

## Supplementary Materials for

### The Chinese import ban and its impact on global plastic waste trade

Amy L. Brooks, Shunli Wang, Jenna R. Jambeck

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- fig. S3. Linear fit for the last 10 years of cumulative Chinese imports of plastic waste ( $R^2 = 1.0$ ) (9–12).
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- table S5. Projected displaced plastic waste based on 100, 75, and 50% restriction scenarios for Chinese imports of plastic waste after the implementation of the new Chinese import ban policy.
- table S6. Ranking of top countries that exported plastic waste to China in 2016 (MT) (13).

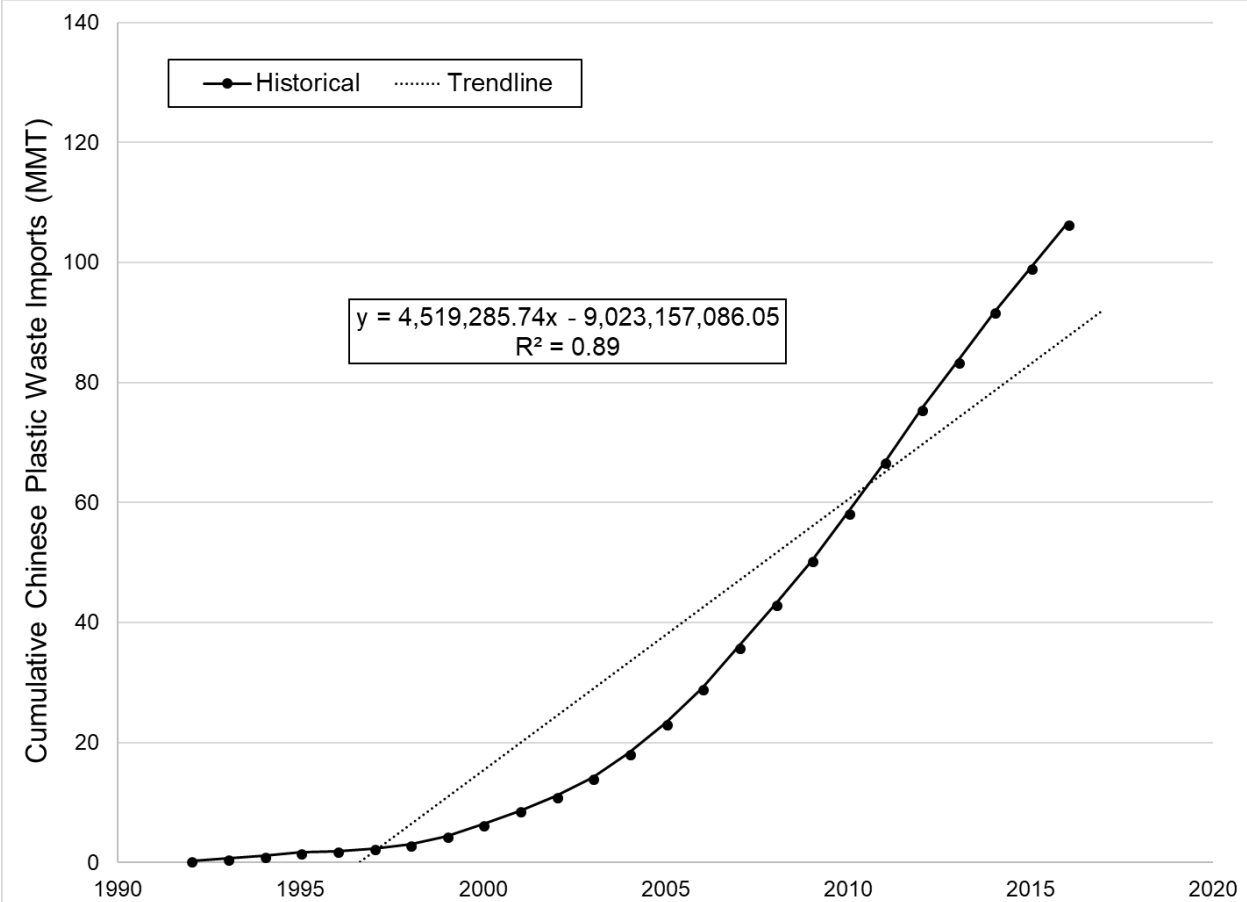
**Other Supplementary Material for this manuscript includes the following:**

(available at [advances.sciencemag.org/cgi/content/full/4/6/eaat0131/DC1](https://advances.sciencemag.org/cgi/content/full/4/6/eaat0131/DC1))

