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Do Non-Tariff Barriers Divert Trade? A Case Study of Plastic Waste Export.

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Abstract

Globally, production and waste generation have been increasing for several decades. The flow of recyclable waste from developed to developing countries has also risen. Notably, China was the primary importer of recyclable waste for recycling and reuse. However, to reduce the burden of recycling and solid waste management, China has begun restricting the import of low-quality waste. This study analyzes the impact of trade restriction policy, specifically the National Sword Policy (NSP), on waste exports, with a focus on plastic waste scrap[3]. This waste is exported to China from the rest of the world. The analysis relies on two major data sources: the Center for Prospective Studies and International Information **(**CEPII) database and GDP per capita (GDPPC) from the World Development Indicators (WDI). Using the Gravity model, this study examines trade patterns over a 24-year period from 1995 to 2018, deliberately excluding the pandemic years to avoid bias in the results. The findings indicate that the NSP reduced plastic waste scrap exports to China by 177% while increasing the flow of low-quality plastic waste scrap to the rest of the world by 135%. Considerably, countries with poor environmental regulations received more (339%) plastic, compared to the top 20 importers, which saw an increase of 285%. These findings highlight the need for further analysis of trade patterns, particularly through a multi-product approach and an intensive and extensive margin analysis of all types of plastic waste scrap.

Keyword: National Sword Policy (NSP), Plastic Waste Export.

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1. INTRODUCTION

Globally, industrial and municipal waste has increased significantly in recent decades. The Organization for Economic Cooperation and Development (OECD) estimates that by 2050, the world will generate approximately 27 billion tons of waste, more than double the 12.7 billion tons generated in 2000 (OECD, 2008). In addition to the current and projected increases in waste generation, transboundary movements of recyclable waste have increased due to globalization and trade liberalization. The global trade of waste and scrap has expanded substantially, with 500% between 1992 and 2012 (Kellenberg, 2015). This trade predominantly involves the flow of recyclable waste from developed to developing countries.

Since 1992, China has imported 106 million MT of plastic waste that accounts for around 45% of all cumulative imports (Brooks et al., 2018). In 2016, China imported two-thirds of the world's plastic waste (Alademi, 2020). However, in response to growing burden on solid waste management and environmental concerns, China began limiting trade flows of low-quality of waste even prior to 2010 (Brooks et al., 2018). In 2013, China introduced a temporary restriction on waste imports commonly referred to as the Operation Green Fence (OGF). It aimed to improve the quality of imported plastic waste which restricted illegal smuggling and low-quality waste dumping. While OGF was a temporary measure, it exposed the fragility of global dependence on a single importer. OGF succeeded in its goals; however, it did not entirely stop the informal flow of plastic waste, and true quantities are unknown at this time.

In 2017, China's National Sword Policy (NSP) was more stringent and more permanent aimed to ban the import of nonindustrial plastic waste. On July 18th, 2017, China announced the ban of 24 categories of solid waste import materials to the World Trade Organization (WTO), followed by a decision to phase out imports of solid waste (recyclables) imports and substituting with domestic resources by the end of 2019 **(**Brooks et al., 2018). The NSP set a strict contamination threshold of 0.5% for imported recyclable materials of plastic items and other waste. Making it the most severe restriction compared to previous policies (Alademi, 2020). The motivation behind NSP was to reduce the flow of poor-quality plastic waste, and for protecting China's environment and eliminate public health risk.

The gravity model of trade has been commonly used to analyze the effects of trade barriers, including border effects, trade creation or diversion, and tariff and non-tariff barriers between countries (McCallum, 1995). This paper explored the impact of the US-Canada border on trade, an influential study that was later criticized by Anderson and Wincoop (2003). The later study

pointed out failure to consider multilateral resistances in the former study. Beyond border effects, this model has also been applied to analyze the influence of trade agreements on trade patterns. For instance, Yang and Martinez-Zarzoso (2014) found that the ASEAN-China Free Trade Agreement (ACFTA) led to trade creation within the ASEAN region. However, Montenegro and Soloaga (2006) found that the North American Free Trade (NAFTA) did not necessarily result in trade creation. It suggested that global trade treaties may sometimes lead to trade diversion rather than facilitation.

