higher demand in a given developing state-year (Figure 2).

Hypothesis 2a *All else equal, developing states set lower import tariffs on waste products that are net-imported into developing states, compared to waste products that are not.*

Second, when a global product market is not USD 1 but USD 1 billion, it dangles more opportunities, enticing new entrants and motivating current firms to remain competitive. A large and growing market also hints at longer-term opportunities for economic growth and strategic investments attractive to political actors. Overall, domestic economic and political interests around ensuring market access are more likely to align when the global product market is large. Additionally, a larger global market for a waste product signals deep downstream interest in its constituent raw materials and possibilities for importers to integrate into thriving global value chains.

Hypothesis 2b *All else equal, developing states set lower import tariffs on waste products with larger global markets, compared to other waste products.*

Given support for conceptualizing waste product tariffs as Pigouvian "sin" taxes, the question emerges: (when) can a developing state accommodate the economic dimension of the environmental-economic tradeoff at a higher tariff level? I argue that the structure of international markets, in combination with the physicality of waste products' negative externalities, create conditions under which developing state governments can increase the Pigouvian tariff higher at lower economic cost. These conditions have to do with a developing state's power in what I call the market for a waste product's negative externalities, or its "market for sin."

Waste product importers and exporters engage in voluntary transactions in commercial markets. Because waste products are physical goods, and negative externalities are embedded in the physical form of the waste product's EOL component, transferring the waste product across national borders also

[30] While specified and tested on the subset of traded waste products in order to demonstrate the economic side of the Pigouvian tradeoff, H2a and H2b are getting at dynamics relevant to traded goods in general.

transfers its negative externalities. Think of this as creating a second marketplace around the international distribution of the waste product's negative externalities. An importer's voluntary transaction simultaneously makes its state a "buyer" of the waste product's negative externalities, in a marketplace where its state "competes" with other national jurisdictions to hold EOL waste in its territory. In setting a Pigouvian tariff on a waste product, the state trades off the harm generated by its "competitiveness" in the waste product's market for negative externalities against the benefits generated by its importers' competitiveness in the waste product's commercial market.

When there is only one buyer in a market it is a monopsonist, and the seller must meet the monopsonist's demands or else the transaction fails. If all importers of a waste product are located in one state, it is the only national jurisdiction available as a geographic destination for a waste import's EOL component, so the state is the monopsonist in the waste product's market for negative externalities. Monopsony power allows a state to achieve its intended goal on the environmental side of the environmental-economic tradeoff with a higher Pigouvian tariff than otherwise. Monopsony power is a continuous concept, resulting from the interaction of two factors: the concentration in the market for negative externalities across national jurisdictions, and a state's share of that market. It can only operate if the market is concentrated enough to allow for outsized price-setting power. Therefore, the theoretical prediction is that beyond some threshold of market concentration, tariffs increase with import market share. The testable hypothesis is as follows:

Hypothesis 3 *A developing state sets a higher import tariff on a waste product when it has a higher share of the waste product's global import market, conditional on the global import market being highly geographically concentrated.*

The key scope condition behind H3 is that the developing state is constrained by a Pigouvian environmental-economic tradeoff in making its decision over openness to waste imports. As such, the state does not intend to raise the tariff so high as to select out of the market for negative externalities altogether. It is therefore useful to observing H3 that OECD states and their waste exporters are extremely inelastic to price. If a would-be exporter cannot agree to a low-enough price to make the commercial transaction worthwhile to it and the would-be importer, the waste product remains at home. For politicians, the international market mechanism failed to solve the "not in my backyard" (NIMBY) problem by relocating negative externalities to another sovereign's "backyard." These politicians have yawning incentives to subsidize their exporters enough to get the commercial market to clear, lest they have to devise another solution to the NIMBY problem.[31]

[31] Inter alia, the European Union's ban on single-use plastics took effect on 2 July 2021. Tests of observable implications for OECD states are left to future research.

Additionally, H3 can be adapted to speak to change over time. If and when a developing state finds itself no longer constrained by Pigouvian dynamics, it can set environmental protection higher – even to the level that it rejects imports of a waste product altogether. China did exactly that when it banned imports of 26 (HS 6-digit) waste products in its market-roiling 2017 "National Sword" policy. This article does not offer a theory of why China, or any developing state, would select out of the import market for a given waste product at a given time. Instead, H3 carries implications for what a reduction in the number of "competitors" in the market for negative externalities means for the developing states that remain.[32] Specifically, one or more remaining "competitors" can find themselves with very high import market shares after trade is diverted. All else equal, these "competitors" have an increased ability to exercise monopsony power and should set higher tariffs than they would have otherwise.[33]

Hypothesis 4 *Should a developing state ban the import of a waste product, developing states receiving high shares of diverted imports are likely to raise the import tariff higher, all else equal.*

5 Garbage Empirics

To provide support for H1-H3, I conduct regression analyses on novel panel data. To provide support for H4, I leverage the shock to the concentration of markets for negative externalities for 26 waste products that followed China's unexpected 2017 ban on imports of those (but not other) waste products. The dependent variable is the product-state-year applied most favored nation (MFN) import TARIFF for each waste product on the novel list of 179 introduced here (HS 6-digit level).[34] Figure 3 summarizes trends in the dependent variable, aggregated by the waste product's type, with the smoothed non-OECD average tariff for comparison.[35] Like the average tariff, waste product tariffs have generally followed a downward trend in recent decades. Considerable heterogeneity across waste type makes it an important fixed effect in empirical analyses.[36]

Variables of interest include MIXED PRODUCT, which equals one if the HS code definition indicates that the waste product is sold in a mixed or unsorted form (H1); NON-OECD NET IMPORT, which equals one if the waste product is net-imported into non-OECD states in the study period (H2a; see again Figure 2); and PRODUCT MARKET SIZE, which is the (logged USD) value of the worldwide trade in that product-year (H2b).

[32] The expansion of competitors is not relevant in this domain.

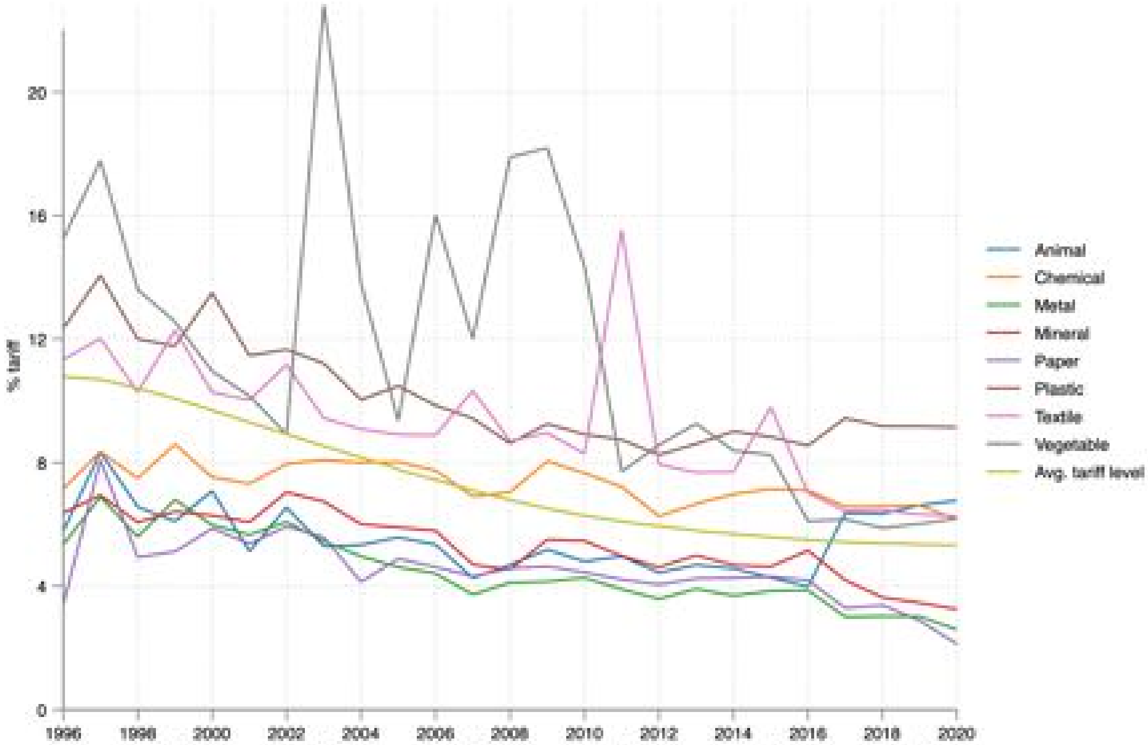
[33] Contained in "all else equal" is that market concentration remains high enough for monopsony power to operate (H3).

[34] Average WITS (TRAINS) ad valorem (or equivalent) duties expressed in percentage terms across all directed dyads for a given product-country-year. Enormous thanks to In Song Kim and collaborators for organizing these data in the TradeLab platform (Barari and Kim, 2022).

[35] Weighted mean applied tariff across all products (World Bank Open Data).

[36] See Appendix C.1 – C.3 for heterogeneity by product, state, and time.

Figure 3: This figure summarizes heterogeneity in non-OECD waste import tariff levels over time, with the non-OECD average tariff level as reference.



Notes: Observations report the average across all non-OECD states. Lines are the mean tariff for waste products by category. Smoothed line is the weighted mean applied tariff for all products.

Monopsony power builds from the share of surplus imports for a given waste product-state, as well as the distribution of the import surplus across all states by waste product-year, measured in tons.[37] Figure 4 summarizes the distribution of the Import surplus share, or the share of net imports located in the state's jurisdiction. For presentation purposes, Figure 4 summarizes average product-level import shares across the study period and reports values greater than 0.1. China has high import surplus shares for many waste products, but so do many other developing states. Further, the waste trade is indeed heterogeneous, as shares have varied considerably within developing states (including China). Herfindahl-Hirschman Indices (HHIs) account for the concentration of import surpluses across all states by waste product-year. Each waste product-year HHI is the sum of squared national shares of the worldwide import surplus (in tons).[38] Figure 5 shows that, while the mean HHI across waste product import market-years is relatively stable, there is considerable variation across distributions. Monopsony power is the interaction of Import surplus share and HHI, with the expectation that when HHI is sufficiently high, the product-level tariff increases with the state's Import surplus share (H3).

[37] Data from CEPII/COMPUSTAT (footnote 15). Placebo tests confirm that hypotheses are not supported when the import surplus is measured by value (USD), which is inconsistent with the physicality of EOL waste (Appendix B.3).

[38] HHIs necessarily include OECD state import surpluses where present, whereas the theoretically relevant sample of states making decisions over tariffs are non-OECD states. Placebo tests confirm that the theory is not supported with regard to the tariff decisions of OECD states (Appendix B.3).

Importantly, Figure 5 reports a number of outliers at very high HHIs, providing descriptive evidence that a theory built around monopsony power can be of practical use in understanding real-world outcomes.

Control variables address state-level economic and political factors. The Environmental Kuznets Curve literature suggests that GDP PER CAPITA is correlated with a lower waste product tariff and its squared term is correlated with a higher waste product tariff.[39] INDUSTRIAL OUTPUT is the value added by industry and construction as a percentage of GDP, which is expected to be positively correlated with demand for waste products as a source of raw materials and thus negatively related to the tariff. High UNEMPLOYMENT makes the state less interested in increasing costs to business, so it should also have a negative relationship with the tariff. TRADE PER GDP, electoral democracy (POLYARCHY, Lindberg et al. (2014)), and WTO MEMBER are all also known to have negative relationships with tariffs.

