CIPS
Center for Indonesian Policy Studies

WORKING PAPER NO. 4

Assessing the Importance of the Indonesian Plastic Waste Imports to Industrial Growth and the Environment

by **Krisna Gupta** and **Biyan Shandy Paramayudha**

www. cips-indonesia.org

Working Paper No. 4

Assessing the Importance of the Indonesian Plastic Waste Imports to Industrial Growth and the Environment

Authors:

Krisna Gupta (Center for Indonesian Policy Studies)

Biyan Shandy Paramayudha (Center for Indonesian Policy Studies)

Jakarta, Indonesia

November, 2024

Acknowledgement:

We thank the Templeton World Charity Foundation, Inc. (funder DOI 501100011730) for its financial support (for the grant details, see doi.org/10.54224/30486).

Cover:
frimufilms - Freepik.com

ABSTRACT

The impact of international trade is often associated with economic development, especially for emerging markets. However, under conditions like negative externalities, trade can have negative consequences. Research on the impact of trade on the environment is still lacking despite its recent emergence. In this paper, we examine the relationship between trade, the environment, and industrial development, specifically in the plastic waste trade. We examine a sudden relaxation of a plastic waste import ban in Indonesia and try to link it with the development of Indonesian recycling industries and other plastic waste importing industries more generally. We find little evidence to suggest that importing plastic waste benefits Indonesia. Moreover, since importing plastic waste is not followed by investment in the recycling industry, it is plausible that most of this plastic waste goes untreated. Not only this policy brings no benefit to Indonesia, it is also not in line with the notion that the developed countries, which are the biggest source of the Indonesian plastic waste, export their plastic waste to be recycled in developing countries.

JEL: F13, Q56

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

INTRODUCTION

The impact of international trade on industrial development and economic development has in general been positive (Kee, Nicita, Olarreaga, 2009; Disdier, Fontagne & Cadot, 2015; Fajgelbaum, Grossman & Helpman, 2011; World Bank, 2020). In the Indonesian case, studies have shown that international trade helps alleviate poverty (Kis-Katos & Sparrow, 2015) and support industrialization through improved access to markets of both final goods and intermediate products (Pane & Patunru, 2022).

Along with poverty alleviation and development can come challenges in mitigating the environmental effects of new economic activity. The World Trade Organization (2022a) has turned its attention to understanding this relationship. One way this can manifest is that intensifying trade can increase emissions coming from shipping and manufacturing activities (Qalati et al., 2023; Kartal & Pala, 2023; Li et al., 2022; Xu et al., 2023; Shahbaz et al., 2017). In developing countries, the increased plastics use that comes with industrialization also leads to increased ocean pollution (Ullah et al., 2023).

Plastic recycling can, in theory, mitigate some of the problems created by excessive plastic waste. Typically, the plastic recycling industry involves collection and sorting, shredding, polymer separation, washing and extrusion. One of the key problems with plastic recycling is at the collection and sorting stage, which can be costly and labor intensive. This creates an opportunity in exploiting comparative advantage in labor-abundant countries such as Indonesia, which encourages international trade. The plastic waste trade is the global trade in recyclable plastics. These plastics generally flow from developed countries to developing countries, with the intention that they be recycled in the developing countries.

Bai & Givens (2021) provide perspective about the plastic waste trade in developing and developed countries. In developing countries, plastic waste imports are correlated with wealth, as measured by GDP per capita. Among developed countries, those with lower GDP per capita are more likely to export plastic waste. Bai & Givens (2021) also find that developed countries export the environmental harm of the plastic waste trade and developing countries bear the environmental burden.

Indonesian plastic consumption is high. With an estimated population of 270 million people in 2019, Indonesia's plastic consumption was estimated to be more than 6.2 million tons, 65% of which came from food and beverage packaging (Ismawati, Septiono & Proboretno, 2022). Indonesia also imported around 200 million kg of plastic waste in 2022, mainly from developed countries.

Major increase of plastic waste imports to Indonesia began in 2010, when the government started to allow plastic waste import. It increased again in 2018 when China started to restrict plastic waste imports. Unfortunately, Indonesia's plastic waste management is heavily under capacity (Ismawati, Septiono & Proboretno, 2022; World Bank, 2021). Indonesian plastic waste management must be able to bear the burden of the plastic waste in the country, or the burden will be borne by the environment.

Although some research exists about Indonesian plastic waste management in general, the link between Indonesian plastic waste management and plastic waste imports is understudied. Also understudied are the possible benefits of importing plastic waste. This paper attempts to link the Indonesian plastic waste trade pattern with the potential benefits of the industry and the possible environmental costs. Therefore, this paper offers insights for both environmental and trade and development studies.

In this paper, we explore imported plastics in Indonesia and their policy implications. We provide background information about the relevant changes in Indonesian and later Chinese trade policy, which coincide with the sudden increase in Indonesian plastic waste imports between 2010 and 2018. We then look at how imported plastics affect related Indonesian industries. We also review studies of the management of plastic waste in Indonesia.

We look at two possible channels through which importing plastic waste may be beneficial to Indonesia as the buyer country. First, we look at the development of the Indonesian recycling industry from the perspective of investment and value creation. If Indonesia has comparative advantage in this industry, then trade benefits both Indonesia by providing jobs, also western plastic waste exporters which can benefit from more efficient recycling services. Second, we examine the performance of other types of manufacturing firms that import plastic waste. Plastic waste is also used by industries like chemical, textile and apparel, and a sudden increase in input would improve productivity of these firms.

The main challenge is data availability. The impact of Indonesian trade policy changes in 2010 and Chinese plastic waste restrictions in 2018 is evident. It is harder to link plastic waste imports with environmental damage and industrial development without time series data. Unfortunately, data regarding plastic waste are not collected on an ongoing basis but typically only at specific times and places (World Bank,2021; Iskandar et al., 2021; Iskandar et al., 2022; Cordova et al., 2022). Data on the Indonesian plastic recycling industry, where it does exist, are either aggregated with other waste management industries or not collected over a long enough period.

The paper is organized as follows. First, we discuss the broad problem of plastic waste in Indonesia and the policy evolution that has allowed for a large influx of plastic waste imports. Next, we look at possible benefits of importing plastic waste, mainly from an industrial development perspective. That is, we look at how important is importing plastic waste to Indonesian industrial development. We conclude with an overview of our findings.

THE INDONESIAN PLASTIC WASTE TRADE

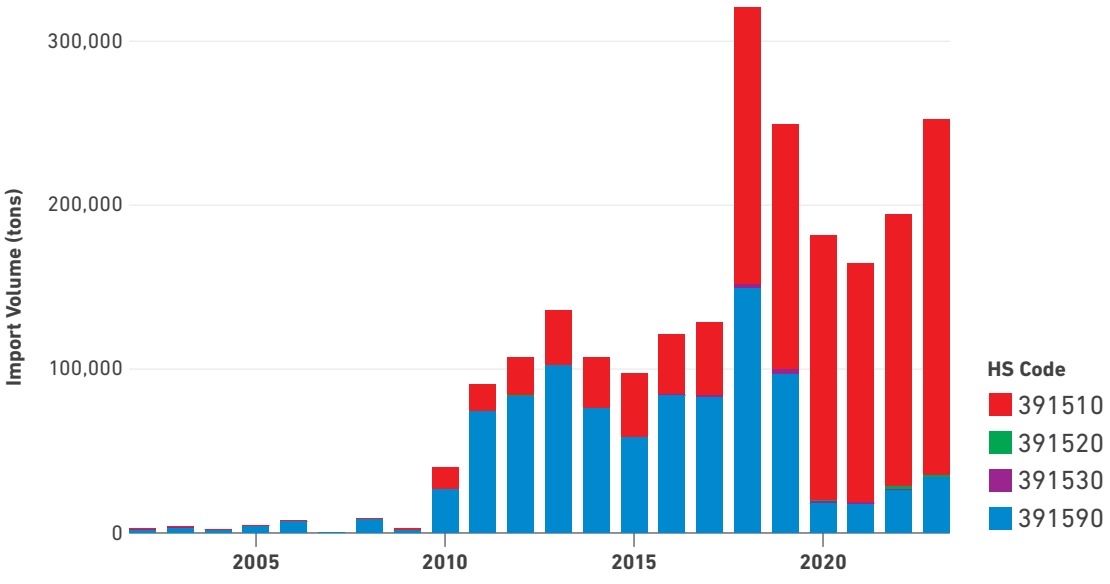
Indonesia's plastic waste imports have been increasing for two decades. Figure 1 and Figure 2 shows the trend from 2002 to 2022. We define plastic waste using a Harmonized System (HS) classification code, which rests under the heading 3915, following the approach of Asokan, Abeynayaka & Hotta (2023). The six-digit descriptions are shown in Table 1. Data is obtained from Statistics Indonesia, (*Badan Pusat Statistik* or BPS).