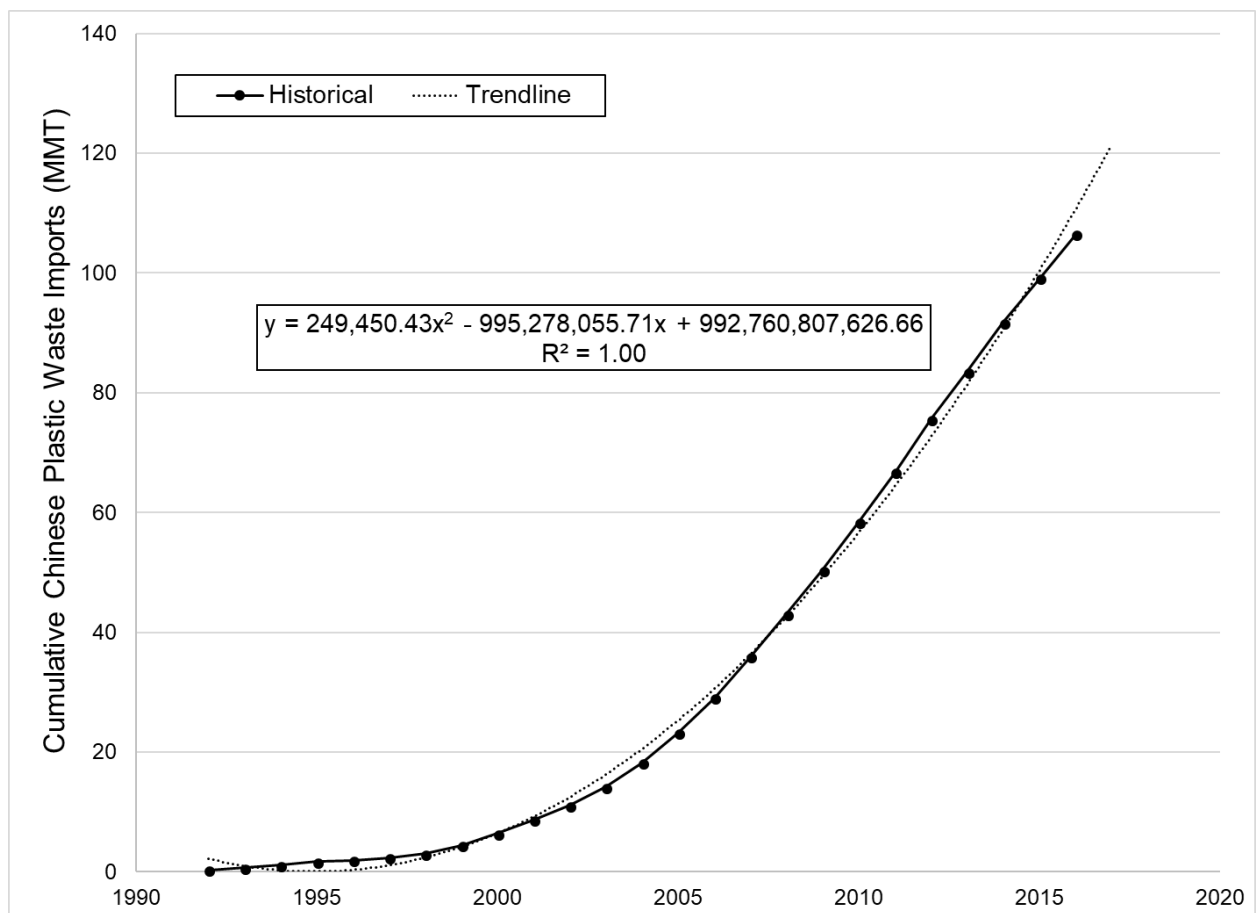
- database S1. Trade Data Compilation Framework (Excel file).

## **Supplementary Text**

Along with advances in engineering and material separation technology, and in order to increase participation in recycling, the concept of “single stream” recycling was introduced. Citizens put all recyclable items into one single recycle bin (without source separation) and the materials go to a Materials Recovery Facility (MRF) to be separated out through both mechanical and manual means. Separated materials are baled and sold as commodities. While switching to single stream did increase the quantity of materials collected from citizens, it also resulted in two things 1) more residuals and non-recyclable materials going to MRFs and 2) dirtier commodity streams coming from MRFs. Both results have impacted the bottom line of recycling all over the world.