Trade in recyclable materials is principally driven by demand for waste-based raw materials. Several studies, such as Kellenberg and Levinson (2014), Higashida and Managi (2014), Balkevicius et al. (2017), and Wang et al. (2017), have studied the determinants of recyclable waste trade. Higashida and Managi (2014) developed a theoretical model illustrating the interaction between import demand, export supply, and global trade in recyclables. Their study focused on five recyclable waste categories: three types of plastic waste scrap, ferrous waste (iron and steel), and copper waste. The objective for trading recyclables is to repurpose waste into raw materials for the manufacturing sector. It is often more cost-effective than using virgin materials. However, such trade also presents environmental and public health challenges when low-quality waste is improperly disposed of. It usually results to landfill overflow and solid waste mismanagement in importing countries.

The impact of trade restrictions on plastic waste flows has been studied extensively. Brooks et al. (2018) projected that if China fully restricts plastic waste imports, approximately 111 million MT of plastic waste would be displaced by 2030. Similarly, Wang et al. (2018) estimated global plastic waste flows after 2013, following China's implementation of OGF policy, were diverted to Southeast Asian countries such as Malaysia and Thailand. These temporary restrictions imposed by China highlighted the vulnerabilities of the global waste trade system. Balkevicius et al. (2017) also found that China’s restrictions reduced waste imports but increased the flow of lower-quality waste to developing countries. Subsequent after OGF policy, China introduced the NSP, which permanently restricted low-quality waste imports. It shifted the global plastic waste trade patterns extensively. Therefore, this study aims to analyze the impact of NSP on global plastic waste flows, particularly its effects on China and the rest of the world.

To empirically explore objectives of this study, we use a Gravity Model framework with fixed effects to account for unobserved heterogeneity among exporting and importing countries. The

preliminary results suggest that NSP has significantly reduced plastic waste exports to China. However, it has raised the flow of low-quality waste to other countries, particularly those with weaker environmental regulations. After the NSP policy, the low-quality plastic waste scrap has heterogeneously diverted towards environmentally less-regulated countries, specifically more than to the top 20 importers. Alongside the outcomes of trade diversion, it not only increases concerns about the waste management burden on less developed nations but also expected environmental and public health consequences. After considering prior literature and empirical evidence from this study enhances attention towards international waste trade policies and their unexpected outcomes. For future research work, this study expresses focus on multi-product trade incorporating the intensive and extensive margin analyses of all categories of plastic waste scrap.

2. Data Description

2.1Sample and data

For the analysis purpose we use CEPII Database for bilateral exports of Plastic waste, World Development Indicators (WDI) for GDP per capita and rest of variables are dummy variables which are self-calculated. The sample comprises of 24 years, i.e., annual data from year 1995 to 2018 including . all exporters provided by the CEPII Database.

Table 1 provide descriptive statistics which includes type of variable, mean, standard deviation and observations for China and Rest of World model. The mean of Exports of Plastic waste Scrap is 6120 kg and 1346 Kg to China and Rest of World. Comparatively, China was importing more than 4 times of plastic waste as compared to the rest of the world. For China model, NSP, Low Quality and GDP per capita exporter and importer has mean of 0.07, 0.378, 628024 units, and 33202 units. For Rest of the World NSP, Low Quality, Environmental Lax Importer, Big Importer and GDP per capita of Exporter and Importer has mean of 0.10, 0.037, 0.385, 384031 units, and 2051520 units.