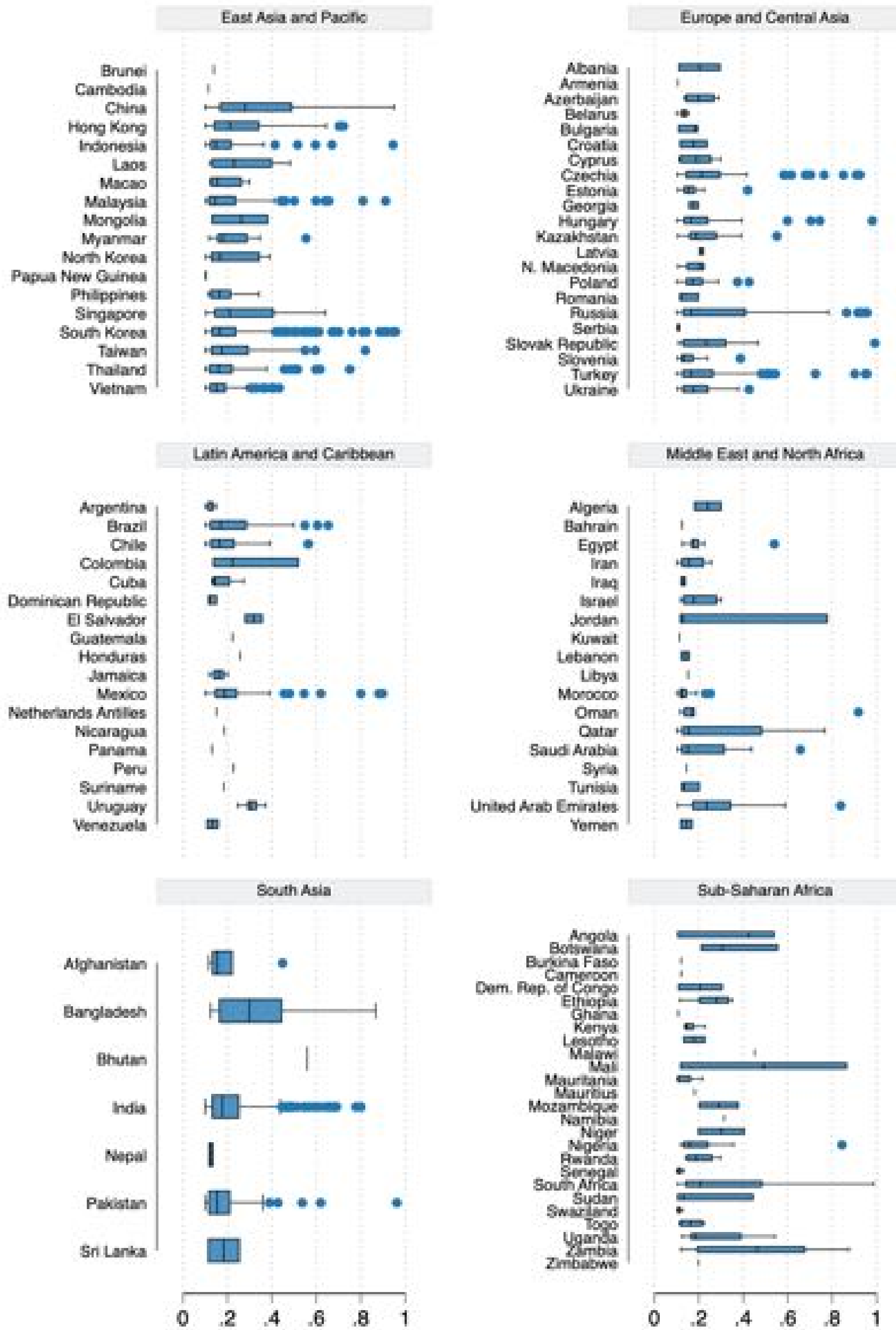
While this article's focus is on explaining variation in trade protection at the product-level as captured by the tariff, states also set national-level non-tariff barriers (NTBs) around waste imports. A state's holistic waste trade policy is surely more interrelated than is captured by an additive linear OLS model, and further research is needed on endogenous and potentially post-treatment choices over product-level tariffs in light of choices over NTBs (Brandi, Blümer and Morin, 2019). The theory's observable implication is simply that results on product-level tariffs should be robust to controlling for NTBs; coefficients should not be interpreted. I introduce an indicator for BASEL MEMBER, but the limitations of the Basel Convention suggest incentives for states to set their own regulatory policies as well (Yang, 2020). I therefore introduce a novel dataset of national-level NTBs that have the effect of restricting waste imports, coded from the Food and Agriculture Organization of the United Nations FAOLEX database.[40] In the study period (1995-2020), 157 non-OECD states adopted around 1200 national laws and regulations that restrict waste imports in some way. These appear on the whole to apply to targets or levels of aggregation other than the product-level. For example, 1997 legislation in Bulgaria established licensing protocols for importing waste and its transit through the country, and 2003 legislation in Ethiopia established a framework to implement Basel Convention reporting requirements. The empirical suggestion of complementarity between product-level tariffs and aggregated NTBs is consistent with states' increasing delegation of the operationalization of environmental laws to environmental ministries (Aklin and Urpelainen, 2014). As 80% of observations are of one or two NTBs introduced in a state-year, NATIONAL-LEVEL NTB is an indicator variable.

For all estimations, the unit of analysis is at the product-state-year level, and the sample covers the list of 179 waste products for up to 137 non-OECD states (1995-2020). The dependent variable

[39] The bivariate plot of IMPORT SURPLUS SHARE and GDP PER CAPITA reflects the suggested inverted U-shaped pattern (Appendix C.5). All variables are from the World Bank Open Databases unless otherwise specified.

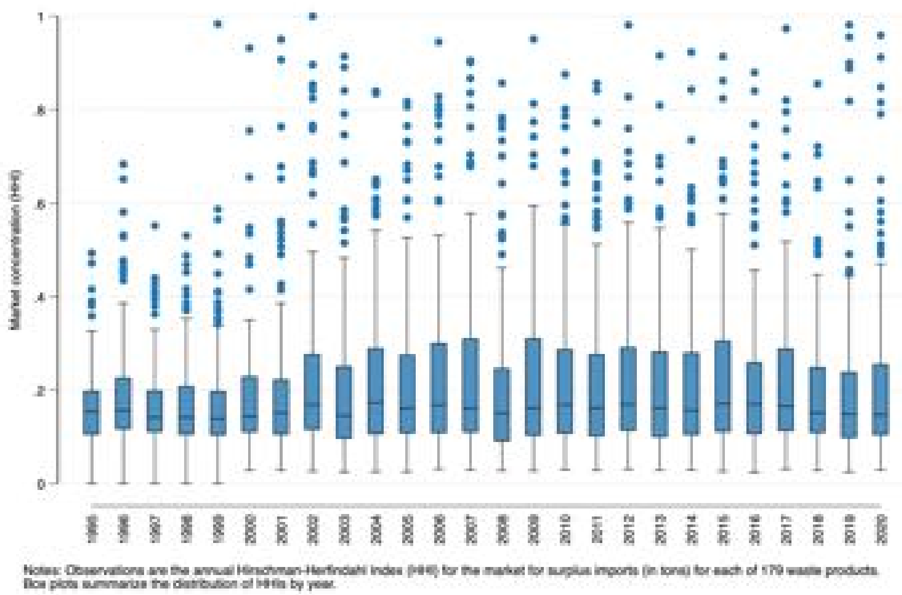
[40] Appendix C.6.

Figure 4: This figure illustrates cross-national heterogeneity in waste product import shares.



Notes: Observations are the national share of the world import surplus (in tons), for each of 179 products (avg. 1995-2020). Shares > 0.1 reported and summarized in box plots.

Figure 5: This figure summarizes heterogeneity in the concentration of markets for negative externalities for each of the 179 waste products, by year.



and all other transformed variables containing zero or negative values are the natural log of the inverse hyperbolic sine transformation of the unscaled underlying value (Aihounton and Henningsen, 2021). All independent variables are lagged, and standard errors are clustered by product-state. All models include state and year fixed effects, as well as waste type fixed effects (animal, chemical, metal, mineral, paper, plastic, textile, or vegetable).

5.1 Garbage Regressions

Table 1 presents the main results from OLS regressions. Across models, the coefficient on the high-negative externality indicator Mixed product is positive, significant, and of stable magnitude (H1). In support of a negative correlation between domestic demand and the tariff, coefficients on Non-OECD net import (H2a) and Product market share (H2b) are negative, significant, and of stable magnitude. The monopsony power coefficient of interest is on the interaction term between Import surplus share and HHI; it is positive across all models. The coefficient is smaller in magnitude once control variables are included in Model 4, and its magnitude is smaller in Model 5 that includes NTB covariates. To gauge support for H3, I plot marginal effects of Import surplus share on the tariff at all levels of HHI from 0 to 1. The marginal effect is increasing with HHI, and it becomes statistically significant at the 95% level starting at an HHI of about 0.5 in Model 4 (Figure 6) and at about 0.4 in Model 5 (Figure 7). Figures 6 and 7 display the histogram of values of HHI observed in the estimation sample, which makes clear that values of HHI above 0.5 are rare, consistent with the intuition that extreme market concentration should be rare. Nonetheless, the HHI exceeds 0.5 for 59 wastes products at some point in the sample period, and HHI exceeds 0.4 for 88 waste products, which reinforces the practical usefulness of the theory. Additionally, as the theory makes no prediction about tariff levels in the absence of a sufficiently concentrated market, the null results at low levels of HHI are consistent with H3.

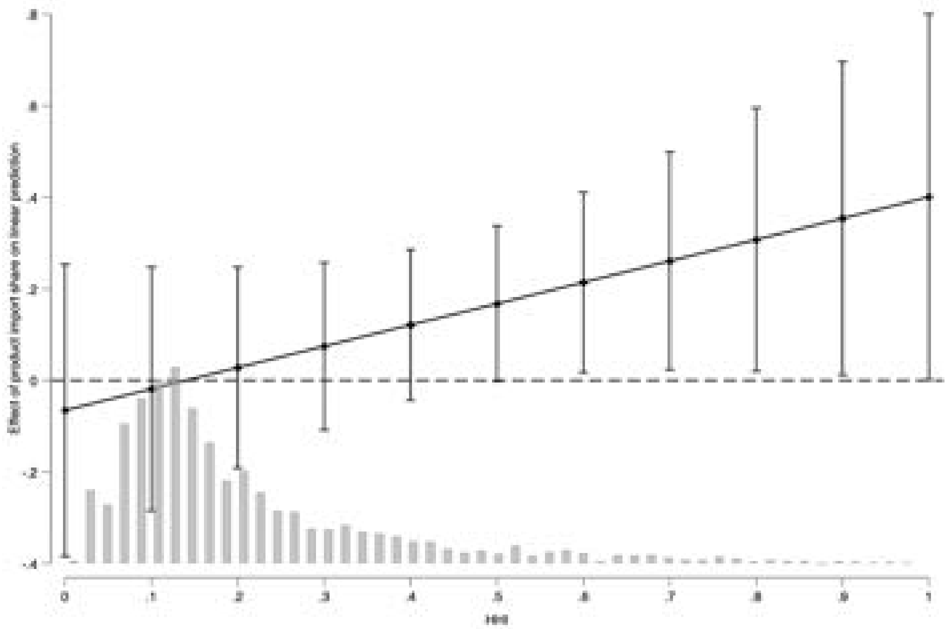


Figure 6: Marginal effects: Baseline (Table 1, Model 4). HHI exceeds 0.5 for 59 wastes products at some point in the sample period.