**fig. S1. Linear fit of all historical cumulative Chinese imports of plastic waste ( $R^2 = 0.89$ ) (9–12).**



**fig. S2. Polynomial fit for historical cumulative Chinese imports of plastic waste ( $R^2 = 1.0$ ) (9–12).**

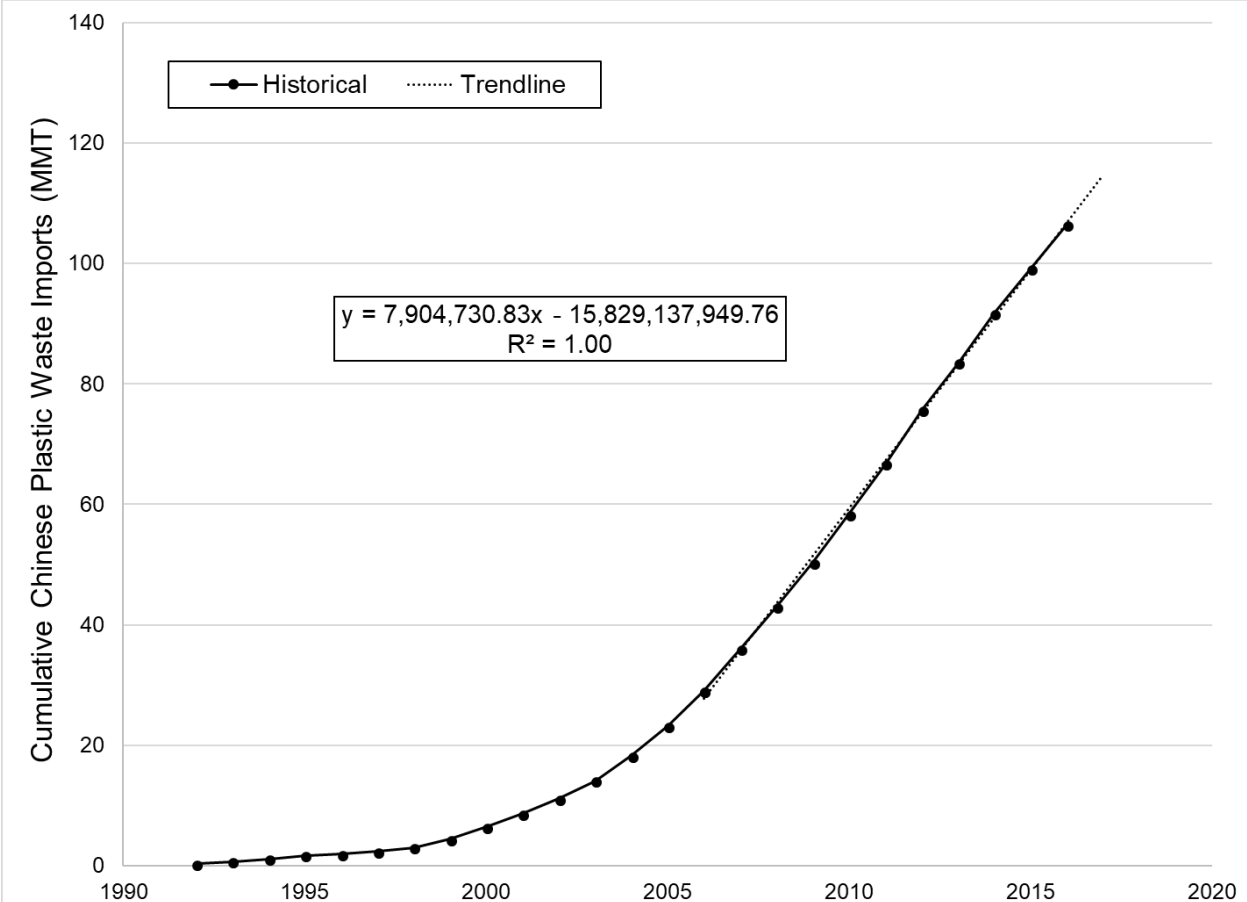


fig. S3. Linear fit for last 10 years of cumulative Chinese imports of plastic waste ( $R^2 = 1.0$ ) (9–12).