Table 1.
The classification of plastic waste

HS Code	Description
3915	Waste, parings and scrap, of plastics.
3915.10	– Of polymers of ethylene
3915.20	– Of polymers of styrene
3915.30	– Of polymers of vinyl chloride
3915.90	– Of other plastics

Source: World Customs Organization, n.d.

Figure 1.
Indonesian import of plastic waste in tons



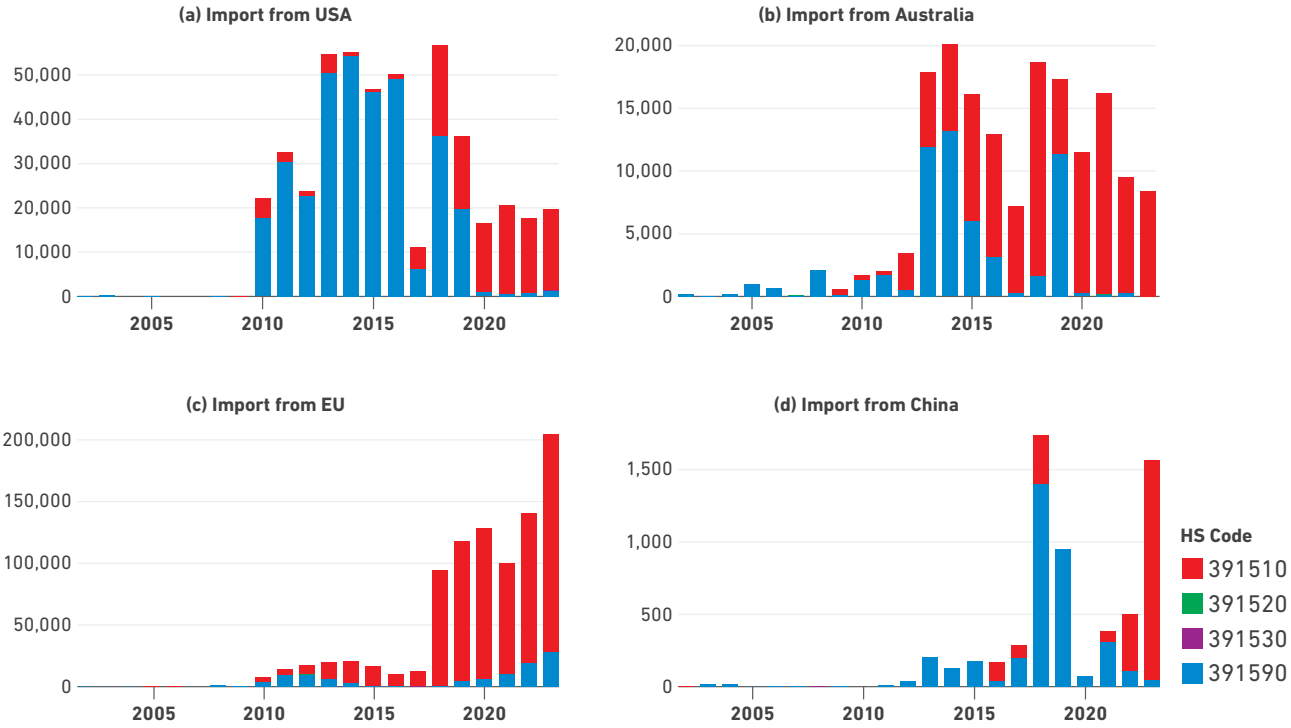
Source: UN Comtrade

Figure 1 illustrates at least two notable periods where the amount of imported plastic substantially increased. The import volume spikes happened in 2010 (1157% increase from 2009) and 2018 (149% increase from 2017). These spikes coincide with policy changes in Indonesia and China, a major contributor in the global plastic waste trade. The vast majority of plastic waste imported is

classified as either ethylene polymers (391510) or the catch-all of other polymers (391590). The proportion of ethylene polymers jumped dramatically in 2018.

We break down Figure 1 into the three largest source markets: the European Union (EU), the United States (US), and Australia. We also include China to the mix to show the immediate source of the increase in 2018. Exports from Australia and the US jumped in 2010, while imports from the EU jumped in 2018.

Figure 2.
Indonesian plastic waste imports from large markets by type in tons



Source: UN Comtrade

In 2010 there was an unprecedented relaxation on the rules governing Indonesian imports of waste products. This relaxation explains the sudden jump in the Indonesian plastic waste imports in 2010. China banned most plastic waste imports through its regulation change in 2018 for environmental reasons. This ban leads to countries, particularly rich ones, diverting their exports. This explains the sudden increase in the EU plastic waste exports to Indonesia.

One of the earliest regulations of plastic waste imports in Indonesia was Ministry of Industry and Trade Decree No. 231/MPP/kep/7/97 On Waste Imports in July 1997. In this decree, waste importers are classified into three categories: general waste importer, hazardous waste importer, and nonhazardous waste importer.

A general waste importer is able to trade their imported waste, while hazardous and non hazardous waste importers are only allowed to use imported waste for production purposes. Each group has to be approved by the Directorate General of International Trade and has a dedicated

list of waste types they can import. Among the three groups, only hazardous waste importers and non hazardous waste importers are able to import plastic waste. However, plastic waste was not directly mentioned in the decree. Plastic waste is also not included in the list of waste that these groups can import, although the decree stated they could import waste not mentioned in the list.

Ministry of Industry and Trade Decree No. 231/MPP/kep/7/97 stipulated that all waste importers submit details about:

- exporter;
- HS code of imported waste;
- quantity in weight/volume;
- waste treatment measures;
- shipment plan; and
- approval from the Environmental Damage Control Agency (*Badan Pengendalian Dampak Lingkungan* or BAPEDAL) for hazardous waste imports.

In order to monitor waste imports procedures, every shipment of waste required a certificate based on the results of monitoring by a surveyor at the loading docks. This certificate signifies that the traded waste is in accordance with the permit, agreed amount, and existing regulations. All importers are required to report their import realization[1] to the Directorate General of International Trade, forwarded to BAPEDAL and Directorate General of Metal, Machinery, and Chemical Industry.

The next major regulatory change was the passage of Ministry of Trade Regulation No. 41/MPP/PER/10/2008 in November 2008, which superseded the 1997 regulation. There were further minor changes between 2008 and 2009 as Ministry of Trade Regulation No. 41/MPP/PER/10/2008 was revised or revoked four times. Of these amendments, the last was Ministry of Trade Regulation No. 26/M-DAG/PER/6/2009, which came into force in September 2009.

The 2008–2009 regulatory changes were associated with the significant increase in plastic waste imports between 2009 and 2010. During this period, imports increased from 3.17 million kg in 2008 to 39.9 million kg in 2009. This suggests that explicitly including plastic waste on the list of approved imports provided the regulatory clarity for firms in Indonesia to import plastic waste. Moreover, the sudden increase of waste import suggests the waste importing is a lucrative business.

The 2008 regulation provided more direct regulation of plastic waste imports by listing plastic waste as a category of waste and provided the HS code for plastic waste as a waste that can be imported. The purpose of plastic waste importation was also limited to production purposes. Institutions allowed to import plastic waste according to this regulation are nonhazardous waste importers recognized by the Directorate General of International Trade. These importers, once recognized, are called IP Limbah.

Between 2008 and 2016, the requirements for importers to be acknowledged as IP Limbah include:

- copy of industry permit;
- copy of firm registration (TDP);
- copy of taxation identification (NPWP);

[1] Waste importing firms must submit their planned import, which is then used for their import quota in the following year

- producer's import identification number (API-P) or limited import identification number (API-T);
- recommendation from the Ministry of Industry; and
- recommendation from the Ministry of Environment.