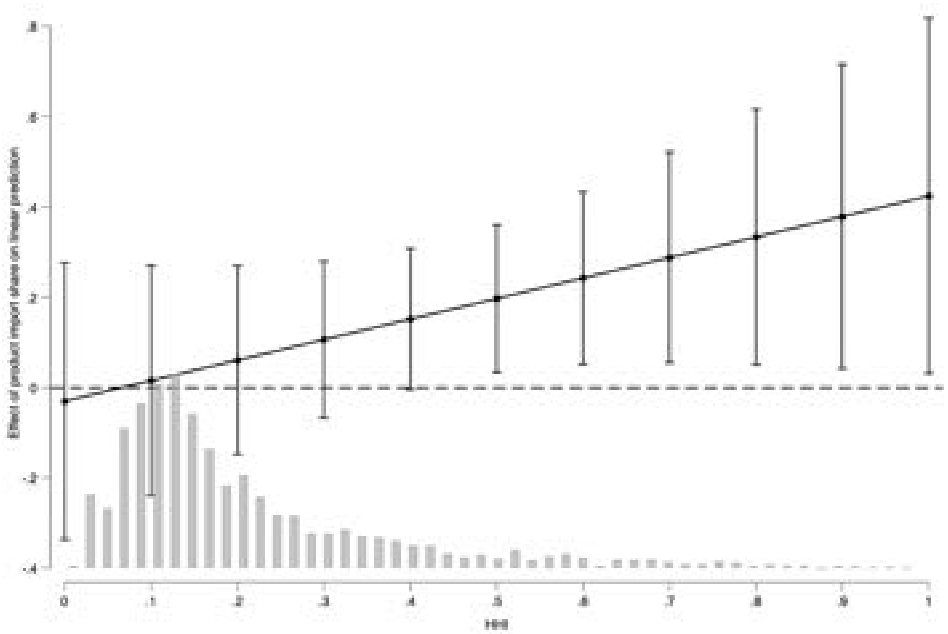


Figure 7: Marginal effects: With non-tariff barrier controls (Table 1, Model 5). HHI exceeds 0.4 for 88 waste products at some point in the sample period.

In additional tests, I focus on the sensitivity of the monopsony power results; other results are

Table 1: Garbage Tariffs: Trade-offs and Monopsony Power

	(1)	(2)	(3)	(4)	(5)
Mixed product	0.272***		0.273***	0.302***	0.302***
	(0.0305)		(0.0305)	(0.0335)	(0.0336)
Non-OECD net import	-0.148***		-0.149***	-0.169***	-0.169***
	(0.0167)		(0.0167)	(0.0177)	(0.0177)
L.Product market size	-0.00743***		-0.00730***	-0.00594***	-0.00601***
	(0.00143)		(0.00143)	(0.00150)	(0.00150)
L.Import share		-0.326**	-0.222	-0.0626	-0.0545
		(0.154)	(0.154)	(0.163)	(0.162)
L.HHI		-0.0225	-0.0304	-0.0596**	-0.0598**
		(0.0259)	(0.0259)	(0.0267)	(0.0267)
L.Import share × L.HHI		0.654**	0.534*	0.463	0.456
		(0.319)	(0.319)	(0.325)	(0.325)
L.GDP per capita				-3.467***	-3.324***
				(0.559)	(0.563)
L.GDP per capita sq.				4.145***	4.047***
				(0.598)	(0.602)
L.Industrial output				-0.342***	-0.347***
				(0.0401)	(0.0400)
L.Unemployment				-0.0201***	-0.0201***
				(0.00202)	(0.00203)
L.Trade per GDP				-0.109***	-0.110***
				(0.0262)	(0.0259)
L.Polyarchy				-0.351***	-0.357***
				(0.0560)	(0.0558)
L.WTO member				-0.124***	-0.128***
				(0.0232)	(0.0232)
L.Basel member					0.0744***
					(0.0255)
L.National-level NTB					0.0265***
					(0.00445)
Constant	3.244***	3.162***	3.250***	5.248***	5.278***
	(0.0884)	(0.0846)	(0.0885)	(0.225)	(0.225)
Waste Type	Yes	Yes	Yes	Yes	Yes
State	Yes	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes	Yes
Observations	133,449	133,449	133,449	116,943	116,943
Clusters	15,799	15,799	15,799	13,556	13,556
R-squared	0.428	0.422	0.428	0.428	0.428

Min. sample: 137 non-OECD states, 179 products, 25 years (1996-2020).

SE clustered by product-state. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

robust.[41] First, I reestimate Table 1 Model 4, dropping products of each waste type in turn. The coefficient size closely overlaps with that of Model 4 in all instances but one. When metal waste is excluded, the point estimate decreases to the lower end of the confidence interval from Model 4, implying that empirical evidence in support of H3 is strongly influenced by metal waste products – which are in fact 64 of the 179 products. Second, although market concentration is a continuous concept, I check robustness to binary indicators generated by binning HHIs above and below different thresholds. Overall, this exercise suggests that meaningful variation important to the results is lost when dichotomizing HHI.[42] Third, consistent with the argument that monopsony power acts through trends in physical negative externalities, the interaction term has the wrong sign if its constituent variables are generated from USD values and not volume. Fourth, consistent with the theory's scope conditions, results are not robust to an estimation sample comprised of OECD states. Fifth, given China's importance in the global waste trade, I exclude China from the sample and find that monopsony power marginal effects no longer attain significance. While there is no theoretical reason to drop China from the sample, China's importance motivates the next section testing H4, where I leverage China's decision to drop itself from the sample for 26 waste products.

6 China's Garbage Ban

China's rise and its near-insatiable demand for raw materials over the last decades have been central in the development of the global waste trade (Minter, 2015).[43] So, when on 18 July 2017 the Chinese government issued its "National Sword" policy – "A Comprehensive Ban on the Entry of Foreign Garbage" – it shocked the waste trade.[44] The ban's precise timing was a product of issue linkage, serving as one of China's opening salvos in the US-China trade war.[45] For its part, the global waste management industry had thought China's "Green Fence" policy that revamped regulatory enforcement four years earlier was successful enough to preclude the need for further action anytime soon, and certainly not at such a scale.[46] The specific effect of what came to be called the China ban was to ban imports of 26 HS 6-digit waste products, including several ash, residue, and slag products containing mixed metals; several yarn and textile waste products made of cotton, wool and animal hair, or artificial fibers; sorted

[41] Appendix B.1 – B.3.
[42] The coefficient is positive and significant for HHI thresholds of 0.5 and 0.7 (at the 90% level).
[43] At some point in the study period (1995-2020), China accounted for over 50% of the import share for 45 different waste products.
[44] "General Office of the State Council on the issuance of a ban on the entry of foreign garbage to promote the reform of the solid waste import management system" State Office [2017] No. 70. 18 July 2017. In the text of the ban, China contextualizes how important the waste trade has been to it: "since the 1980s, in order to alleviate the shortage of raw materials, China began to import solid wastes from abroad." Translations from DeepL.
[45] The US had begun national security investigations of China on 20 April. Bown, Chad P. and Melina Kolb. "Trump's Trade War Timeline: An Up-to-Date Guide." Peterson Institute for International Economics. June 2022.
[46] Flower, Will. "What Operation Green Fence has meant for Recycling." 11 February 2016. Waste 360.

and unsorted rags; unsorted paper; and all post-consumer plastics products.[47] Import bans on unsorted waste paper and post-consumer plastics would be fully implemented in the five months before the end of 2017; the implementation timeline for other bans was delegated to regulators, although the goal of speed was implied. In the wake of the China ban, recycling and waste management systems buckled worldwide (Brooks, Wang and Jambeck, 2018).

Another way to understand the China ban is that in 2017 China suddenly selected out of the markets for negative externalities for 26 waste products. The China ban led to trade diversion for banned waste products, as traced by a number of careful studies (Ma et al., 2021; Brooks, Wang and Jambeck, 2018, e.g.). This makes it an appropriate setting to operationalize and test H4. Given that trade diversion "treats" some developing state-banned product combinations with higher import market shares than they would have had absent the China ban, the theory predicts that Pigouvian motivations lead to higher tariffs among treated combinations, all else equal. For all else to be equal, it must be the case that banned waste product's market concentration (HHI) remains sufficiently high after China's exit for monopsony power to operate (H3). This is an empirical question; this article offers no theory about why China selected out of these waste import markets in particular. In fact, HHIs for banned waste products have steadily declined, making it more difficult to find support for H4.[48]

The research design most suited to this setting is differences-in-differences (DiD) estimation of the average treatment effect on the treated (ATET), or the effect on the tariff for treated developing state-banned product combinations, compared to the counterfactual in which those developing state-banned product combinations were not treated. For DiD to be identified, we must be satisfied with the "parallel trends" assumption: the trends in tariffs for treated and untreated developing state-banned product combinations were parallel before the China ban, and they would have remained parallel if not for the China ban. This is a high hurdle. Theoretically, developing states that "compete" in markets for negative externalities are surely motivated to account for expectations over the policy choices of their "competitors," and especially one as big as China.[49] That said, it is likely that the trade-war timing of China's ban was unpredictable enough to weaken the ability of China's "competitors" to have fully anticipated the 2017 action in their previous waste trade policy. I conceptualize the treatment in two ways, each of which differently address the theoretical plausibility of the parallel trends assumption.[50] While neither is dispositive methodologically, I offer that the results in combination provide judicious support for H4.

[47] Appendix D.

[48] As it happens, China had large import market shares for the 26 banned products, more than double those for other waste products. The volume of worldwide exports of banned products has trended downwards post-treatment, compared to an upward trend in exports of other waste products. Appendix C.7.

[49] Empirically, HHIs for banned product import markets were already following a downward trend prior to the China ban. Appendix C.7.

[50] On empirical plausibility, see Appendix C.8 for parallel trends plots.

The first conceptualization of the treatment is geographical: in the commercial market, exporters were likely to divert banned waste products to importers in China's neighborhood – especially in an emergency situation when ships at sea suddenly needed new ports of entry. So, the treatment in the market for negative externalities applies to combinations of Asia-Pacific developing states and banned waste products. In terms of the parallel trends assumption, of all the developing states in the world, surely China's neighbors are motivated to anticipate a shock that would divert foreigners' garbage from China to their own shores. On the other hand, the Asia-Pacific geographic treatment has the advantage of exogeneity; it likely marks as treated many developing state-banned product combinations are not real "competitors" of China, making the treatment assignment less precise and effects more difficult to uncover.

The second conceptualization of the treatment is based on worldwide distributions of markets for negative externalities before the China ban. A developing state-banned product combination is treated if at any point in the pre-treatment period its import market share passed the 99th (95th) percentile threshold of the pre-ban distribution of import market shares (1995-2016). The Pre-ban 99% (Pre-ban 95%) treatment reflects the intuition that exporters are more likely to divert trade to buyers in commercial markets with more preexisting import activity. On one hand, this conceptualization risks circular logic; the correlation between the Pre-ban 99% treatment and the same calculation using post-treatment data is very high at 0.76, while somewhat lower for the Pre-ban 95% treatment at 0.40. On the other hand, for the three years before the China ban, I cannot reject the null that the distributions were the same for banned and other waste products, while a significant difference does appear in each of the three years following the China ban.[51] Further, the correlations between the distribution-based Pre-ban 99% and Pre-ban 95% treatments and the Asia-Pacific treatment are very low, at 0.02 and 0.16 respectively, making it more difficult to find consistent support for H4 across all.