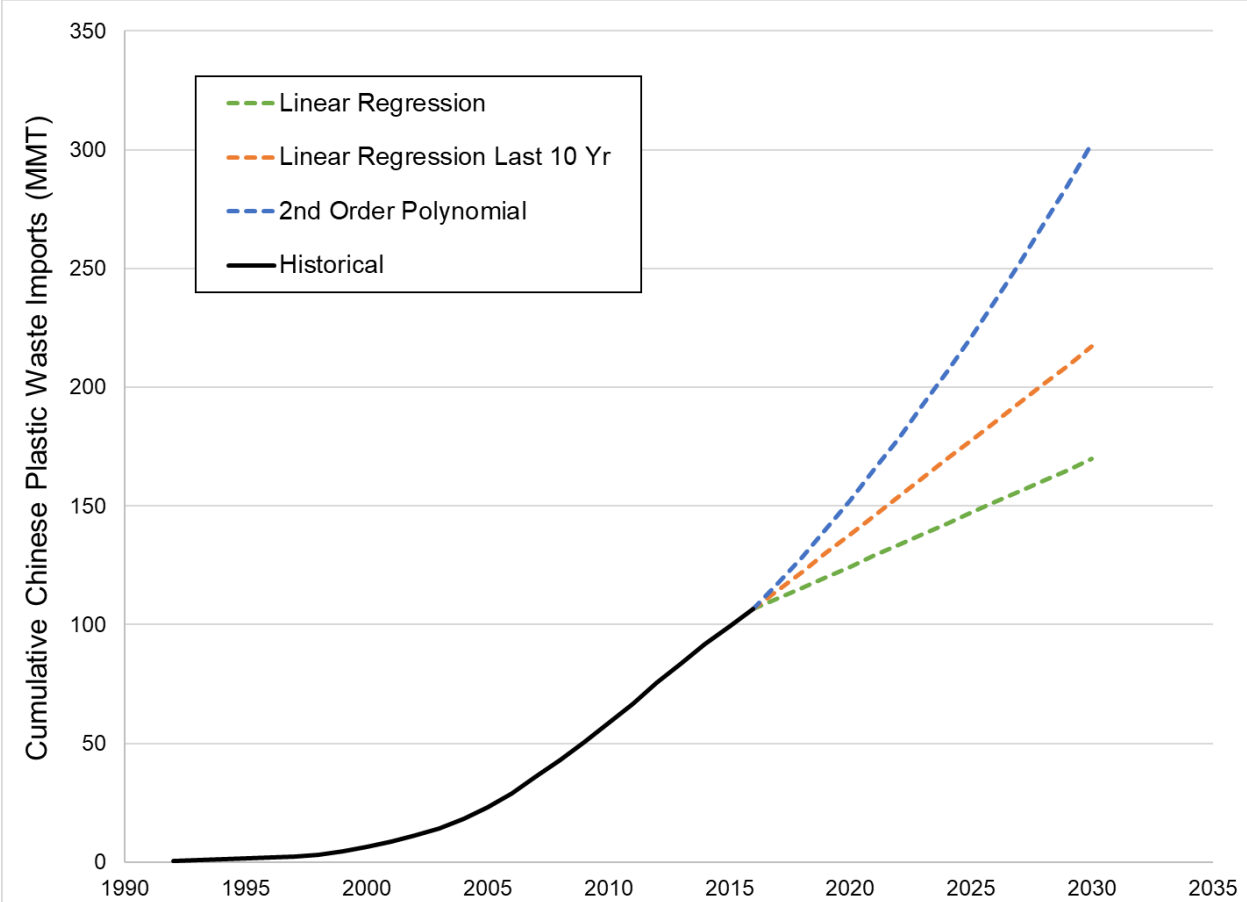
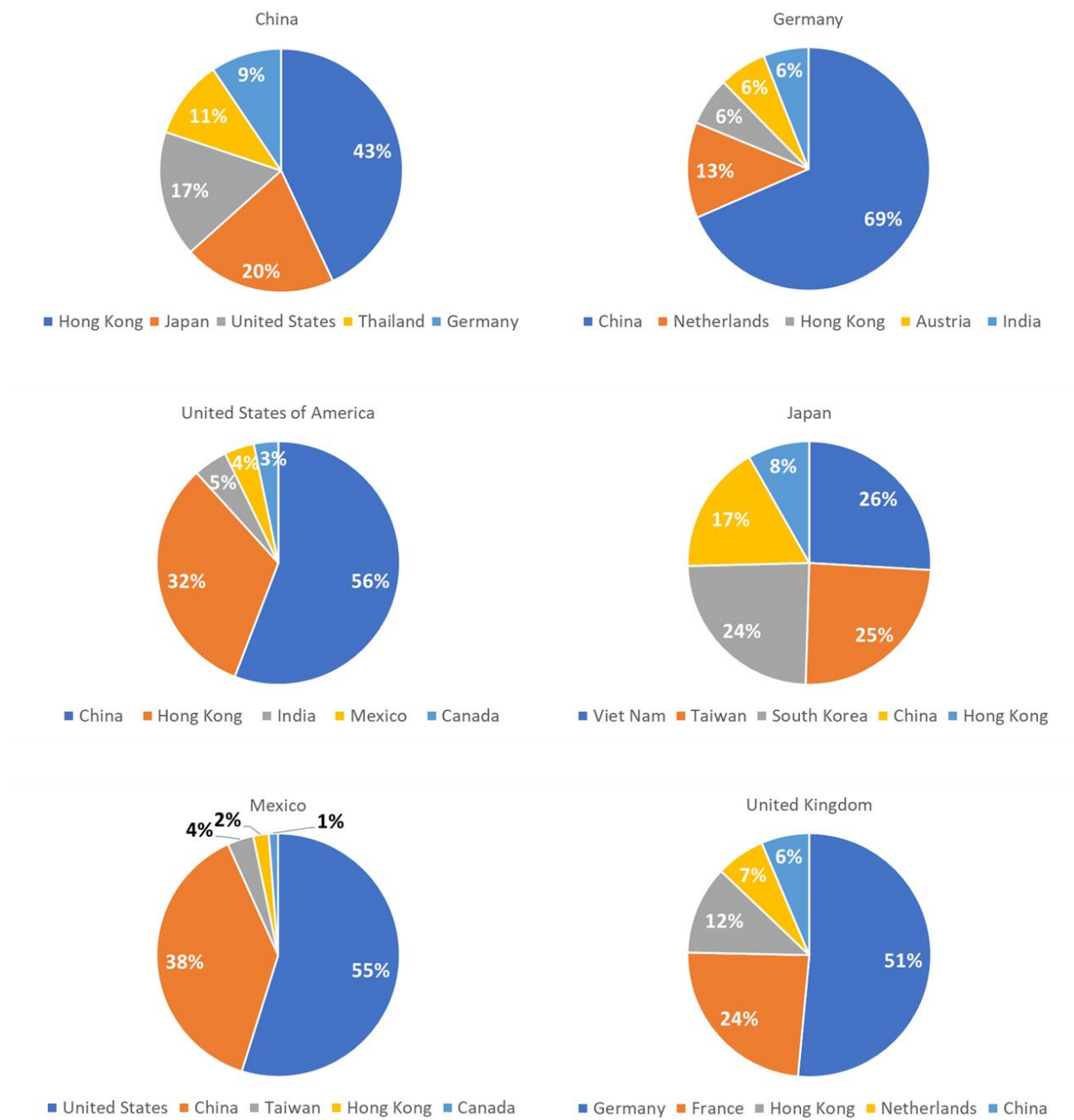