When it received a request for recognition from importers, the directorate general was required to respond within seven working days. The directorate general then assigns a surveyor to inspect the firm and its ability to manage the amount of import quota they requested. The recognition granted by the directorate general lasted for one year and could be extended. Ministry of Trade Regulation No. 26/M-DAG/PER/6/2009 required a recommendation from the Ministry of Industry (MoI); and the Deputy of Hazardous Waste, Ministry of Environment and Forestry (MoEF) for extension of the designation.

Terms on import verification and surveyor in the 2008 regulations were carried over from 1997. In Ministry of Trade Regulation No. 26/M-DAG/PER/6/2009, requirements for the surveyor were extended to its technical requirements and verified items The technical requirements include: having survey service permit (*Surat Izin Usaha Jasa Survey* or SIUJS), minimum of five years' experience, representative/affiliation in other countries, and track records on import verification. Surveyors are also required to submit monthly reports to the Directorate General of International Trade.

In May 2016 the regulations were updated again with Ministry of Trade Regulation No. 31/M-DAG/PER/5/2016. This regulation adds further criteria for waste plastics that can be imported. First, the imported waste must not originate from a landfill or be in the form of trash. The imported waste cannot be mixed with other types of waste beyond what is specified in the regulation. In addition to being untradable, the imported waste must now be processed independently by importers. As for the parties that can import, limited import identification number (API-T) holders are not listed anymore, resulting in only import identification number (API-P) holders. API-P holders are also required to own and operate their own waste treatment facilities.

Secondly, the terminology of the waste import permit in Ministry of Trade Regulation No. 31/M-DAG/PER/5/2016 changed. In the previous regulation, parties that can import waste are recognized as IP Limbah. The permit for waste imports was changed to import approval (*Persetujuan Impor or* PI), and API-P holders need to apply for PI in order to import waste. (This terminology is carried forward through all subsequent regulations through to the most recent, Ministry of Trade Regulation No.25/2022.)

As with IP Limbah, the import permit has a validity period set by Ministry of Trade Regulation No. 31/M-DAG/PER/5/2016 is also one year. However, the possibility of import permit extension is limited to 30 days and applications for extension must be completed before the license expires.

The requirements to qualify for the import license differ significantly from IP Limbah. The license requirements include:

- industry permit (IUI);
- API-P Number;
- environmental permit(s) from relevant bodies;
- proof of advanced treatment facility ownership;
- production capacity and plan for one year; and
- statement from importer.

Additionally, the license requirements also included a statement letter from the exporter, recommendation from the Directorate General of Hazardous Waste, MoEF, and recommendation from Directorate General of IAK, MoI. However, unlike under previous regulations, the process of PI registration is done online (through a web-based application called INATRADE) instead of by offline document submission.

Ministry of Trade Regulation No. 31/M-DAG/PER/5/2016 also added power for PI importers not available through previous regulation. Through these changes, importers are able to propose changes to import licenses regarding type of goods, goods classification (HS code), volume of goods, and/or destination port. This change required recommendation from the Directorate General of Hazardous Waste, MoEF. As an additional requirement, surveyors must also obtain accreditation from the National Accreditation Committee (*Komite Akreditasi Nasional* or KAN).

In April 2021, Ministry of Trade Regulation No. 20/2021, came into effect, replacing the 2016 regulation. The new regulation introduced another criteria for imported waste: it must be homogenous and sourced from registered exporters. The regulation also loosens importers' waste processing obligations by allowing them to process their waste through partnerships with authorized waste-processing entities, rather than requiring them to own their own facilities. In line with the new provision, the requirements for API-P holders to provide proof of waste treatment ownership were revoked.

Ministry of Trade Regulation No. 20/2021 introduced only minor changes to import license requirements. Importers must submit proof of a registered exporter (Bukti Eksportir Terdaftar or BET) from the Ministry of Trade. Other requirements include:

- environmental permit;
- statement letter from importer and exporter;
- recommendation from KLHK; and
- recommendation or master list from MoI.

The new regulation also included details on the requirements for each type of the import license change, as well as its extension.

According to article 19 (2) of Ministry of Trade Regulation No. 20/2021, plastic waste is subject to an import verification process done by surveyors. As in previous regulations, these surveyors are appointed by the Ministry of Trade.

Ministry of Trade Regulation No. 20/2021 was superseded by Ministry of Trade Regulation No. 25/2022 which went into effect in May 2022. The new regulation did not bring substantial updates for plastic waste imports.

Aside from national policy, Indonesia's plastic waste trade flow is subject to global trends, especially China's waste import ban. In 2018, China issued an import ban on 24 types of solid waste, including plastics. China's plastic import ban has had a global effect. Wen et.al (2021) found that global plastic waste trade decreased by 45.5% in 2018. This incident happened because China had been the largest plastic waste importer From 1991 to 2017, importing 13.69 million tons in 2017 (Wang et.al, 2020). They also found a high correlation between China's plastic waste trade and global plastic waste trade. This emphasizes China's importance in the global plastic waste trade, and especially in Southeast Asia.

As a consequence of China's import ban, plastic waste trade flows to Southeast Asian countries doubled (Sun & Tabata, 2021). This argument is supported by the findings of Wang et.al (2020) of a sharp increase in the plastic waste trade flows to Southeast Asia in 2018. Developed countries, especially those most reliant on the Chinese recycling industry, shifted their exports to Southeast Asia (Sun & Tabata, 2021; Wang et.al, 2020). Indonesia's plastic waste import volume data corroborates this explanation, with plastic waste imports increasing from 128.86 million kg in 2017 to 320.45 kg in 2018 (refer to Figure 2).

The World Trade Organization (WTO) has also played an important part in plastic waste trade. In November 2020, several WTO members[2] raised the issue of environmental sustainability. Through a joint communication, they suggested structured discussions between WTO members and stakeholders in improving environmental sustainability, including by reducing plastic pollution and promoting a sustainable plastic trade (World Trade Organization, 2020). This led to informal dialogues on plastics pollution and environmentally sustainable plastics trade (IDP), first held in July 2021.

By December 2021, WTO issued a Ministerial Statement at Ministerial Conference 12 (MC12) which ruled out the key focus of further discussions which include: improving plastic waste trade transparency, supply chain and trade policies, and strengthening trade assistance on vulnerable economies. MC12 also encouraged WTO members and relevant stakeholders to improve cooperation and share best practices.

In February 2022, the ongoing informal dialogues resulted in IDP Plan 2022, which outlines further the implementation of MS12 (World Trade Organization, 2022b). This group will also prepare actions and outcomes regarding the sustainable plastic waste trade in time for the upcoming Ministerial Conference 13 (MC13). These topics include:

- cross-cutting issues;
- promoting trade to tackle plastic pollution; and
- reduction to tackle plastic pollution and circular economy for plastics.

Eventually, MC13 was held in February 2024 and produced a Ministerial Statement. This Ministerial Statement ruled out the shared principles and priorities of actions for sustainable plastic waste trade.

[2] Australia; Canada; Chad; Chile; Costa Rica; European Union; the Gambia; Fiji; Iceland; Japan; Korea, Republic of; Liechtenstein; Maldives; Mexico; Moldova, Republic of; Montenegro; New Zealand; North Macedonia; Norway; Senegal; Switzerland; the Separate Customs Territory of Taiwan, Penghu, Kinmen and Matsu; and the United Kingdom

PLASTIC WASTE PROBLEMS IN INDONESIA

There is a clear argument for a global policy governing the plastic waste trade. Research has shown that plastic waste affects both terrestrial and aquatic ecosystems. In terrestrial ecosystems, plastic waste in the form of microplastics or nanoplastics can cause nutrient cycle imbalance of substances such as nitrogen and phosphorus, reducing the growth of food crops (Kumar et.al., 2021). Macroplastic waste can also deteriorate environmental conditions if not properly supported by solid waste management. This affects not only agricultural products such as livestock (Diggle & Walker, 2022), but also natural environments such as mangrove forests, in which plastic waste can hinder root and leaf growth (van Bijsterveldt et.al, 2021).

In aquatic ecosystems, plastics can damage animals through entanglement or ingestion (Diggle & Walker, 2022). When these effects are pronounced enough, the effects can cascade into biodiversity loss. As stated by Gove et.al (2019), plastic ingestion by larval fish reduces their likelihood of survival. Plastic waste can also affect commercially important fishes.