Table 1: Descriptive Statistics of Model using Exports to China

Variable	Definition	Type	Mean	Standard Deviation	Observations

Exports of Plastic Waste Scrap	Quantity of plastic waste scrap exports from country 'i' to country 'j' in time period 't'	Continuous Variable	6120	12388	367
National Sword Policy (NSP)	1 for import ban by China in year 2017 and 0 otherwise	Dummy Variable	0.070	0.25619	367
Low Quality	1 for wastes that are within the lowest price = the lowest unit value in any given year of waste from exporter and 0 for otherwise	Dummy Variable	0.3787	0.4857	367
GDP per capita of Exporter	GDP per capita is a gross domestic product divided by midyear population	Continuous Variable	628024	1677071	367
GDP per capita of Importer	GDP per capita is a gross domestic product divided by midyear population	Continuous Variable	33202	14603	367

Table 2: Descriptive Statistics of Model using Exports to the Rest of the World

Variable	**Definition**	**Type**	**Mean**	**Standard Deviation**	**Observations**
Exports of Plastic Waste Scrap	Quantity of plastic waste scrap exports from country 'i' to country 'j' in time period 't'	Continuous Variable	1346	6859	6,542
National Sword Policy (NSP)	1 for import ban by China in year 2017 and 0 otherwise	Dummy Variable	0.10	0.300	6,542
Low Quality	1 for waste that are within the lowest price = the lowest unit value in any given year of waste from exporter and 0 for otherwise	Dummy Variable	0.037	0.310	6,542
GDP per capita of Exporter	GDP per capita is a gross domestic product divided by midyear population	Continuous Variable	384031	1491083	6,525
GDP per capita of Importer	GDP per capita is a gross domestic product divided by midyear population	Continuous Variable	2051520	7317643	6,542
Environmental Lax Importer	1 for the importers with weak environmental regulations and 0 otherwise	Dummy Variable	0.037	0.1895	6,542

Big Importer	1 for countries that were amongst largest waste importers of plastics during the year 2017.	Dummy variable	0.385	0.4867	6,542

To enhance the understanding of data we have done the trend analysis to highlight the changes in the pattern of plastic scrap export to China and rest of the world.

Figure 1: Exports of Plastic Waste to China

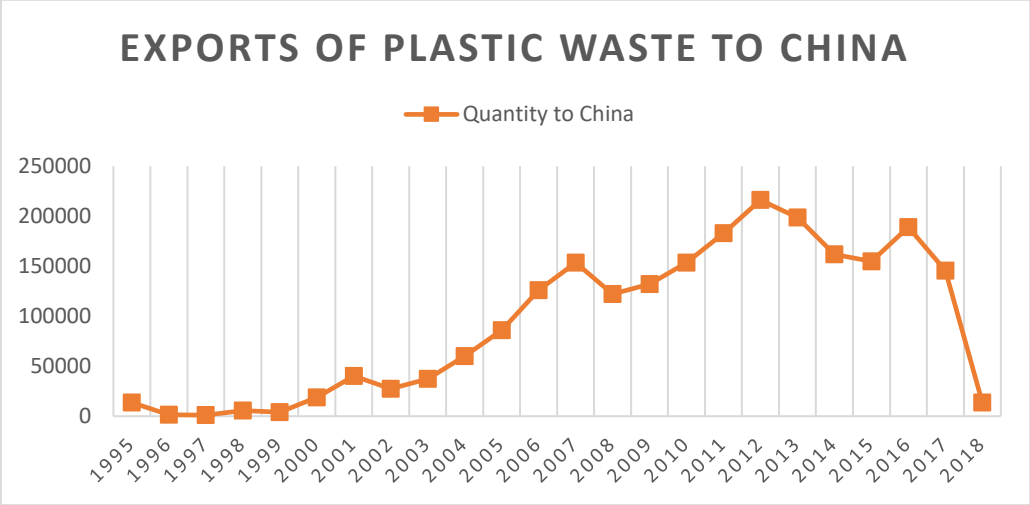

Figure 1 shows rising trend of plastic waste scrap to China from 1998 to 2013 then a fluctuation till year 2017. After year 2017, it had a sharp dip till year 2018 which reflects more than 60 percentage decrease in exports of plastic waste to China.

Figure 2: Exports of Plastic Waste to Rest of the World

Figure 2 shows fluctuations in quantity of Exports of Plastic Waste to Rest of World before 2005 year. After it, there is a drop till the year 2008. Again after 2008 , it remained fluctuating slightly till 2017. Then, there comes a drop in the year 2018.