Table 2 reports results using each treatment, for both reduced form and full models. Effects are positive and significant as expected for all treatment specifications. Magnitudes are largest for the Pre-ban 99% treatment, although note that there are few treated clusters. Effect sizes using the Asia-Pacific treatment and Pre-ban 95% treatment are smaller but of similar magnitudes, lending credence to the reliability of results despite different shortcomings across conceptualizations.[52] Overall, Table 2 provides judicious support for H4: in the wake of the China ban's shock to some commercial waste product markets, developing state-banned product combinations treated with higher import market shares are more likely to exercise monopsony power in setting higher product-level tariffs.

[51] At the 90% level or higher. Using the *distcomp* package in Stata (Kaplan, 2019). See replication files.

[52] The ATET is not robust when the treatment is defined at the 90th percentile (1317 clusters are treated; correlations with the Table 2 treatments are 0.18, 0.26, and 0.73 respectively).

Table 2: China Garbage Shock: Monopsony Power and Higher Tariffs

	(1)	(2)	(3)	(4)	(5)	(6)
ATET						
Treated: Asia-Pacific	0.128***	0.0888**				
	(0.0259)	(0.0359)				
Treated: Pre-ban 99%			0.327***	0.339***		
			(0.0684)	(0.0789)		
Treated: Pre-ban 95%					0.101**	0.115**
					(0.0458)	(0.0536)
Full Model	No	Yes	No	Yes	No	Yes
Observations	156,949	115,317	156,949	115,317	156,949	115,317
Clusters	19,171	13,379	19,171	13,379	19,171	13,379
Treated clusters	1,427	1,427	92	92	701	701

Sample: 136 non-OECD states (China excluded) Full Model = Table 1 Model 4 covariates.
SE clustered by product-state. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Since the 2017 China ban, some other developing states have made forays into not just taxing but banning certain waste imports. The theory's scope condition implies that if a developing state were to ban imports of a waste product for which it faced a binding Pigouvian environmental-economic tradeoff, it should face politically consequential backlash from industry. Such backlash played out in Turkey when it attempted a ban on the import of ethylene polymer waste and scrap (HS 391510), a waste product banned by China that European exporters subsequently diverted in large quantities to Turkish importers (Gundougdu and Walker, 2021). The Turkish ban was announced in May 2021, went into effect for a week in July, and was then overturned. The Turkish plastics recycling association estimated that the uncertainty around the ban cost the industry USD 547 million. In a press release, the association celebrated the success of its lobbying campaign and named government officials who were particularly helpful.[53] Just as in Turkey, India faced backlash when in June 2022 it enacted a ban on the full set of waste plastic products China had banned five years earlier. The Indian plastics industry was "up in arms," protesting that "thousands of jobs are at stake," and the ban's enforceability was immediately in question.[54] Even developing states like Turkey and India that find themselves with outsized monopsony power in the wake of the China ban have not broken out of the theory's scope condition. One implication is that Turkey, India, and similarly placed developing states might remember tariffs as a means of trading off between environmental and economic priorities, despite being old-fashioned and less headline-worthy.

[53] "Polyethylene Waste Imports Ban is Lifted with Active Control!" PAGEV News Release, accessed January 2023. See also: Algedik, Onder. "Who opened the door to Europe's waste?" 4 April 2022. Duva.R. Turkish President Erdogan's wife Emine has gotten the nickname "the Queen of Trash" amid rumors of personal influence around waste imports, as well as politically-correlated inequities in the subnational distribution of EOL waste.

[54] Masih, Niha and Anat Gupta. "India imposes ban on single-use plastics. But will it be enforced?" 1 July 2022. Washington Post.

7 Garbage Conclusion

The global waste trade exists because importers in one national political jurisdiction demand waste products, and exporters in another national jurisdiction find it profitable to offer them for sale. Waste products are not inferior sources of inputs in themselves: 40% of raw materials are sourced from waste products globally.[55] What makes the waste trade different is that these voluntary transactions relocate physical, even smelly negative externalities from one national jurisdiction to another. Because waste products by definition contain recyclable and EOL waste content, one importer's "treasure" still contains trash. Foreigners' trash generates environmental, social, and political costs that accrue especially in developing states, on whose "backyards" developed states rely in dealing with their own NIMBY problems. In this way, the waste trade can manifest a race to the bottom. Usefully, a product-line tariff – a standard protectionist trade policy tool – can operate as a Pigouvian "sin" tax allowing the developing state to negotiate the tradeoff between mitigating environmental harm and benefiting from economic openness. Tariffs can be repurposed to abate the race to the bottom.

The structure of international markets and the physicality of the waste trade's negative externalities generate power for developing states with more, and more consequential, piles of foreign garbage. Alongside the commercial market is a market for negative externalities, or a "market for sin" brought along with the recyclable portion of a waste import. States "compete" in the market for negative externalities, with product-line tariffs as a means of adjusting the "price" at which they are willing to "buy" EOL waste from commercial market actors. As in any marketplace, if and when a player gains monopsony power, it gains price-setting power. Monopsony power in a waste product's market for negative externalities enables a developing state to set a higher import tariff, extracting more compensation for environmental harms while still accommodating domestic demand.

The theory and evidence in this paper demonstrate that economic globalization, sustainability, and the normative appeal of the "circular economy" approach come together in complex ways. Market mechanisms reallocate productive materials across national borders. But, when the traded product is waste, voluntary transactions simultaneously offshore materials that are harmful – even morally so. The waste trade illustrates that developing states can leverage market power to their advantage in alleviating the consequences of low state capacity and protecting the environment within their territorial jurisdictions. I hope for this article to raise more questions than it answers about the context and consequences of this market power, and that the rubbish circumstances around the waste trade provide a jumping off point for more scholars of international relations and political economy.

For now, think again of my parents parsing the City of Mesa mailer explaining what is and is

[55] As of 2023. Bureau of International Recycling `https://www.bir.org/the-industry`

not recyclable as of January 2022.[56] In defending its new "When in Doubt, Keep it Out" tagline, Mesa includes in the mailer's fine print that its service providers are only accepting items with "strong market value." The theory and evidence in this article clear up the backstory: developing states have been demanding more compensation in exchange for serving as repositories for foreigners' garbage, which squeezes exporters' margins and undermines Mesa's ability to use international markets to solve its NIMBY problems. Mesa writes that "generating less trash is always our BEST option." But for the time being, Mesa needs my parents to take into account whether an (un)washed plastic yogurt container collected in Mesa, Arizona is sufficiently attractive as a source of recyclable inputs to importers, and the developing states in which they are located, to put it in the recycle bin or throw it in the trash.[57]

[56]See again Appendix A.

[57]At the time of writing, it goes in the trash.

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Waste to the Bottom: Garbage Appendix

Table of Contents

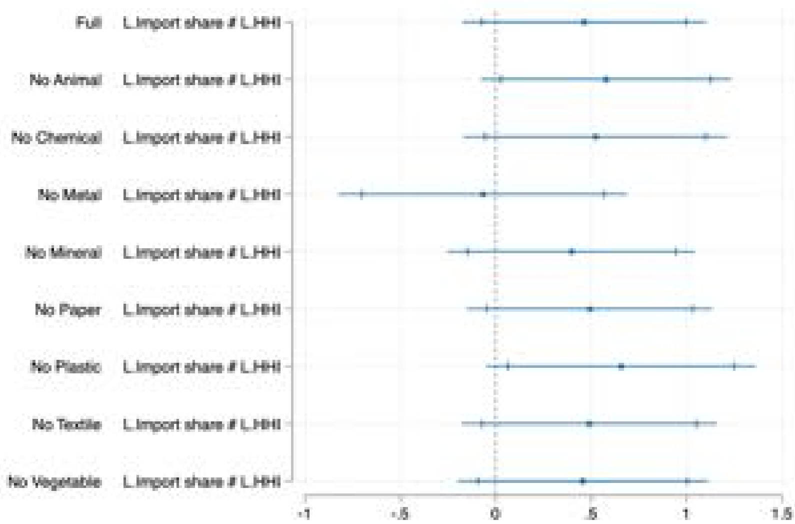
A "When in Doubt, Throw it Out"

Figure 8: City of Mesa mailer to households, January 2022.

B Additional Results

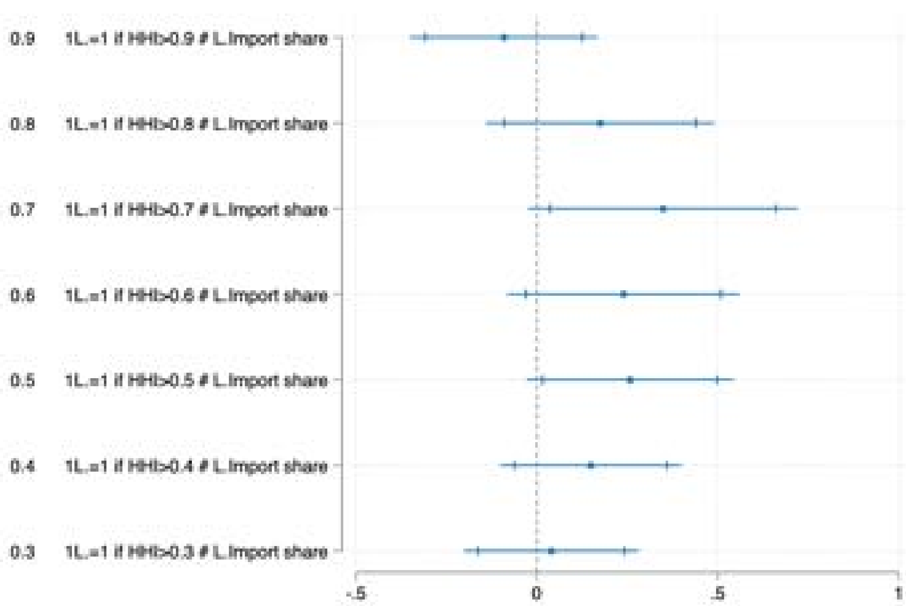
B.1 Robustness: Manipulating waste product sample

Figure 9: Monopsony power coefficients of interest, Table 1 Model 4, excluding types of waste products (Full results in replication files)



B.2 Robustness: Binary operationalizations of market concentration

Figure 10: Monopsony power coefficients of interest, Table 1 Model 4, with HHI dichotomized as indicated (Full results in replication files)



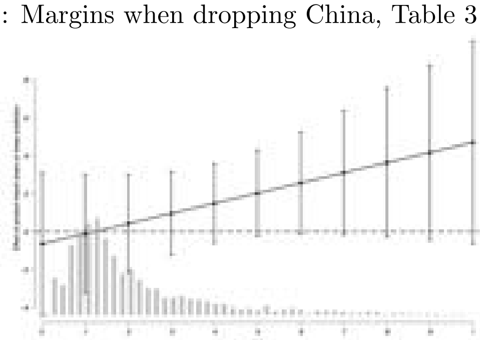
B.3 Robustness: Sensitivity and placebo tests

Table 3: Garbage Tariff Robustness and Placebo Tests

	(1) USD Shares	(2) OECD Only	(3) No China
L.Import share (USD)	0.0589 (0.173)		
L.HHI (USD)	-0.0765** (0.0369)		
L.Import share (USD) × L.HHI (USD)	-0.121 (0.358)		
Mixed product	0.302*** (0.0335)	0.0983 (0.119)	0.305*** (0.0338)
Non-OECD net import	-0.169*** (0.0177)	0.0489 (0.0523)	-0.169*** (0.0179)
L.Product market size	-0.00600*** (0.00151)	-0.0261*** (0.00859)	-0.00591*** (0.00151)
L.Basel member	0.0745*** (0.0255)		0.0734*** (0.0255)
L.National-level NTB	0.0265*** (0.00445)	0.0491*** (0.00967)	0.0234*** (0.00451)
L.GDP per capita	-3.306*** (0.563)	8.328*** (1.755)	-5.093*** (0.628)
L.GDP per capita sq.	4.027*** (0.603)	-8.145*** (1.392)	5.987*** (0.673)
L.Industrial output	-0.347*** (0.0400)	0.533*** (0.152)	-0.333*** (0.0401)
L.Unemployment	-0.0201*** (0.00203)	-0.0313*** (0.00719)	-0.0222*** (0.00204)
L.Trade per GDP	-0.109*** (0.0259)	0.319*** (0.0978)	-0.115*** (0.0261)
L.Polyarchy	-0.357*** (0.0558)	-0.637** (0.305)	-0.361*** (0.0557)
L.WTO member	-0.127*** (0.0233)		-0.158*** (0.0248)
L.Import share		0.205* (0.124)	-0.104 (0.199)
L.HHI		-0.0168 (0.0422)	-0.0579** (0.0270)
L.Import share × L.HHI		-0.334* (0.192)	0.539 (0.417)
Constant	5.279*** (0.225)	-4.037*** (1.061)	5.281*** (0.225)
Waste Type	Yes	Yes	Yes
State	Yes	Yes	Yes
Year	Yes	Yes	Yes
Observations	116,943	18,034	115,317
Clusters	13,556	1,321	13,379
R-squared	0.428	0.152	0.428

SE clustered by product-state.
* p < 0.1, ** p < 0.05, *** p < 0.01.