Depending on how it is disposed of, plastic waste can also contribute to increasing greenhouse gas emissions through alteration in water biogeochemical properties (Kumar et.al., 2021). This is supported by Adeniran & Shakantu (2022) who found that incinerated poly vinyl chloride (PVC) in South Africa released hazardous halogens and polluted the air. Adeniran & Shakantu (2002) also find that plastic additives can harm humans through skin contact due to their carcinogenic nature.

Aside from the environmental and health impacts, previous research has estimated the economic cost of plastic waste pollution at various geographical levels. At a global level, it is estimated that a 1–5% decline of marine ecosystem quality can lead to $500–$2500 billion equivalent of environmental benefit loss (Beaumont, 2019). At the regional level, Kumar et.al (2021) find that Asia-Pacific regions are experiencing an annual loss of $1.2 billion from marine waste where approximately 12.7 million tons of plastics entered the ocean in 2010.

National level studies show that the monetary value of landfilled plastic in the US is between $4.5 billion and $9.2 billion (Milbrandt et.al, 2022). In the canal environment in Chad's capital city, Croitoru et.al (2022) estimated the economic cost of plastic waste pollution from welfare aspects including health, house devaluation, and flood damages reaches $3000 per ton on average. Residents near the canal also pay a relatively higher price due to their direct exposure to plastic waste pollution in the canal.

In Indonesia, we first look at the plastic recycling industry specifically. A large flow of plastic waste imports should provide inputs for recycling industries, which may encourage investment in this sector. Recycling is the main reason that western economies export their plastic waste. A sudden jump in foreign plastic waste may increase the foreign value added to the Indonesian recycling industry. However, recycling capacity in Indonesia is insufficient to take advantage of any such opportunity. According to Darus et al (2020), Indonesia's plastic recycling production capacity is around 1.65 Mt a year—not enough to handle Indonesian plastic waste imports, let alone the plastic waste generated by the domestic Indonesian economy.

UNDERSTANDING THE ECONOMIC EFFECTS OF THE PLASTIC WASTE INDUSTRY IN INDONESIA[3]

Figure 3 shows the dynamics of the Indonesian recycling industry from 2002 to 2020. We use data from The OECD Inter-Country Input-Output (ICIO) about how much sectoral foreign and domestic value is added by specific industries. We examine the Indonesian waste collection, treatment and disposal activities, materials recovery industry, which includes plastics recycling, and calculate its output and its foreign input. We operate under the assumption that large changes to this industry in 2010 and 2018 result from changes in the plastic waste trade.

Figure 3.
Value added in the Indonesian collection and recycling industry (ICIO, 2023)

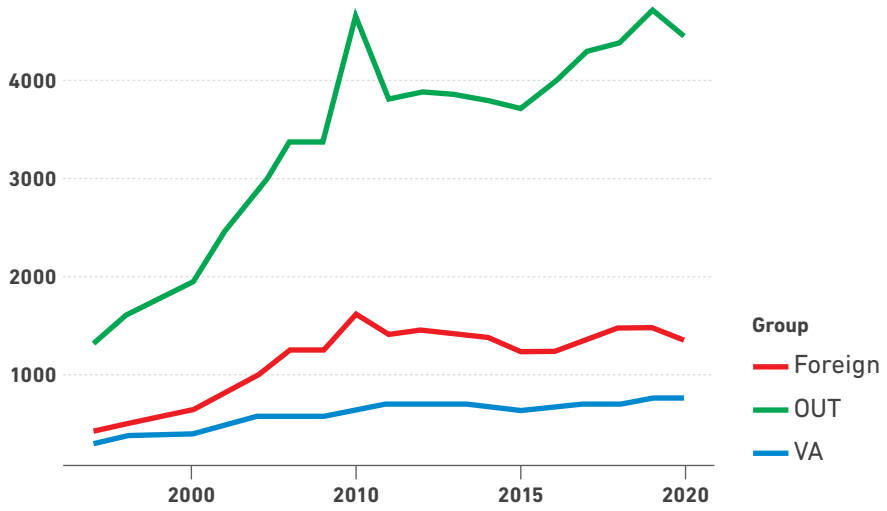


Figure 3 illustrates increasing output from 2002 through 2008, the year when the Global Financial Crisis (GFC) hit the US and the EU. The growth of output of the collection and recycling industry flatlined after 2011 when the commodity boom ended and the global trade slowed (Pangestu, Rahardja & Ing, 2015) before trending up again in 2015.

Foreign value added captures the importance of imported inputs to the industry. We see a trend proportional to output in foreign value added in the industry. The growth of foreign value added stopped in 2010 and 2018, the most important milestones for the Indonesian plastic waste trade.

We see a similar disconnect between output and investment in the waste collection, treatment and disposal activities, and materials recovery industry.

[3] Appendix A provides notes on methods, data sources, and an important assumption that changes to Indonesian Division 38 (waste collection, treatment and disposal activities, materials recovery) in 2010 and 2018 are the result of changes in the plastic waste trade.

Figure 4.
Investment realization in the waste collection, treatment and disposal activities; materials recovery industry (division 38), 2011–2023

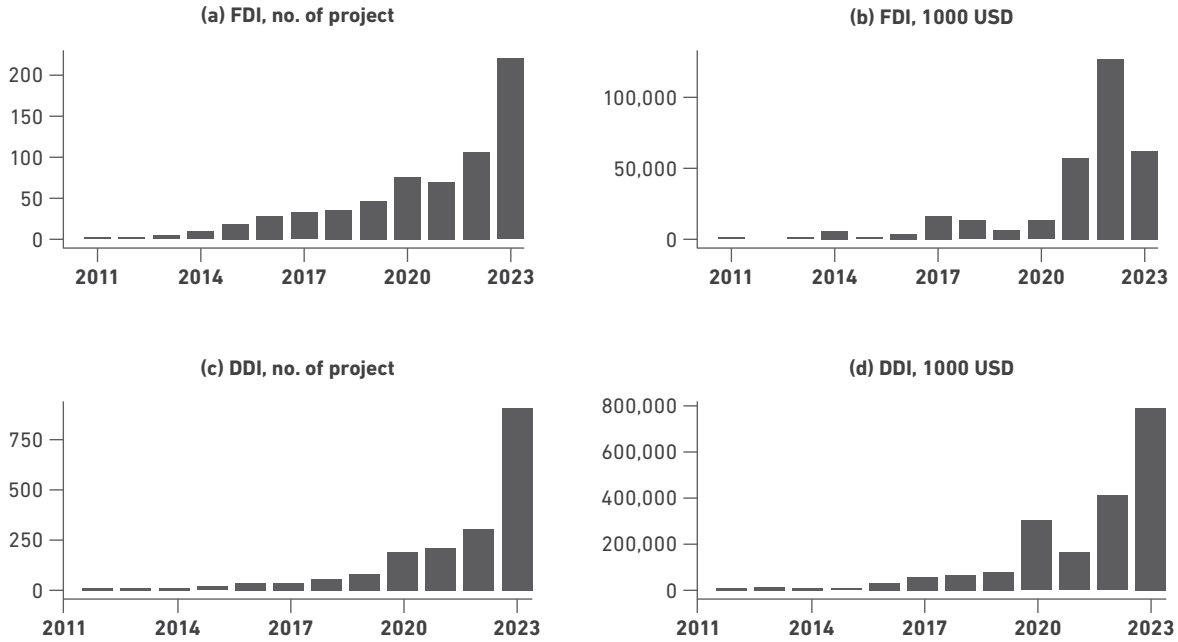


Figure 4 illustrates that the number of projects closely follows total investment in USD. This is not surprising. However, there is no notable change in 2018. This suggests that despite a large increase in plastic waste flowing into the country, there was no corresponding increase in capacity. Investment in the industry did increase sharply in 2023, perhaps due to a delayed effect of the Ministry of Trade Regulation number 20/2021. However, the limited increase in collection and recycling capacity since 2011, even after 2018, suggests that the majority of plastic waste is not collected and recycled.

In fact, Indonesia's recycling capacity is small compared to its plastic consumption. The National Plastic Action Partnership (NPAP) found that in 2020 Indonesia only managed to recycle 10% of the 6.8 million tonnes of plastic waste that it produced. Meanwhile, 4.2 tones (61%) of plastic waste leaked to the environment and the remaining 29% ended up in landfills (World Economic Forum, 2020).