3. METHODOLOGY

In this study, we apply Gravity model, the theoretical specification of the model is as follows:

The Gravity model is rooted in Newton Law of Gravity. Tinbergen (1962) uses this model to define trade between countries. It defined as "size of bilateral trade flows (X_{ij}) depends on the economic sizes (Y_i and Y_j) and distance (d_{ij}) between two units". Mathematically, given as below,

$$X_{ij} = \frac{AY_i^{\beta_1} Y_j^{\beta_2}}{d_{ij}^{\rho}}$$

This simple gravity model has been used in numerous studies. for example (McCallum 1995,) have analysis border effect,, (Yang, & Martinez-Zarzoso) used same model to find the nexus between trade creation and divergence, similarly, Montenegro and Soloaga, 2006, Kellenberg and Levinson (2014), Higashida and Managi (2014), Balkevicius et al., 2017 and Wang et al., 2017 use it to find the implication of and tariff and non-tariff barriers (Anderson and Wincoop 2003, Yang and Martinez-Zarzoso 2014,). Hence, this model have diverse/multiple implication in the analysis of trade dynamics, in this study we we divide our empirical specifications into two models related to China and Rest of the World.

Model 1: Impact of NSP on Plastic Waste Exports to China

$$\text{Log}\,(X_{ict}) = \beta_0 + \beta_1(NSP)_t + \beta_2(NSP*\text{Low Quality})_{it} + \beta_3\,\text{Log}\,(Y_{it}) + \beta_4\,\text{Log}\,(Y_{jt}) + \alpha_i + \varepsilon_{ict}$$

Where, X_{ict} = Exports of Plastic Waste Scrap from country 'i' to country China in time period 't', NSP_t = 1 for Import Ban by China in year 2017 and 0 before 2017, Low Quality = 1 for exporters sending low quality (value) exports, o=otherwise, Y_{it} = GDP per capita for Exporter and Y_{jt} = GDP per capita for Importer.

Model 2: Impact of NSP on Plastic Waste Exports to Rest of World

$$\text{Log}\,(X_{ijt}) = \beta_0 + \beta_1(NSP)_t + \beta_2(NSP*\text{Low Quality})_{jt} + \beta_3\,\text{Log}\,(Y_{it}) + \beta_4\,\text{Log}\,(Y_{jt}) + \beta_5(\text{Low Quality}*\text{Lax})_{it} + \beta_6(\text{Low Quality}*\text{Big Importers})_{it} + \alpha_i + \rho_j + \gamma_{ij} + \varepsilon_{ijt}$$

Where, X_{ijt} = Exports of Plastic Waste Scrap from country 'i' to country j in time period 't', NSP_t = 1 for Import Ban by China in year 2017 and 0 before 2017, Low Quality = 1 for exporters sending low quality (value) exports, o=otherwise, Low Quality*Lax_i= 1 if the importing country imports low quality of Plastic waste scrap and scores a low score of environmental stringency index and 0 otherwise, Low*Bigi=1 for countries importing low quality of Plastic waste scrap and were amongst top 20 importers of a plastic waste scrap, Y_{it} = GDP per capita for Importer, Y_{jt} = GDP per capita for Exporter, α_i = Exporter Fixed Effect, ρ_j = Importer Fixed Effect, γ_{ij} =country pair fixed effect and ε_{ijt} = error term.

RESULTS

This chapter provides results for the impact of NSP on Waste Export to China and Rest of the World.