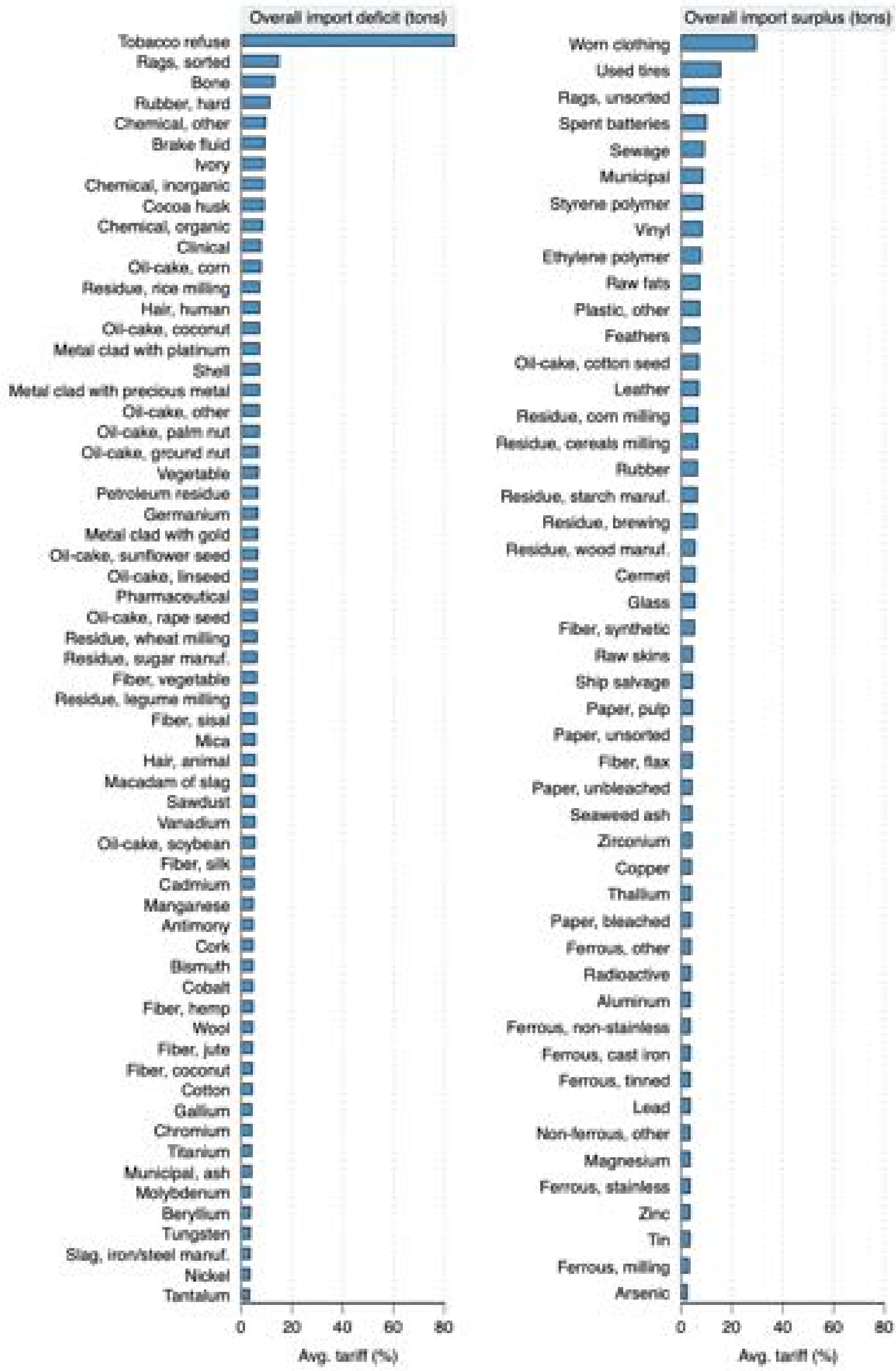
Figure 11: Margins when dropping China, Table 3 Model 3



C Descriptive Information

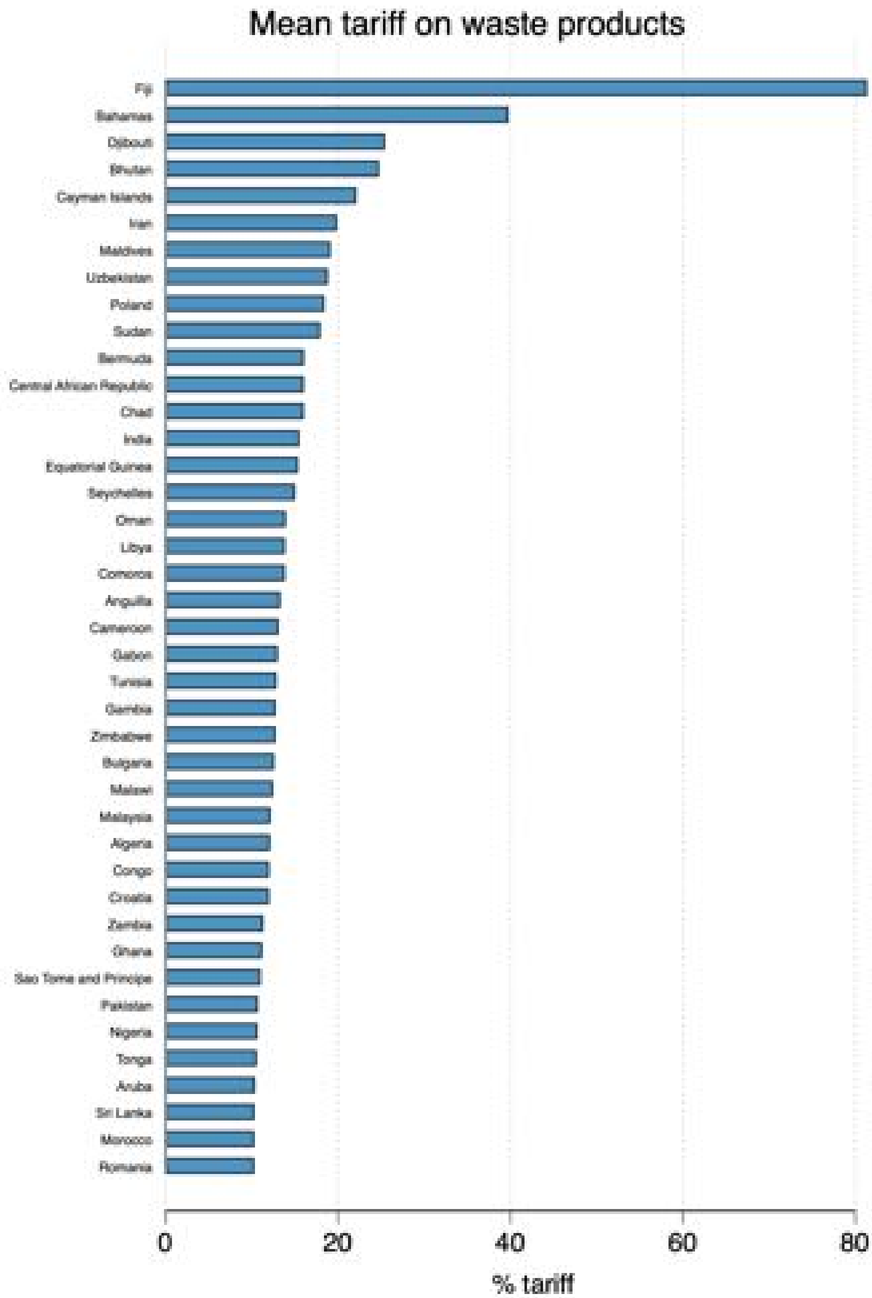
C.1 Average waste product tariffs, by non-OECD import status

Figure 12: Summary of average tariffs, 1996-2020. The left (right) panel includes products for which non-OECD states have a net import deficit (surplus) in the study period. HS codes with similar definitions have been collapsed for presentation purposes.



C.2 Non-OECD states with very high average waste product tariffs

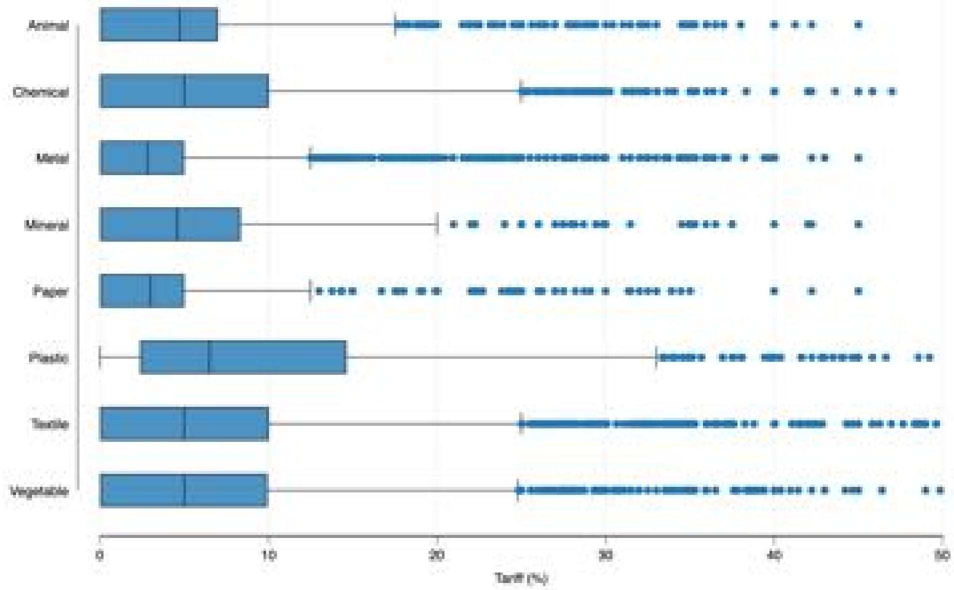
Figure 13: Summary of non-OECD states with average import tariffs over 10%, 179 waste products (1995-2020). Note that Fiji stands out in the number one position for exceptionally high average tariffs, of over 80%. Fiji is not a member of the primary multilateral organization in this space, the Basel Convention on the Transboundary Movement of Hazardous Wastes and Their Disposal; it could be that Fiji's high tariffs are somehow compensating for its lack of access to Basel Convention regulatory resources.