Darus et al. (2020) argue the problem starts with collection. Their study in Java in 2019 shows that only 11.83% of plastic waste was collected upstream before it went to the landfill. The rest goes directly to landfills or remains uncollected and unmanaged. Indonesia in general does not separate plastic waste, making it much harder to sort. Darus et al. suggest a stronger, community-driven plastic waste collection reform.

Ismawati, Septiono & Proboretno (2022) argue that a shortage of firms in the recycling industry in Indonesia is the main problem. Indonesia's recycling industry consists of 600 large and 700 small firms with a combined production capacity of 2.3 million tons per year. Despite the small number of firms, big firms are investing in the recycling industry.

Indorama Ventures, a multinational company, invested US$1.5 billion in 2019 with the aim of increasing recycled PET productions. However, this investment is spread across not only Indonesia but also countries such as Thailand, Philippines, India, and Brazil. Danone is another company that has made investments to improve its recycling capacity in Indonesia. Danone invested US$5.25 million to produce 25,000 tons of recycled PET plastic annually. These large firms have the ability to chemically reprocess post-consumer plastic goods as well, while smaller firms mainly physically reprocess post-consumer plastic goods.

Another notable player in Indonesia's recycling industry are the *Bank Sampah* or Garbage Banks (Ismawati, Septiono & Proboretno, 2022). Acknowledged by The Ministry of Environment through Ministry of Environment Regulation No. 13 of 2012, this facility collects and sorts recyclable waste with economic value. Waste brought to a *Bank Sampah* by the community is valued based on a price provided by the brokers or the factories with which that *Bank Sampah* is partnered. Although only contributing to 1.2% of nationally generated waste, *Bank Sampah* employs approximately 163 thousand people and the population of *Bank Sampah* keeps growing over time, notably from 1,172 units in 2014 to 7,488 units in 2018.

Some challenges faced by plastic recyclers include (Darus et al., 2020; Ismawati, Septiono & Proboretno, 2022):

- lack of infrastructure to tap plastic waste from domestic sources;
- poor quality plastic waste due to poor waste separation;
- lack of incentives from the government to support the recycling industry.

Finally, there is lower market demand for post-consumer recycled plastics (Darus et al., 2020). Recycled plastics are often more expensive compared to virgin plastics, both imported and domestically produced. This creates a vicious cycle because without demand, firms will not improve production capacity, and production capacity could reduce prices. The government should focus on driving producers (and ultimately consumers) toward using recycled plastics.

International trade can, theoretically, help with these problems. It is clear that rich nations want their exported plastic waste to be recycled abroad. In this case there are policy goals they should pursue to assist nations like Indonesia. Logistics for better-sorted plastic waste may help recyclers build capacity and reduce sorting costs by ensuring waste arrives sorted in the importing country. Additionally, regulations that nudge recycled plastic use can be more easily implemented in rich nations, increasing the pressure of foreign demand on the domestic recycling industry.

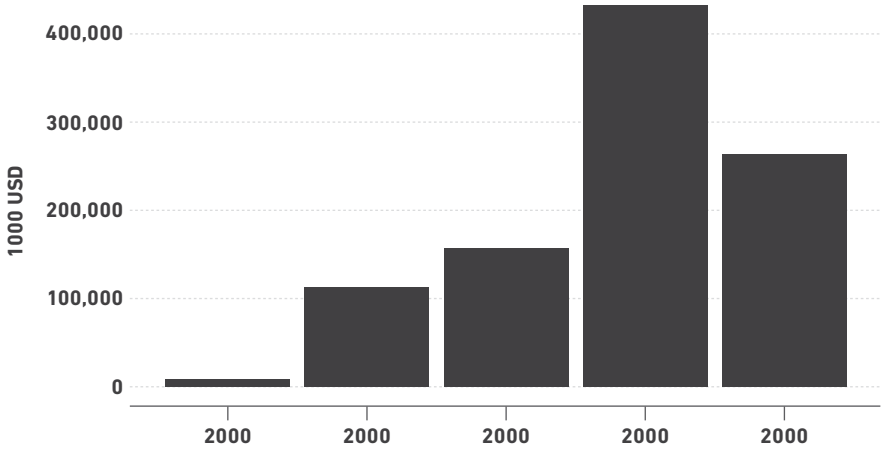
INDUSTRIAL IMPACT OF PLASTIC WASTE TRADE[4]

The second channel imported plastic waste can be useful is reuse, and that using these waste provides a competitive advantage compared to firms that do not use plastic waste. If that is the case, it is possible that a large proportion of imported plastic waste is absorbed by industries other than waste collection and recycling.

We use data on manufactures' plastic waste imports and manufacturing surveys to estimate the output, labor, and capital associated with plastic waste imports over the period of 2008–2012, which is the range of time allowed by our data. Figure 5 shows the plastic waste imports by the Indonesian manufacturing sector over this period.

Only 145 of 32,318 manufacturers surveyed are plastic waste importers—not surprising since only 10% of Indonesian manufacturing engages with international trade (Pane & Patunru, 2022; Gupta, 2022). The firms that import plastic waste also tend to be more foreign-owned and larger than the average Indonesian manufacturer. A complete table of descriptive statistics can be found in Appendix B.

Figure 5.
The amount of plastic waste imported by Indonesian manufacturers



We estimate whether importing plastic waste increases firms' value added, considering firms' workers, capital, and total factor productivity. We find that plastic waste imports do not have a significant effect. There may be a small (0.3%) statistical gain in value added when a firm switches from a non-plastic waste importer to a plastic waste importer, but with such a small effect, any such gain is practically unimportant. Our full model and results can be found in detail in Appendix B.

[4] See Appendix B for a detailed description of data and methods, as well as regression tables.

Assuming the insignificant import volume and gain from the input industry regression can be generalized, it is suggestive that the majority of plastic waste import went to either the recycling industry, landfill, or unmanaged. We also show in our previous analysis that the recycling industry, with no noticeable increase in recycling industry output, would not be able to absorb large influxes of plastic waste. This means those imported plastic waste are either landfilled or unmanaged.

As discussed in the previous section, plastic waste carries with it various negative environmental impacts. Importing plastic waste can only be justified if the local capacity to manage them is present. Indeed, the fact that some limitation was introduced in the 2021 regulation suggests the weak capacity improvement in the recycling industry and waste management.

CONCLUSION

While trade is important for economic development, its environmental impact also deserves attention. Plastic waste imports increased in Indonesia when the country relaxed its import rules in 2010, resulting in a large influx of plastic waste to the country's market. In this paper, we examine how important trade policy has been for increasing the flow of Indonesian plastic waste trade. We provide a brief background on the dynamics of the relevant trade policy.

More importantly, we review the possible implications of this increase of plastic waste imports to the economy. We find no evidence that increasing plastic waste imports leads to increases in foreign value added, investment, and the general value added of the collection and recycling industry. While industries like apparel and chemical industries also import some plastic waste, the amount is trivial compared to the overall plastic imports. We then proceed to show that even among overall plastic importers, the value-added gain is too trivial to suggest a noticeable benefit to the economy.

Lack of increased collection and recycling capacity as the amount of waste plastic in the country increased, paired with trivial use in the non-recycling industries, suggest most plastic waste imports to Indonesia either went to landfill or untreated. We complement this study with a review of Indonesian plastic waste capacity and its non-trivial amount of unmanaged plastic waste. While there are many studies about the mismanagement of Indonesian plastic waste, this may be among the first to link this problem with trade policy.

In theory, international trade can benefit both parties and the environment more generally. Recycling plastic waste is desirable by consumers who are willing to pay extra for recycled plastics. This demand-pull phenomenon is outsourced to labor-intensive countries like Indonesia and even increasing economies of scale. On the supply side, rich countries can help Indonesian recyclers reduce sorting cost if the imported plastic waste is sorted before shipping and goes directly to recycling plants. These supply-push and demand-pull phenomena will help kick-start Indonesian recycling industries to invest and drive costs even lower.

Unfortunately, this study failed to confirm this theory. There is no evidence that the increase in plastic imports is accompanied by increased capacity in the recycling industry. There is some anecdotal evidence that collection improved and an increase in recycling capacity in 2023, the timing is not aligned with the jumps in plastic imports in 2010 and 2018. Indeed, improving the recycling industry seems to be non-trivial, suggested by the Chinese import ban in 2018 and Indonesia's increased in restrictiveness of plastic waste import in 2016 and 2021. The finding from this study seems to agree with reintroducing ban on plastic waste import.