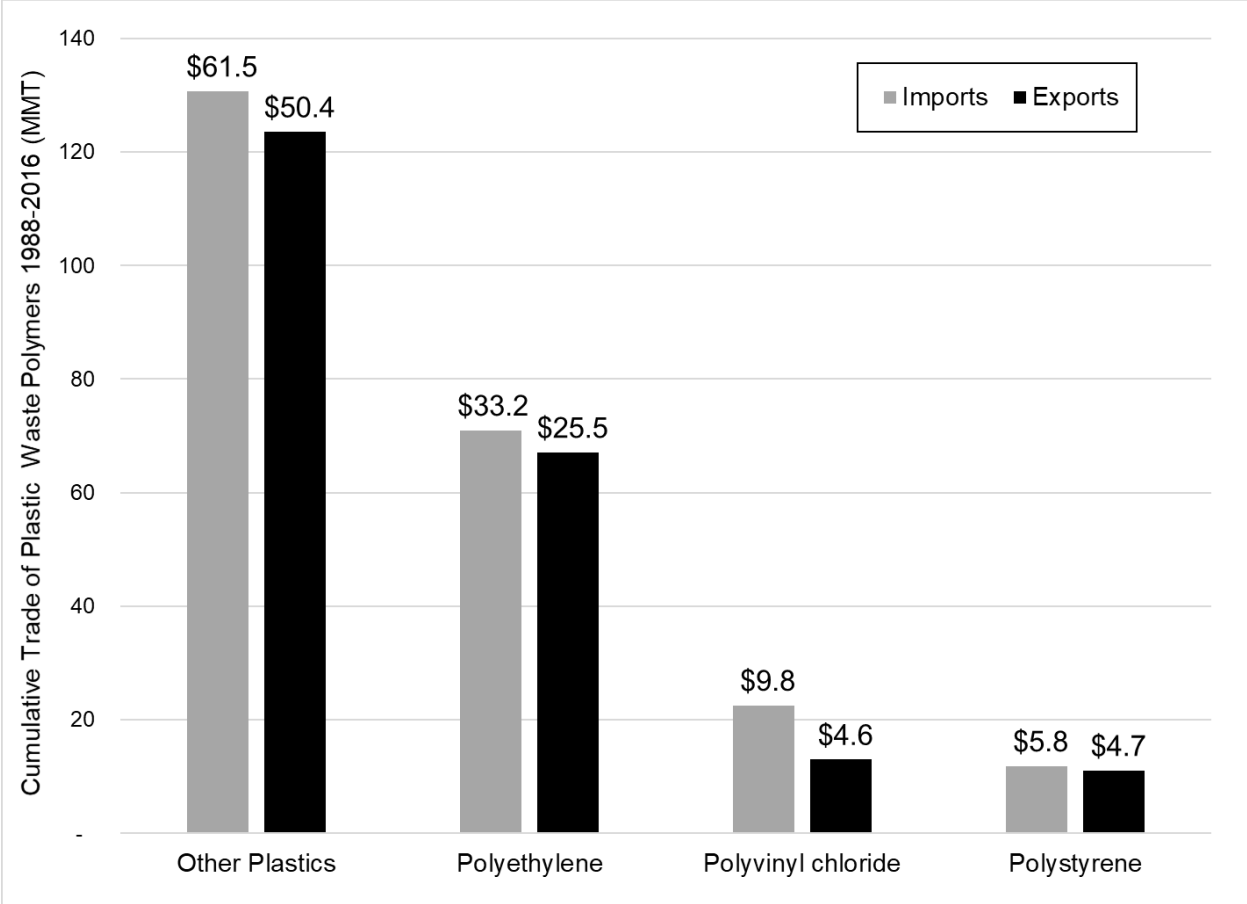