Notes: Observations are the mean import tariff across 179 waste products (1996-2020).
Non-OECD states with values > 10% reported.

C.3 Evidence of waste product tariff heterogeneity

Figure 14: Summary of heterogeneity in import tariffs by waste product-country-year that constitute the dependent variable. Tariffs <50% for Non-OECD states, 179 products, 1996-2020 reported.



Notes: Box plots in this figure summarize distributions and outliers for waste product-country-year tariffs. Observations greater than 50% are not reported.

C.4 Non-OECD import surpluses (deficits), by waste type

Figure 15: Animal products

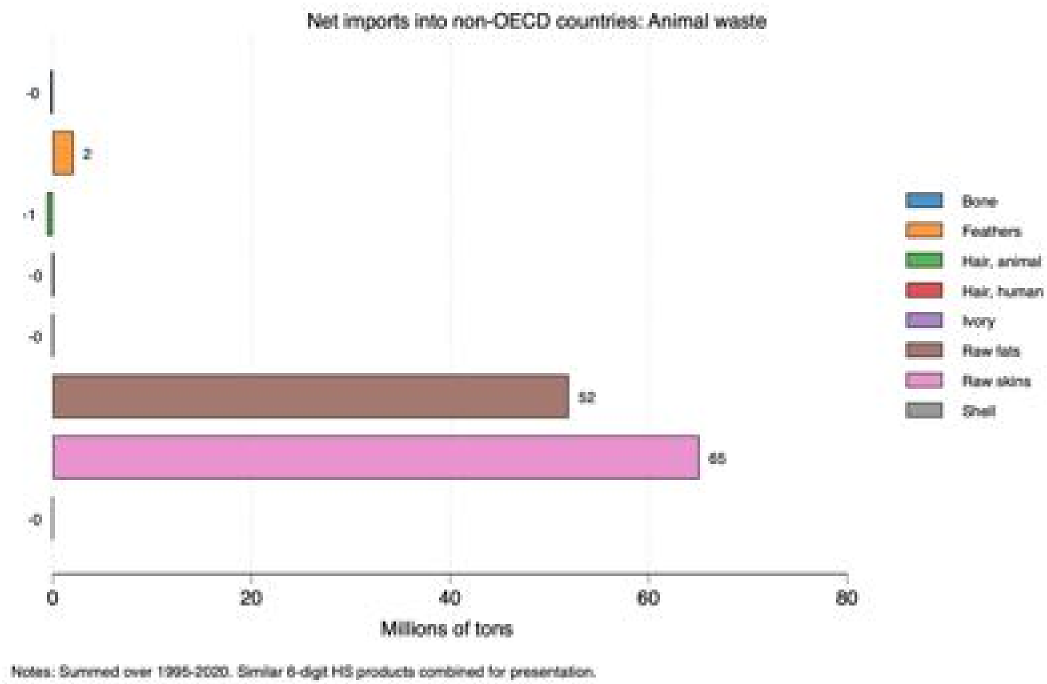


Figure 16: Chemical products

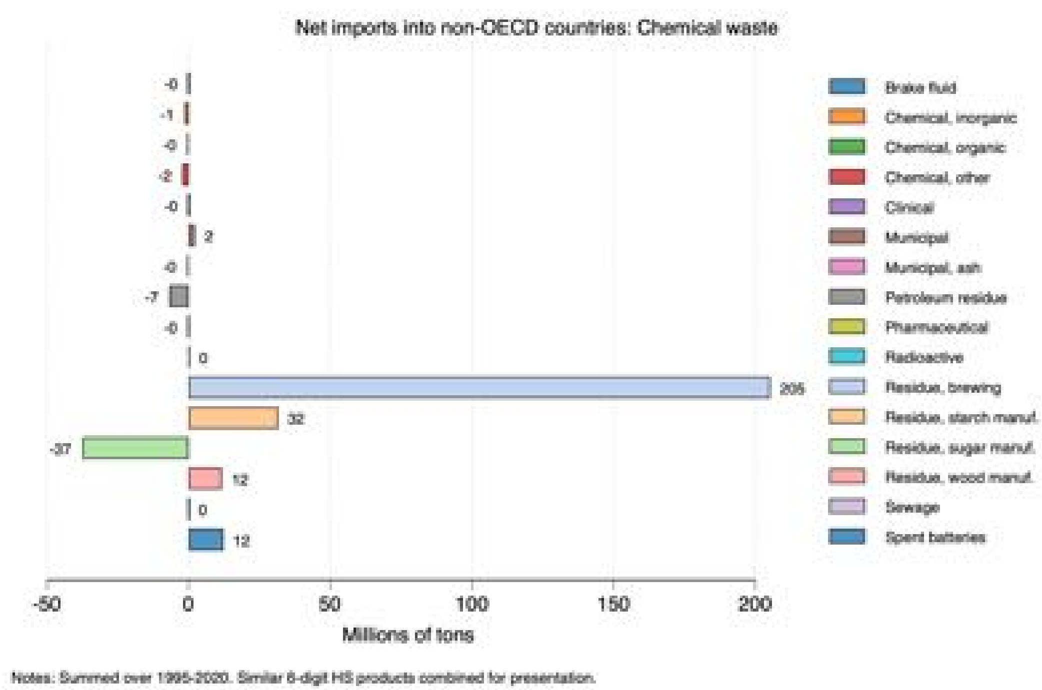


Figure 17: Paper products