This study suffers from poor data availability. Establishing proper causal relationships between changes in trade policy and both ecological impact and economic development requires a long series of data regarding plastics waste ecological impacts, such as marine plastic. Also unavailable is disaggregated data that would allow us to separate plastic recycling industries from other division 38 industries. However, this study complements the literature by discussing the link between Indonesian trade policy and both economic performance (industrial growth) and the environment.

REFERENCES

Adeniran, A. A., & Shakantu, W. (2022). The Health and Environmental Impact of Plastic Waste Disposal in South African Townships: A Review. International Journal of Environmental Research and Public Health, 19(2), 779. https://www.mdpi.com/1660-4601/19/2/779

Asokan, V. A., Abeynayaka, A., & Hotta, Y. (2023). Building Data on the Plastics Value Chain in ASEAN Member States Report.

Bai, Y., & Givens, J. (2021). Ecologically Unequal Exchange of Plastic Waste? A Longitudinal Analysis of International Trade in Plastic Waste. Journal of World-Systems Research, 27(1), 265-287. https://doi.org/10.5195/jwsr.2021.1026

Baumol, W. J. (2000). Leontief's Great Leap Forward: Beyond Quesnay, Marx and von Bortkiewicz. Economic systems research, 12(2), 141-152. https://doi.org/10.1080/09535310050005662

Beaumont, N. J., Aanesen, M., Austen, M. C., Brger, T., Clark, J. R., Cole, M., Hooper, T., Lindeque, P. K., Pascoe, C., & Wyles, K. J. (2019). Global ecological, social and economic impacts of marine plastic. Marine Pollution Bulletin, 142(January), 189--195, pmid = 31232294. https://doi.org/10.1016/j.marpolbul.2019.03.022

Cherniwchan, J., Copeland, B. R., & Taylor, M. S. (2016). Trade and the Environment: New Methods, Measurements, and Results. In (pp. 22636-n/a). Cambridge: National Bureau of Economic Research, Inc.

Cordova, M. R., Ulumuddin, Y. I., Purbonegoro, T., Puspitasari, R., Afianti, N. F., Rositasari, R., Yogaswara, D., Hafizt, M., Iswari, M. Y., Widyastuti, E., Kampono, I., Kaisupy, M. T., Wibowo, S. P. A., Subandi, R., Sani, S. Y., Sulistyowati, L., Muhtadi, A., Riani, E., & Cragg, S. M. (2022). Seasonal heterogeneity and a link to precipitation in the release of microplastic during COVID-19 outbreak from the Greater Jakarta area to Jakarta Bay, Indonesia. Marine Pollution Bulletin, 181, 113926. https://www.sciencedirect.com/science/article/pii/S0025326X22006087

Croitoru, L., Singambaye, A., & Rossignol, A. (2022). The Cost of Plastic Pollution in N'Djamena: A Case Study. Journal of Environmental Protection, 13(08), 575--588. https://doi.org/10.4236/jep.2022.138036

Darus, Nurdiana; Tamimi, Maya; Tirawaty, Silvi; Muchtazar, Muchtazar; Trisyanti, Dini; Akib, Rangga; Condorini, Dyota; and Ranggi, Khair (2020). AN OVERVIEW OF PLASTIC WASTE RECYCLING IN THE URBAN AREAS OF JAVA ISLAND IN INDONESIA. Journal of Environmental Science and Sustainable Development, 3(2), 402-415.

Disdier, A.-C., Fontagné, L., & Cadot, O. (2015). North-South Standards Harmonization and International Trade. The World Bank Economic Review, 29(2), 327-352. https://doi.org/10.1093/wber/lht039

Fajgelbaum, P., Grossman, G. M., & Helpman, E. (2011). Income Distribution, Product Quality, and International Trade. Journal of Political Economy, 119(4), 721-765. https://doi.org/10.1086/662628

Gove, J. M., Whitney, J. L., McManus, M. A., Lecky, J., Carvalho, F. C., Lynch, J. M., Li, J., Neubauer, P., Smith, K. A., Phipps, J. E., Kobayashi, D. R., Balagso, K. B., Contreras, E. A., Manuel, M. E., Merrifield, M. A., Polovina, J. J., Asner, G. P., Maynard, J. A., & Williams, G. J. (2019). Prey-size plastics are invading larval fish nurseries. Proceedings of the National Academy of Sciences, 116(48), 24143-24149. https://doi.org/doi:10.1073/pnas.1907496116

Gupta, K. (2023). The Heterogeneous Impact of Tariffs and Ntms on Total Factor Productivity for Indonesian Firms. Bulletin of Indonesian Economic Studies, 59(2), 269-300. https://doi.org/10.1080/00074918.2021.2016613

Iskandar, M. R., Cordova, M. R., & Park, Y.-G. (2022). Pathways and destinations of floating marine plastic debris from 10 major rivers in Java and Bali, Indonesia: A Lagrangian particle tracking perspective. Marine Pollution Bulletin, 185, 114331. https://doi.org/https://doi.org/10.1016/j.marpolbul.2022.114331

Iskandar, M. R., Surinati, D., Cordova, M. R., & Siong, K. (2021). Pathways of floating marine debris in Jakarta Bay, Indonesia. Marine Pollution Bulletin, 169, 112511. https://doi.org/https://doi.org/10.1016/j.marpolbul.2021.112511

Ismawati, Y., Septiono, M. A., Proboretno, N., & Karlsson, Therese2, Buonsante, V. (2022). Plastic waste management and burden in Indonesia. International Pollutants & Shenzehn Zero Waste/Elimination Network (IPEN), February, 36. https://ipen.org/sites/default/files/documents/ipen-china-2021-epa_v1_2.pdf

Kartal, M. T., & Pata, U. K. (2023). Impacts of renewable energy, trade globalization, and technological innovation on environmental development in China: Evidence from various environmental indicators and novel quantile methods. Environmental Development, 48(August), 100923. https://doi.org/10.1016/j.envdev.2023.100923

Kee, H. L., Nicita, A., & Olarreaga, M. (2009). Estimating Trade Restrictiveness Indices. The Economic Journal, 119(534), 172-199. https://doi.org/10.1111/j.1468-0297.2008.02209.x

Kis-Katos, K., & Sparrow, R. (2015). Poverty, labor markets and trade liberalization in Indonesia. Journal of Development Economics, 117, 94-106. https://doi.org/https://doi.org/10.1016/j.jdeveco.2015.07.005

Kumar, R., Verma, A., Shome, A., Sinha, R., Sinha, S., Jha, P. K., Kumar, R., Kumar, P., Shubham, Das, S., Sharma, P., & Prasad, P. V. V. (2021). Impacts of plastic pollution on ecosystem services, sustainable development goals, and need to focus on circular economy and policy interventions. Sustainability (Switzerland), 13(17), 1–40. https://doi.org/10.3390/su13179963

Levinsohn, J., & Petrin, A. (2003). Estimating Production Functions Using Inputs to Control for Unobservables. The Review of Economic Studies, 70(2), 317-341. https://doi.org/10.1111/1467-937x.00246

Li, J., Dong, K., Dong, X., & Shahbaz, M. (2022). How green trade influences pollution emissions in China: A provincial perspective. Energy Economics, 115(October 2021), 106330. https://doi.org/10.1016/j.eneco.2022.106330

Mahraddika, W. (2019). Does international reserve accumulation crowd out domestic private investment? International Economics, 158, 39-50. https://doi.org/https://doi.org/10.1016/j.inteco.2019.02.003

Milbrandt, A., Coney, K., Badgett, A., & Beckham, G. T. (2022). Quantification and evaluation of plastic waste in the United States. Resources, Conservation and Recycling, 183(March), 106363. https://doi.org/10.1016/j.resconrec.2022.106363

Nepal, R., Paija, N., Tyagi, B., & Harvie, C. (2021). Energy security, economic growth and environmental sustainability in India: Does FDI and trade openness play a role? J Environ Manage, 281, 111886. https://doi.org/10.1016/j.jenvman.2020.111886

OECD. (2023). OECD Inter-Country Input-Output Database. http://oe.cd/icio

Pane, D. D., & Patunru, A. A. (2022). The role of imported inputs in firms' productivity and exports: evidence from Indonesia. Review of World Economics. https://doi.org/10.1007/s10290-022-00476-z