fig. S4. Best-fit regression analysis for future plastic waste imports (9–12).



**fig. S5. Top five importers to China in 2016 and top five export destinations for the top five historical exporters (13, 24–26).** Chinese imports include PE, PS, PVC, PP and PET. Exports of top 5 historical exporters include PE, PS, PVC.





**fig. S6. Comparison of cumulative import and export quantities of plastic waste (MT) from 1988 to 2016 for each plastic waste polymer. Dollar values in billion USD. (9-12)**

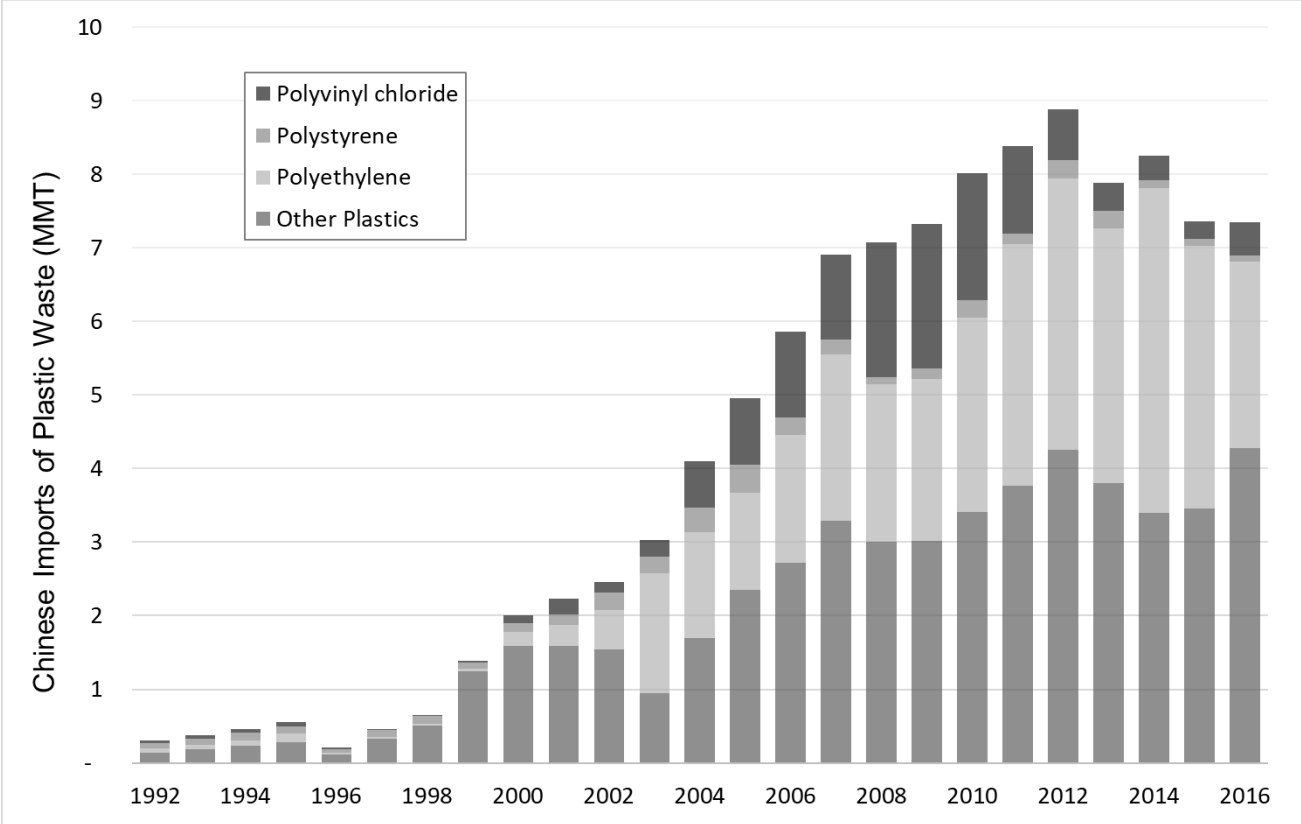
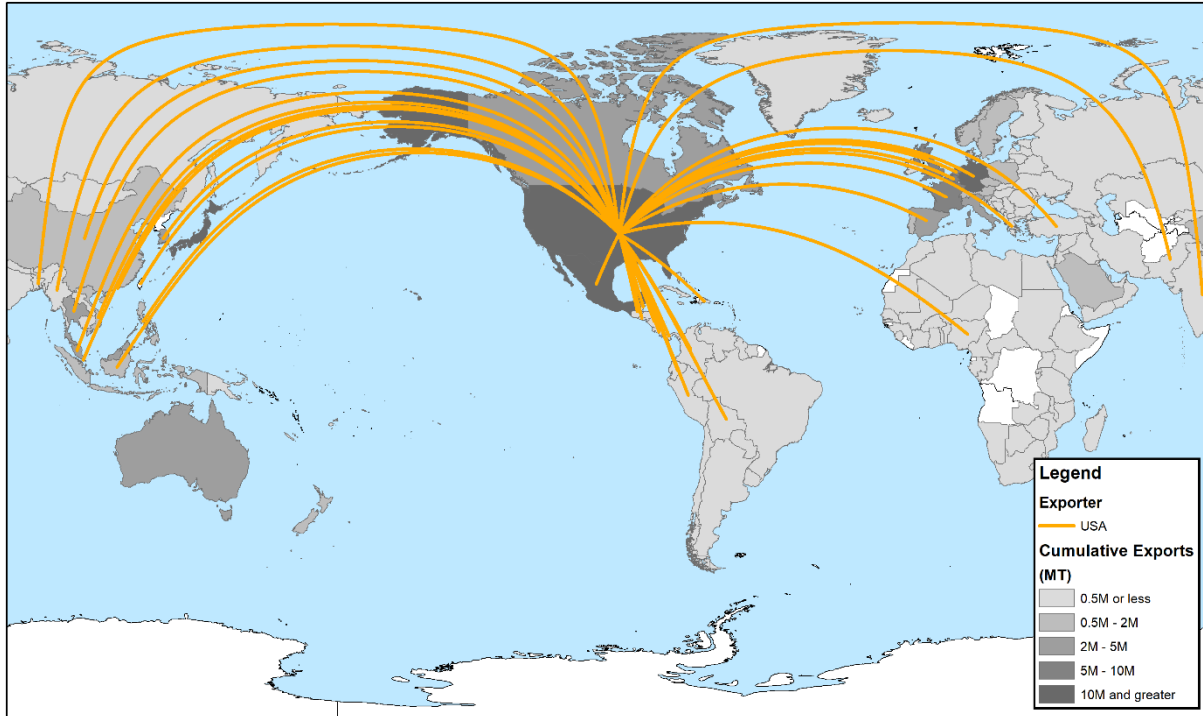
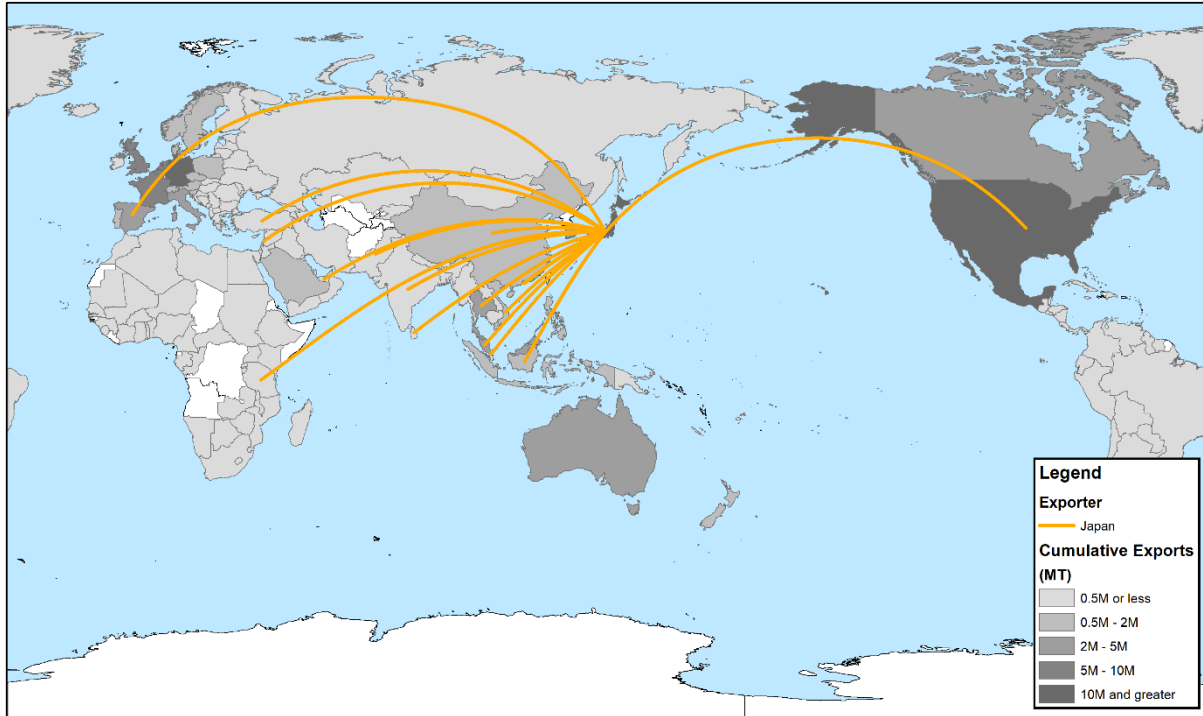