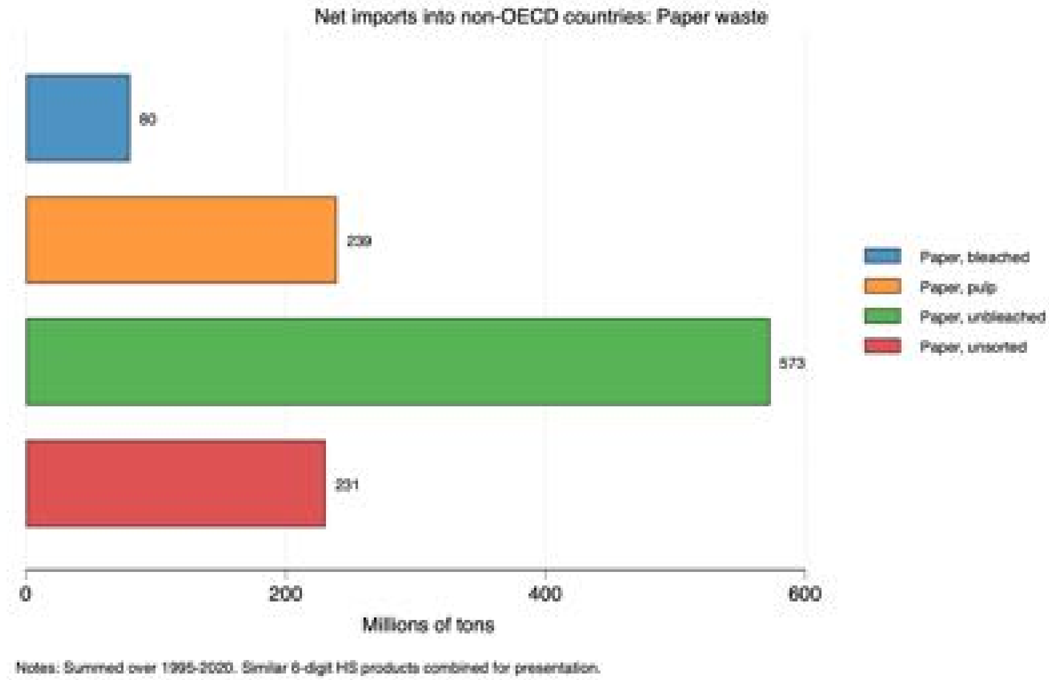


Figure 18: Plastic products

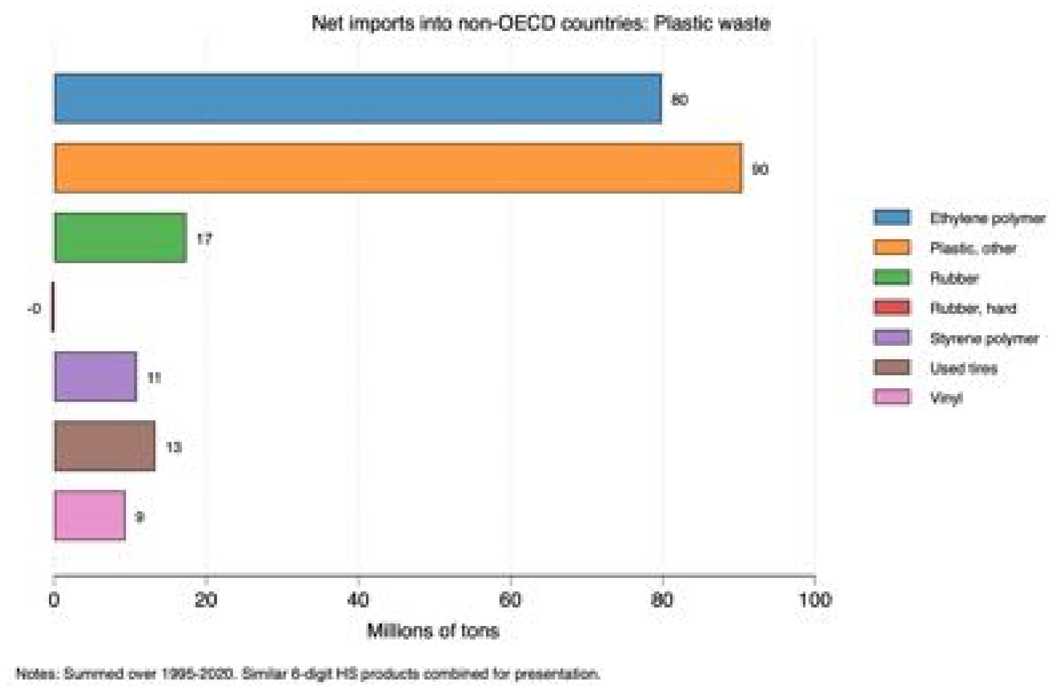


Figure 19: Metal products

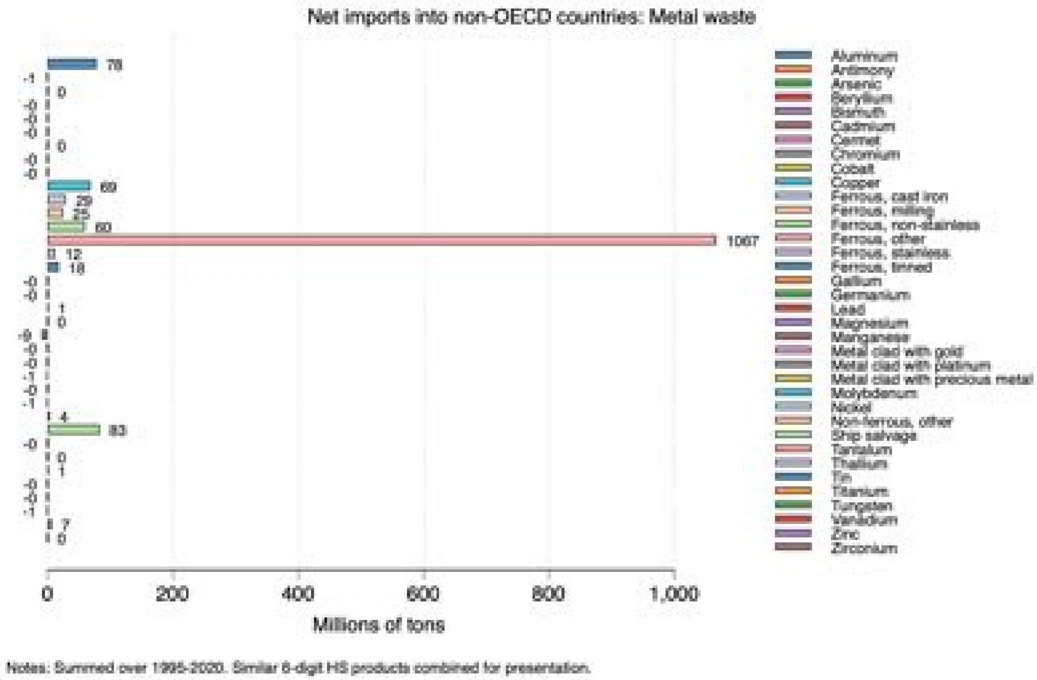


Figure 20: Mineral products

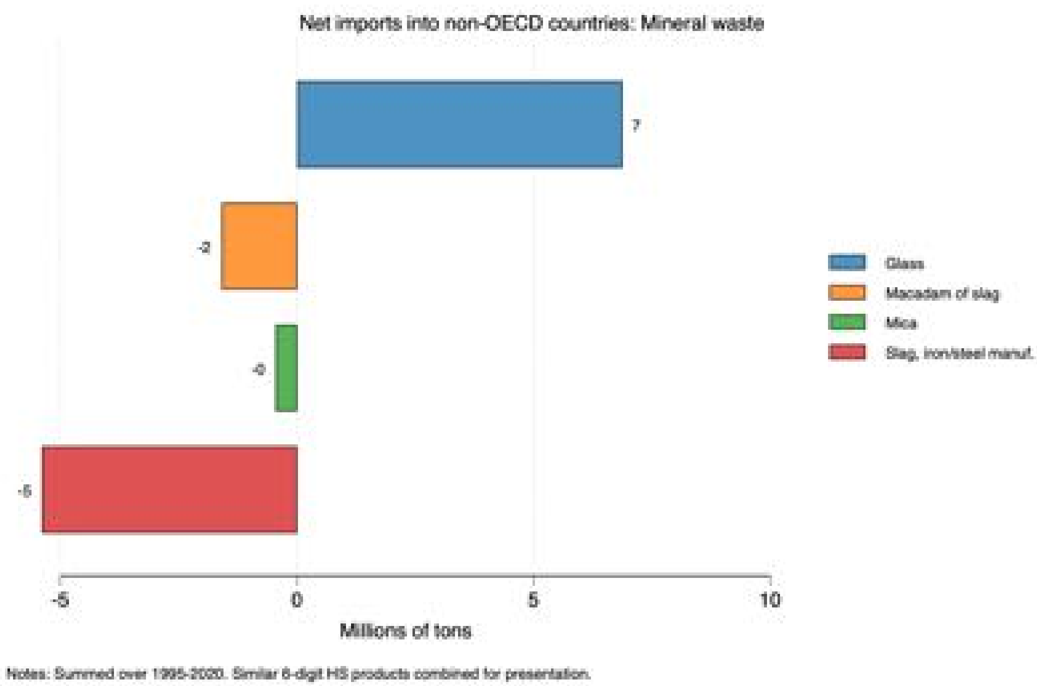


Figure 21: Textile products

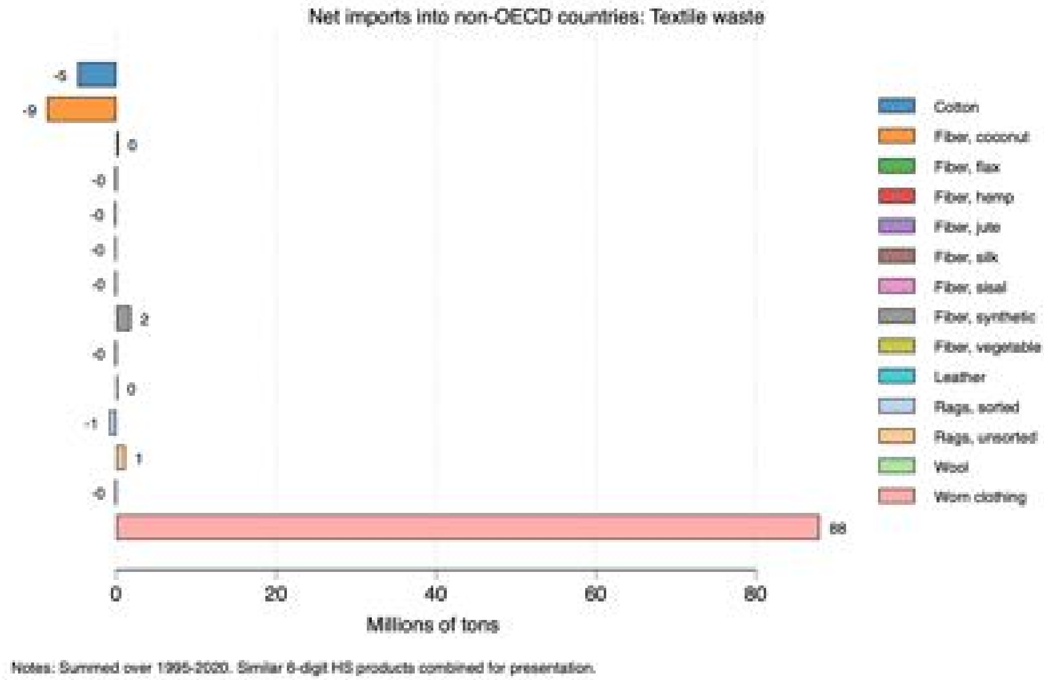
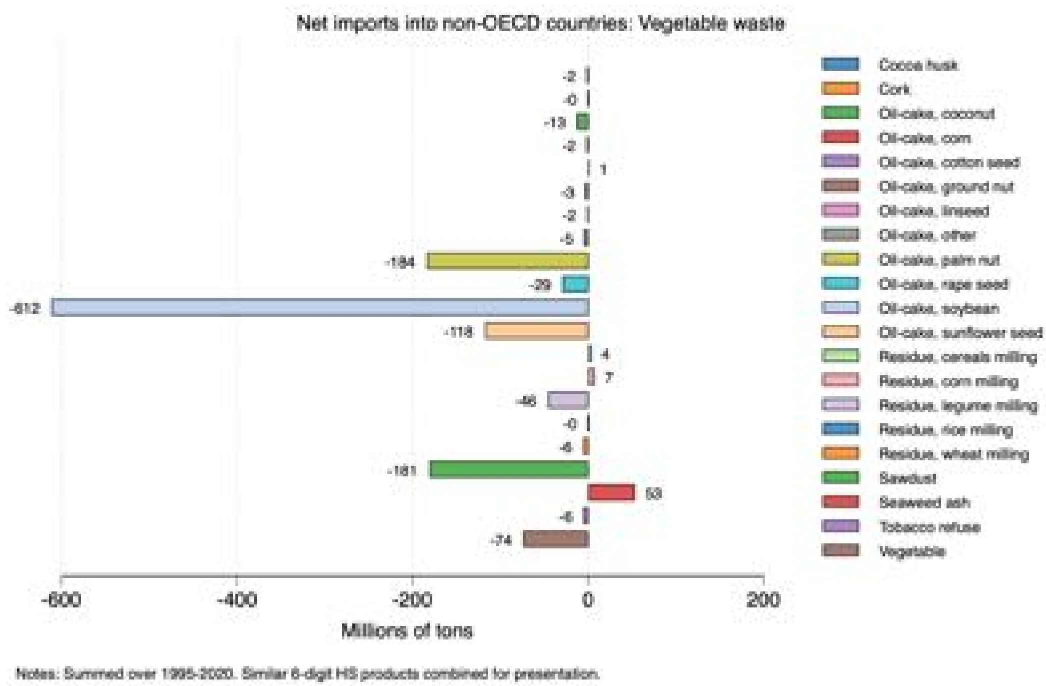
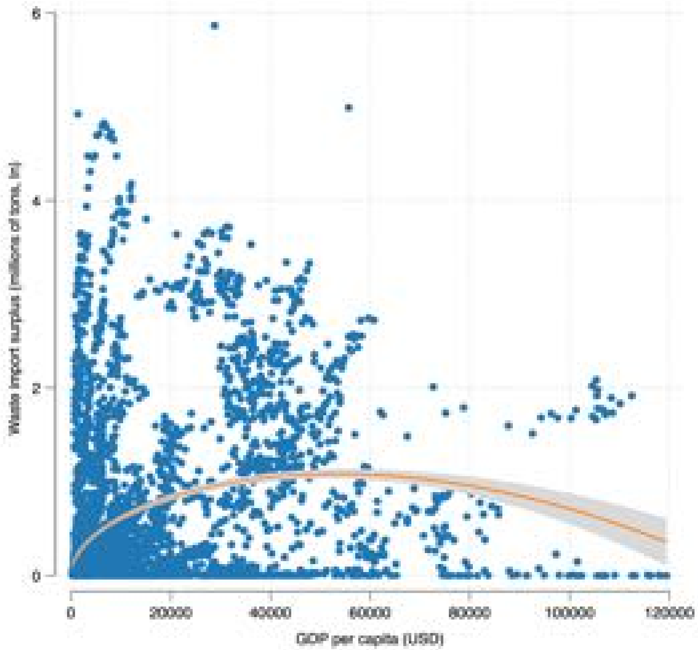


Figure 22: Vegetable products



C.5 Evidence of Environmental Kuznets Curve pattern

Figure 23: Evidence of inverse U-shape pattern as predicted by Environmental Kuznets Curve literature.

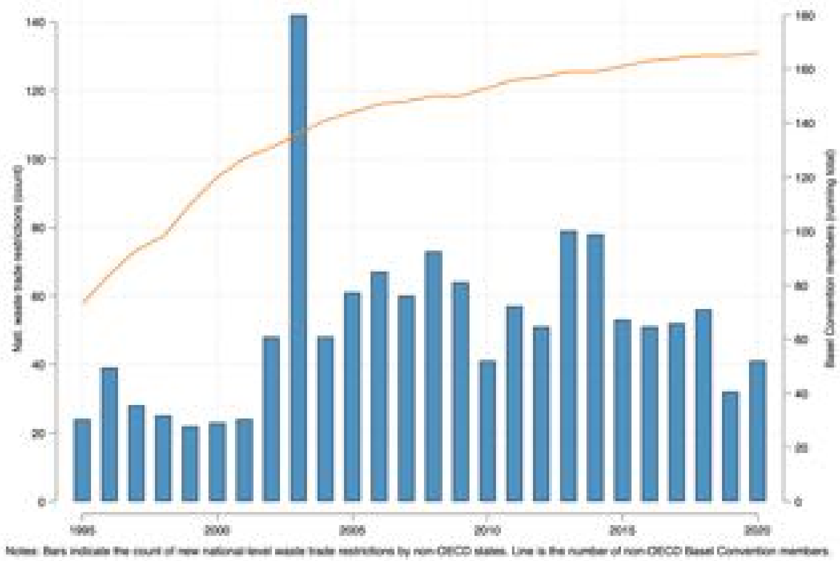


Notes: Observations by country-year (1995-2020). Fractional polynomial fit curve with 95% confidence.