Pangestu, M., Rahardja, S., & Ing, L. Y. (2015). Fifty Years of Trade Policy in Indonesia: New World Trade, Old Treatments. Bulletin of Indonesian Economic Studies, 51(2), 239-261. https://doi.org/10.1080/00074918.2015.1061915

Pesaran, M. H., Shin, Y., & Smith, R. P. (1999). Pooled Mean Group Estimation of Dynamic Heterogeneous Panels. Journal of the American Statistical Association, 94(446), 621-634. https://doi.org/10.2307/2670182

Pesaran, M. H., & Smith, R. (1995). Estimating long-run relationships from dynamic heterogeneous panels. Journal of Econometrics, 68(1), 79-113. https://doi.org/https://doi.org/10.1016/0304-4076(94)01644-F

Petrin, A., Poi, B. P., & Levinsohn, J. (2004). Production Function Estimation in Stata using Inputs to Control for Unobservables. The Stata journal, 4(2), 113-123. https://doi.org/10.1177/1536867X0400400202

Qalati, S. A., Kumari, S., Tajeddini, K., Bajaj, N. K., & Ali, R. (2023). Innocent devils: The varying impacts of trade, renewable energy and financial development on environmental damage: Nonlinearly exploring the disparity between developed and developing nations. Journal of Cleaner Production, 386(January), 135729. https://doi.org/10.1016/j.jclepro.2022.135729

Ren, Y., Shi, L., Bardow, A., Geyer, R., & Suh, S. (2020). Life-cycle environmental implications of China's ban on post-consumer plastics import. Resources, Conservation and Recycling, 156, 104699. https://doi.org/https://doi.org/10.1016/j.resconrec.2020.104699

Shahbaz, M., Nasreen, S., Ahmed, K., & Hammoudeh, S. (2017). Trade openness–carbon emissions nexus: The importance of turning points of trade openness for country panels. Energy Economics, 61, 221-232. https://doi.org/10.1016/j.eneco.2016.11.008

Shinsuke, T., Kensuke, T., & Eric, V. (2022). North-South Displacement Effects of Environmental Regulation: The Case of Battery Recycling. American Economic Review: Insights, 4(3), 271-288. https://doi.org/10.1257/aeri.20210201 (American Economic Review: Insights)

Sigmund, M., & Ferstl, R. (2021). Panel vector autoregression in R with the package panelvar. The Quarterly Review of Economics and Finance, 80(C), 693-720. https://EconPapers.repec.org/RePEc:eee:quaeco:v:80:y:2021:i:c:p:693-720

Sun, N., & Tabata, T. (2021). Environmental impact assessment of China's waste import ban policies: An empirical analysis of waste plastics importation from Japan. Journal of Cleaner Production, 329(October), 129606. https://doi.org/10.1016/j.jclepro.2021.129606

Syakti, A. D., Hidayati, N. V., Jaya, Y. V., Siregar, S. H., Yude, R., Suhendy, Asia, L., Wong-Wah-Chung, P., & Doumenq, P. (2018). Simultaneous grading of microplastic size sampling in the Small Islands of Bintan water, Indonesia. Marine Pollution Bulletin, 137, 593-600. https://doi.org/https://doi.org/10.1016/j.marpolbul.2018.11.005

Ullah, I., Nuta, F. M., Levente, D., Yiyu, B., Yihan, Z., Yi, C., Shah, M. H., & Kumar, R. (2023). Nexus between trade, industrialization, and marine pollution: A quantile regression approach. Ecological Indicators, 155(June), 110992. https://doi.org/10.1016/j.ecolind.2023.110992

van Bijsterveldt, C. E. J., van Wesenbeeck, B. K., Ramadhani, S., Raven, O. V., van Gool, F. E., Pribadi, R., & Bouma, T. J. (2021). Does plastic waste kill mangroves? A field experiment to assess the impact of macro plastics on mangrove growth, stress response and survival. Science of The Total Environment, 756, 143826. https://doi.org/https://doi.org/10.1016/j.scitotenv.2020.143826

Wang, C., Zhao, L., Lim, M. K., Chen, W. Q., & Sutherland, J. W. (2020). Structure of the global plastic waste trade network and the impact of China's import Ban. Resources, Conservation and Recycling, 153(March 2019), 104591. https://doi.org/10.1016/j.resconrec.2019.104591

Wen, Z., Xie, Y., Chen, M., & Dinga, C. D. (2021). China's plastic import ban increases prospects of environmental impact mitigation of plastic waste trade flow worldwide. Nature Communications, 12(1), 1--9 , pmid = 33462243. https://doi.org/10.1038/s41467-020-20741-9 , file = :D\:/BEE/CIPS Werk/Ecopp/Paper Trade/Mas Imed/papers/s41467-020-20741-9.pdf:pdf

World Bank. (2020). World Development Report 2020 : Trading for Development in the Age of Global Value Chains. Washington, DC: World Bank.

World Bank. (2021). Plastic Waste Discharges from Rivers and Coastlines in Indonesia (Marine Plastics Series, East Asia and Pacific Region, Issue. https://www.worldbank.org/en/country/indonesia/publication/plastic-waste-discharges-from-rivers-and-coastlines-in-indonesia

World Customs Organization. (n.d.). Harmonized System. https://www.wcotradetools.org/en/harmonized-system/compare/2022/073915/en/to/2022/073915/en

World Economic Forum. (2020). Radically reducing plastic pollution in Indonesia: a multistakeholder action plan national plastic action partnership. https://www.globalplasticaction.org/resources/case-studies/radically-reducing-plastic-pollution-in-indonesia:-a-multist/aJY680000008ONUGA2#

World Trade Organization. (2020). Communication on Trade and Environmental Sustainability. https://docs.wto.org/dol2fe/Pages/SS/directdoc.aspx?filename=q:/WT/CTE/W249.pdf&Open=True

World Trade Organization. (2022a). World Trade Report 2022. https://www.wto.org/english/res_e/publications_e/wtr22_e.html

World Trade Organization. (2022b). Informal Dialogue on Plastics Pollution and Environmentally Sustaniable Plastics Trade (IDP). https://docs.wto.org/dol2fe/Pages/SS/directdoc.aspx?filename=q:/INF/TEIDP/W5.pdf&Open=True

Xu, Z., Wen, Q., & Zhang, T. (2023). Trade policy and air pollution: Evidence from the adjustment of the export tax rebate in China. Economic Modelling, 128(March), 106497. https://doi.org/10.1016/j.econmod.2023.106497

APPENDIX A:
Data notes on the economic effects of the plastic waste trade

We use input-output analysis (Baumol, 2000) to complement Darus et al. (2020). To define the plastic recycling industry, we use International Standard Industrial Classification of All Economic Activities (ISIC) Revision 4 issued by the United Nation Statistics Department.

The plastic recycling industry is classified under division 38 (waste collection, treatment and disposal activities, materials recovery). Division 38 includes waste treatment and other types of disposal facilities, not only recycling, and all recycling rather than just plastic recycling. We therefore cannot directly attribute changes in division 38 to plastic recycling alone.

Serial data on value added and investment in the Indonesian plastic recycling industry are not accessible to us and may not exist. We therefore make a rather strong assumption that if there are noticeable changes in the year 2010 or 2018, they are largely due to plastic-related collection and recycling. This assumption can be justified because plastic waste imports were zero prior to import relaxations in 2010.

Figure 3 shows the dynamics of the Indonesian recycling industry from 2002 to 2020. We use The OECD Inter-Country Input-Output (ICIO), which has 45 unique industries based on ISIC Revision 4 (OECD, 2023). The database shows how much sectoral value added, both foreign and domestic, that is used by a certain industry. We take Indonesian division 38, and then calculate its output and its foreign input.

For investment in division 38, we use data from the Indonesian investment body, Badan Koordinasi Penanaman Modal (BKPM) which disseminates investment realization in Indonesia, both foreign direct investment (FDI) and domestic direct investment (DDI) at the division level of ISIC from 1990 at the earliest. Data is available for both a number of projects and in USD. Investment data for division 38 is only available since 2011 onwards, so we cannot see how the investment of division 38 looks like prior to the introduction of plastic waste import relaxation. However, we can see if there is any sudden investment spike in this division in 2018. Visualization of such data is shown in figure 4.