Table 2: The Impact of NSP on Waste Export to China

VARIABLES	**(Panel OLS) Log (Exports)**	**(Panel OLS) Log (Exports)**	**(Panel OLS) Log (Exports)**
NSP	0.216	-1.667***	-1.772***
	(0.372)	(0.317)	(0.373)
GDPPC Exporter		2.212***	2.197***
		(0.272)	(0.274)
GDPPC Importer		1.479*	1.531*
		(0.804)	(0.811)
NSP* Low Quality			0.338
			(0.629)
Constant	6.516***	-32.352***	-32.774***
	(0.098)	(6.983)	(7.034)
Exporter Fixed Effect	Yes	Yes	Yes
Observations	362	354	354
R-squared	0.491	0.684	0.685

Note: Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1

Table 2 describes about impact of National Sword Policy (NSP) Policy on Plastic Waste Exports to China. From results, we found NSP reduced exports to China by 166% to 177%. However, the low quality of Plastic Exports is insignificant. The GDP per capita of importer and exporter are positively related to Plastic Waste exports.

Table 3: Regression results for Waste exports to other countries, excluding China.

VARIABLES	(Panel OLS) Log (Exports)	(Panel OLS) Log (Exports)	(Panel OLS) Log (Exports)	(Panel OLS) Log (Exports)
NSP	0.705***	-1.653***	-1.599***	-1.116***
	(0.074)	(0.290)	(0.289)	(0.277)
NSP Low Quality		1.971***	1.913***	1.350***
		(0.298)	(0.297)	(0.286)
GDPPC Exporter		0.540***	0.545***	0.760***
		(0.168)	(0.167)	(0.161)
GDPPC Importer		2.171***	2.162***	1.964***
		(0.184)	(0.183)	(0.176)
Low Quality*Lax			3.355***	3.396***
			(0.542)	(0.519)
Low Quality *Big				2.858***
				(0.133)
Constant	4.092***	-26.431***	-26.300***	-27.598***
	(0.022)	(1.800)	(1.801)	(1.720)
Exporter Fixed Effect	Yes	Yes	Yes	Yes
Importer Fixed Effect	Yes	Yes	Yes	Yes
Exporter Importer Pair Fixed Effect	Yes	Yes	Yes	Yes
Observations	6,172	5,933	5,933	5,933
R-squared	0.628	0.653	0.653	0.653

Table 3 describes the impact of National Sword Policy (NSP) on Exports to Rest of the World. It was found that NSP increased exports to the Rest of the World by 70%. However, when we controlled the low quality of Plastic waste exports, it reduced overall Plastic Waste exports by 155% to 111%. The low-quality Plastic waste exports have increased by 135% to 197%. The low quality of waste has increased by 335% to countries with weak environmental regulations. The low quality of Plastic waste has reduced to big importers by 285%. Similarly, one percent increase of GDP Per Capita of Importer and Exporter increases exports by 196% and 76%.

4. Conclusion & Discussion

Globally, the transboundary movement of waste trade has been increasing, with waste flow from developed to developing countries. China was once one of the major importers of waste,

particularly plastic waste scrap. However, China started to impose trade restrictions on low-quality waste imports since 2013. This study aims to analyze the impact of trade restriction by China, known as the National Sword Policy (NSP) on exports to China and Rest of the World. This analysis of this study is based on Gravity model, using fixed effects, namely importer, exporter, and country pair fixed effects. The study considers two major data sources: CEPII and WDI database, covering a sample comprises of 24 years from 1995 to 2018. Results found that the NSP reduced exports to China by 166% to 177% but increased low quality exports of plastic to the rest of the world by 205%. Markedly, exports of low quality of plastic waste has increased more to countries with weak environmental regulations (335%) than to big importers (285%). Additionally, the GDP per capita of both the importing and exporting countries is positively related to plastic waste exports. Based on these results, we have three important implications to discuss which guides future trade policy making. First, trade ban policies can cause positive and negative externality within and outside of the country. Therefore, it is important to consider its consequences to minimize its negative effects within and across countries. Second, the least developed countries should consider solid waste treatment facilities to meet additional low-quality plastic waste scrap imports. Third, countries with less environmental friendly policies will suffer from plastic waste imports than their counterparts. After discussing results, there are a few caveats of this study as well. First, this study uses pre-pandemic data to avoid any biasness, but one can use post-pandemic data to extend the NSP effects. Second, this study uses simple gravity model framework but does not consider multiproduct, intensive and extensive margin analysis for plastic waste products.

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