C.6 Non-Tariff Barriers

The United Nations FAOLEX database categorizes 10,050 unique laws in the "waste and hazardous substances" domain from 1923-2020 (`https://www.fao.org/faolex/en/` accessed January 2022). To be a non-tariff barrier on waste imports, the law must additionally fit at least one of four additional criteria: FAOLEX codes trade as its primary category; FAOLEX keywords include "international trade"; the law is multilateral (and thus relevant to cross-border issues); and/or the actual text of the law includes at least one of a set of keywords relating to international trade. (See replication files for detail and robustness to alternative coding rules.) There are 1430 unique non-OECD waste import restrictions in the full FAOLEX dataset, 1948-2020. Figure 24 illustrates the relatively steady roll-out of new national-level NTBs across the sample period, against the count of Basel Convention members. The spike in 2003 results from several new EU regulations that apply at the national level for each of the non-OECD EU states.

Figure 24: This figure summarizes national-level waste import restrictions rolled out by non-OECD states, overlaid on the count of Basel Convention members, for the study period (1995-2020).



C.7 China Ban: Descriptives

Figure 25: China's surplus import share for banned and other waste products, before and after 2017. (The ban's rollout over time explains why shares do not drop to zero in the period.)

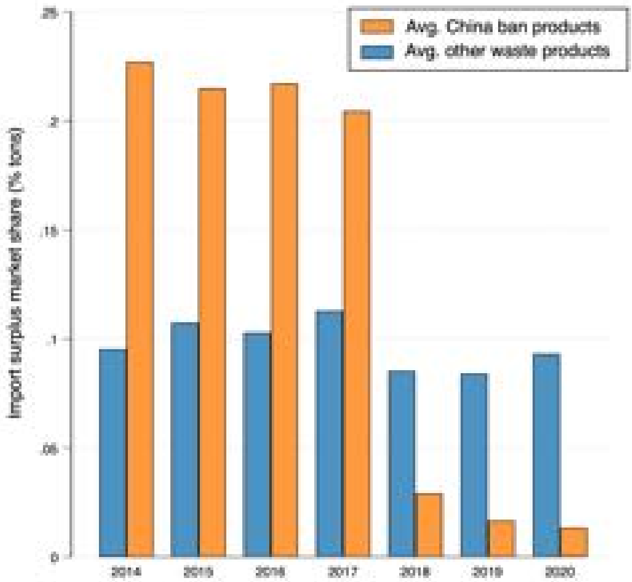


Figure 26: Trends in export volumes for banned and other waste products, before and after 2017.

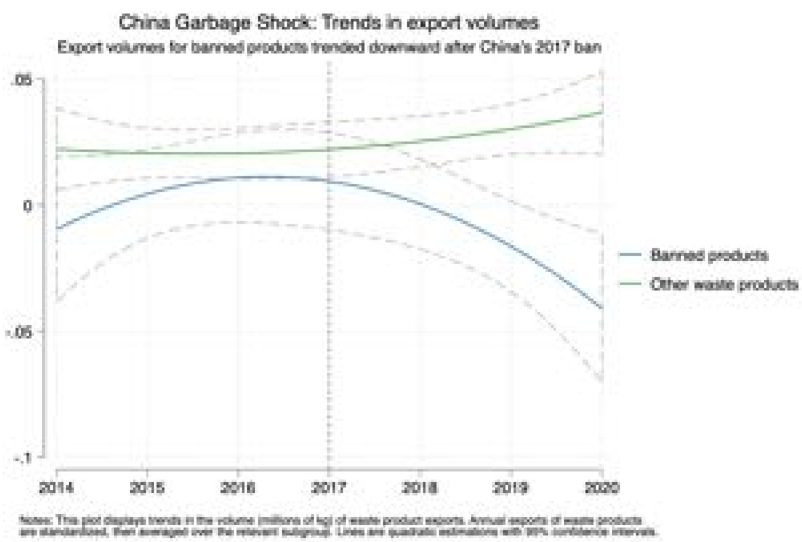
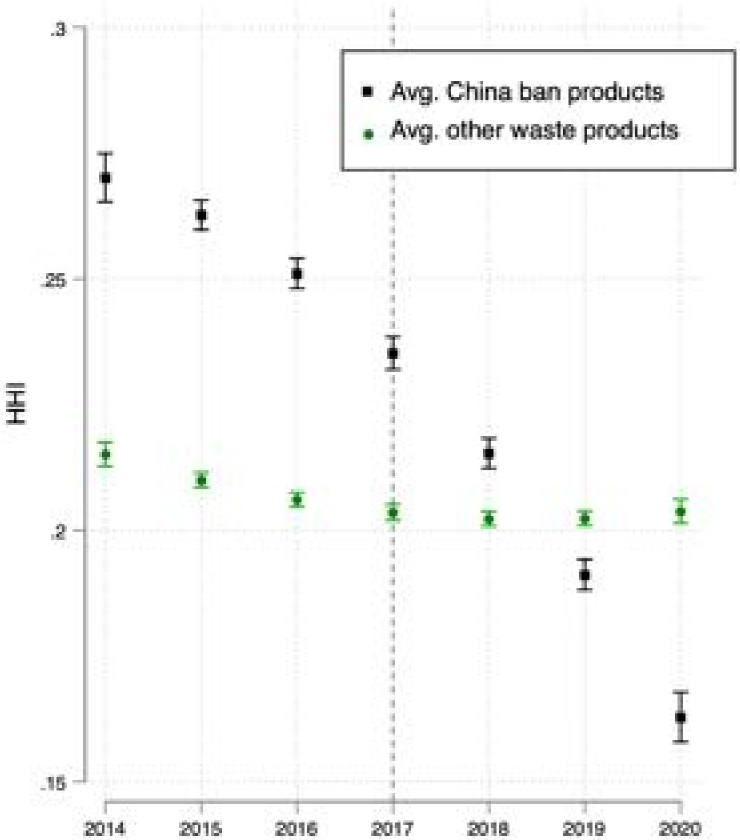


Figure 27: Average HHI for products banned by China and other waste products, before and after 2017.



C.8 Parallel trends plots, by treatment specification

Figure 28: Asia-Pacific treatment

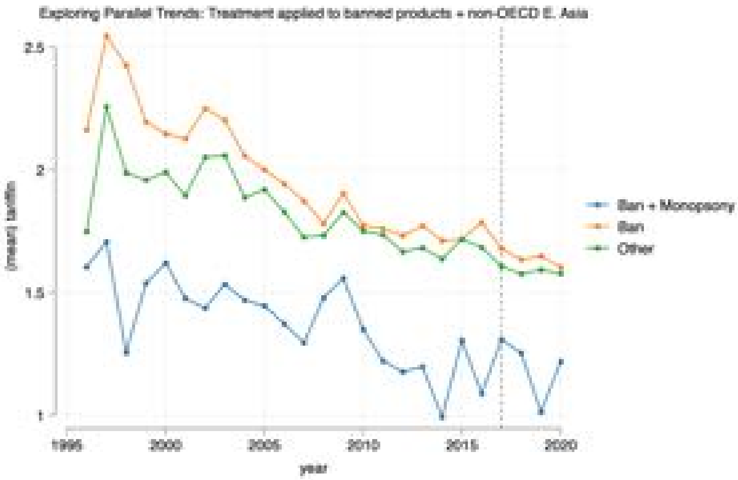


Figure 29: Pre-ban 99% treatment

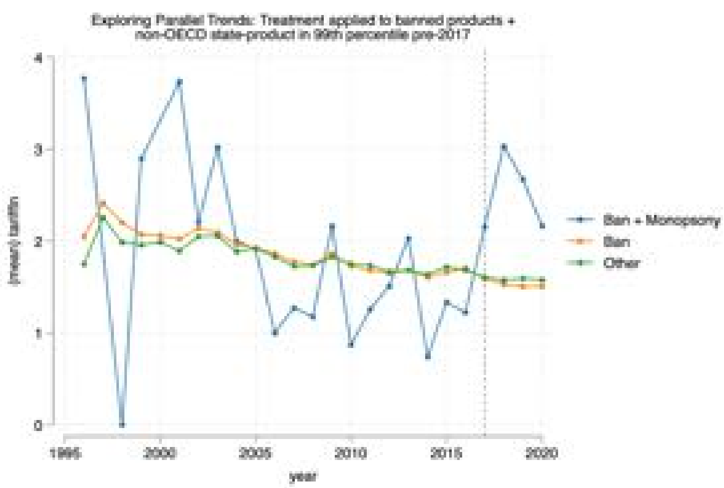
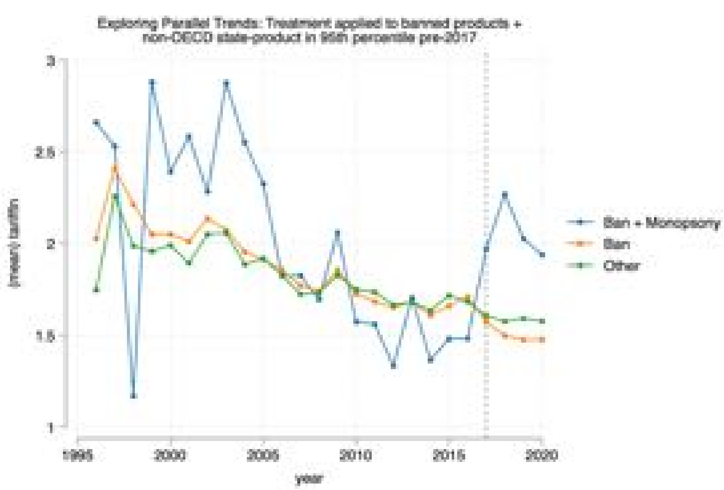


Figure 30: Pre-ban 95% treatment



D Waste Product HS Codes

D.1 Full waste product list

This is a list of 179 6-digit HS codes for waste and scrap products per HS code revisions 1992, 1995, 2002, 2007, 2012, and/or 2017. As discussed in the text, waste and scrap products are likely also traded under 6-digit HS codes that are used for goods "not elsewhere specified." Those additional 6-digit HS codes are available in the replication files should future researchers find them of use. The count of codes by HS revision is as follows: 1992 HS revision - 129 waste products; 1996 - 131; 2002 - maximum of 144; 2007 - 134; 2012 - 134; 2017 - 135. For coding rules, see replication files.

050100 050210 050290 050300 050510 050590 050690 050710 050790 050800 150200 180200 230210 230220 230230 230240 230250 230310 230320 230330 230400 230500 230610 230620 230630 230640 230641 230649 230650 230660 230670 230690 230800 230810 230890 240130 251720 252530 261900 262011 262019 262020 262021 262029 262030 262040 262050 262060 262090 262091 262099 262100 262110 262190 271390 284440 284450 300680 300692 380400 382510 382520 382530 382541 382549 382550 382561 382569 382590 391510 391520 391530 391590 400400 401220 401700 410110 410120 410121 410122 410129 410130 410140 410150 410210 410221 410229 410310 410330 410390 411000 411520 440130 440131 440139 440140 450190 470710 470720 470730 470790 500300 500310 500390 510310 510320 510330 510400 520210 520291 520299 530130 530290 530390 530490 530500 530519 530529 530590 530599 550510 550520 630900 631010 631090 700100 711210 711220 711230 711290 711291 711292 711299 720410 720421 720429 720430 720441 720449 740400 750300 760200 780200 790200 800200 810110 810191 810197 810210 810291 810297 810310 810330 810420 810510 810530 810600 810710 810730 810810 810830 810910 810930 811000 811020 811100 811211 811213 811220 811222 811230 811240 811252 811259 811291 811292 811300 854810 890800

D.2 Waste products banned by China (2017)

These are the 26 6-digit HS codes that are subject to China's ban promulgated in 2017. (Three additional codes fall into the parameters of the ban, however, they were no longer in use as of 2017; these codes are: 262020, 262050, and 262090.)

261900 262011 262019 262021 262029 262030 262040 262060 262091 262099 391510 391520 391530 391590 470790 510310 510320 510330 510400 520210 520291 520299 550510 550520 631010 631090