APPENDIX B:
Data and notes on the industrial impact of the plastic waste trade

To determine how much imported plastic waste is absorbed by other industries, we rely on an Indonesian specialized customs database. This database allows us to look at imports from Indonesian manufacturing firms by HS-6-digit codes. That is, we can observe which firms import 3915 and in what industries they belong. This database can be connected to Indonesian manufacturing surveys. Connecting these datasets allows us to estimate characteristics such as output, labor and capital. This is the same dataset used in Pane & Patunru (2022) and Gupta (2022). It exists for the period of 2008–2012.

We first look at the amount of imported plastic waste by these firms, illustrated in Figure 5. We find no substantial increase in imports in the year 2010, suggesting that these firms' imports are not changing with the overall plastic waste imports. There is a substantial increase in 2011, but imports are modest in the following year. More importantly, these numbers are trivial compared to total import of plastic waste overall, accounting for less than 1%. Among top importers are firms in the textile and apparel industry and chemicals.

We then turn to firm characteristics. Before we look at descriptive statistics, note that few firms import plastic. Out of 32,318 total observations, only 145 are plastic waste importers. This is to be expected, since less than 10% of Indonesian manufacturing is engaging with international trade (Pane & Patunru, 2022; Gupta, 2022). We present a descriptive statistic of both plastic waste importers and non-plastic waste importers in table 2. Also to be expected is that plastic waste importers are generally more foreign-owned and larger in size compared to the average Indonesian manufacturers.

Table 2.
Descriptive statistics of plastic waste importers and otherwise

	Plastic waste importers		Non-importers of plastic waste	
VARIABLES	mean	sd	mean	sd
Foreign ownership	43.41	49.70	8.040	26.23
No. of labor	1,471	2,695	212.8	810.2
Imported inputs	4.216e+07	1.027e+08	1.156e+07	3.794e+08
Capital	6.422e+08	4.267e+09	5.124e+08	8.602e+10
Output	2.318e+08	4.131e+08	6.605e+07	8.160e+08
Value added	1.055e+08	1.890e+08	2.686e+07	2.754e+08
% of exported output	51.07	40.56	16.05	32.73
Total factor productivity	11.79	0.718	10.63	0.913

Source: authors' calculation

Lastly, we want to examine whether importing plastic waste actually helps with increasing firms' value added. We run a fixed effect regression where the log value-added of firms is a function of the number of workers, capital, and total factor productivity (TFP). Value-added and capital are deflated using a wholesale price index deflator, while TFP is estimated using Levinsohn-Petrin method (Levinsohn & Petrin, 2003; Pane & Patunru, 2022; Gupta, 2022).

Our main dependent variable is firms' output. We based our regression equation from a production assumption which depends mainly on capital, labor, and productivity. We assume a Cobb-Douglass production function and using log to linearize the function which translates to

$$y_{it} = \alpha_0 + \alpha_1 K_{it} + \alpha_2 L_{it} + \varepsilon_{it}$$

where *i* and *t* are indices for firms and year respectively.

We proceed the regression with two specifications. For the first specification, we add a plastic waste importer dummy, which is equal to 1 if the firm *i* is importing plastic waste at all at time *t*. For the second, we use log of plastic waste import value for firms importing plastic waste at time *t* or zero otherwise. Results can be seen on Table 3.

Table 3.
Regression results

	(1)	(2)	(3)	(4)
VARIABLES	RE	FE	RE	FE
TFP	1.038***	1.085***	1.038***	1.085***
	(0.0110)	(0.0155)	(0.0110)	(0.0155)
Log #workers	0.595***	0.490***	0.595***	0.490***
	(0.00895)	(0.0175)	(0.00895)	(0.0175)
Log capital	0.0667***	0.0186**	0.0667***	0.0185**
	(0.00465)	(0.00743)	(0.00465)	(0.00743)
plastic waste import dummy	0.268*	0.300**		
	(0.141)	(0.151)		
log plastic waste import			0.0206	0.0265
			(0.0180)	(0.0192)
Constant	-0.146	0.463***	-0.146	0.465***
	(0.0922)	(0.178)	(0.0922)	(0.178)
Observations	18,819	18,819	18,819	18,819
R-squared		0.390		0.390
Number of psid	6,500	6,500	6,500	6,500

Note: *** means the parameter is significant at 0.1% level

Table 3 shows both specifications using random effect (RE) and fixed effect (FE). Results show high consistency across specifications, suggesting a robust specification.

However, the log of plastic waste imports is not significant. For the plastic waste import dummy, it shows a significance in 5% level for RE and at 1% level for FE. This may suggest that there is a small gain of value added when a firm switches from non-plastic waste importer to a plastic waste importer. This gain, however, isn't very strong and economically not meaningful. That is, switching from non-waste importers to importers only increases value added by 0.3%.

ABOUT THE AUTHORS

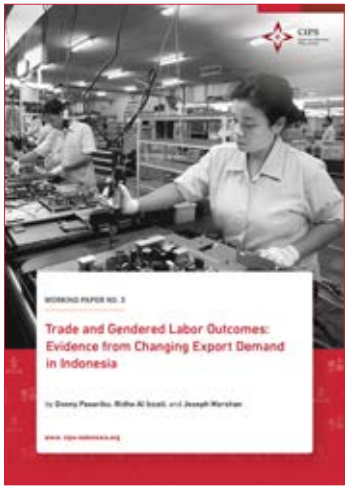
Krisna Gupta is CIPS' senior fellow. He is an economist who uses various types of panel data regressions and other quantitative tools to evaluate international trade and investment policies as well as Indonesian manufacturing growth. He holds a Ph.D. from Crawford School of Public Policy, Australian National University, and two Masters's degrees in economics from Universitas Indonesia and VU University Amsterdam. mIn 2019, he was awarded the Hadi Soesastro Prize by the Australian government for his outstanding academic excellence in Indonesian development research.

Biyan Shandy Paramayudha is CIPS' research assistant. He graduated with a Master's degree in Economic Planning and Development Policy from University of Indonesia. He also holds a Bachelor's degree in Urban and Regional Planning from Institut Teknologi Sepuluh Nopember (ITS) in Surabaya/Indonesia. Prior to joining CIPS, he undertook research for the National Resilience Institute (Lemhannas) of the Republic of Indonesia and ITS Surabaya.

Explore other paper published by Center for Indonesian Policy Studies

A Tale of Two Liberalization Episodes with China: Impact on Poverty in a Developing Nation

Export Expansion and Labor Market Dynamics in Indonesia



Trade and Gendered Labor Outcomes: Evidence from Changing Export Demand in Indonesia

Go to our website to access more titles:
www.cips-indonesia.org/publications

The Center for Indonesian Policy Studies invites those interested to support our advocacy by joining one of our Donor Circles.

If you or your organization is interested to cooperate and engage more closely with the work of CIPS, please contact:

Anthea Haryoko
Chief Innovation and Development Officer
Anthea.haryoko@cips-indonesia.org

ABOUT THE CENTER FOR INDONESIAN POLICY STUDIES

Center for Indonesian Policy Studies (CIPS) is a strictly non-partisan and non-profit think tank providing policy analysis and practical policy recommendations to decision-makers within Indonesia's legislative and executive branches of government.

CIPS promotes social and economic reforms that are based on the belief that only civil, political, and economic freedom allows Indonesia to prosper. We are financially supported by donors and philanthropists who appreciate the independence of our analysis.

KEY FOCUS AREAS:

Food Security & Agriculture: To enable low-income Indonesian consumers to access more affordable and quality staple food items, CIPS advocates for policies that break down the barriers for the private sector to openly operate in the food and agriculture sector.

Education Policy: The future of Indonesia's human capital need to be prepared with skills and knowledge relevant to the 21st century. CIPS advocates for policies that drive a climate of healthy competition amongst education providers. Such competition will drive providers to constantly strive to innovate and improve education quality for the children and parents they serve. In particular, CIPS focuses on the improvement of operational and financial sustainability of low-cost private schools who serve the poor.

Economic Opportunities: CIPS advocates for policies that expand economic involvement and opportunities for Indonesian entrepreneurs and businesses; as well as for policies that open wider opportunities for lowincome Indonesians to access decent incomes and create wealth.

www.cips-indonesia.org

facebook.com/cips.indonesia
@cips_id
@cips_id
Center for Indonesian Policy Studies
CIPS Learning Hub

Jalan Terogong Raya No. 6B
Cilandak, Jakarta Selatan 12430
Indonesia