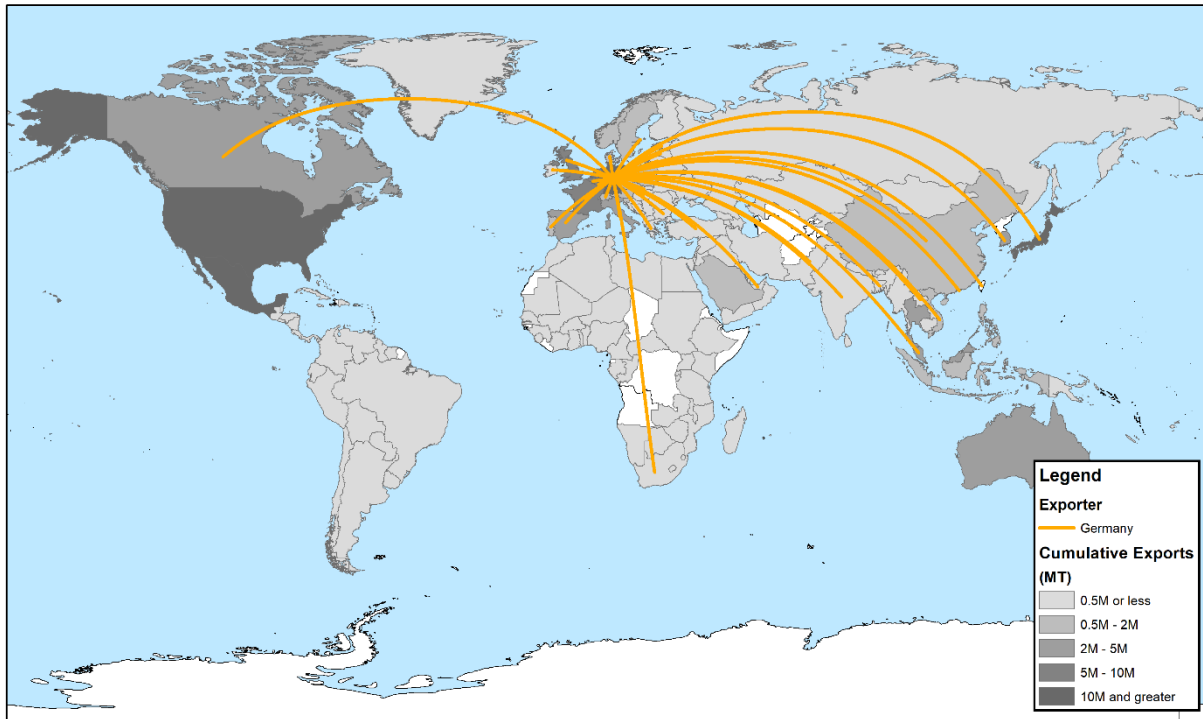
fig. S7. Annual Chinese imports of each plastic waste polymer from 1992 to 2016. (9-12)



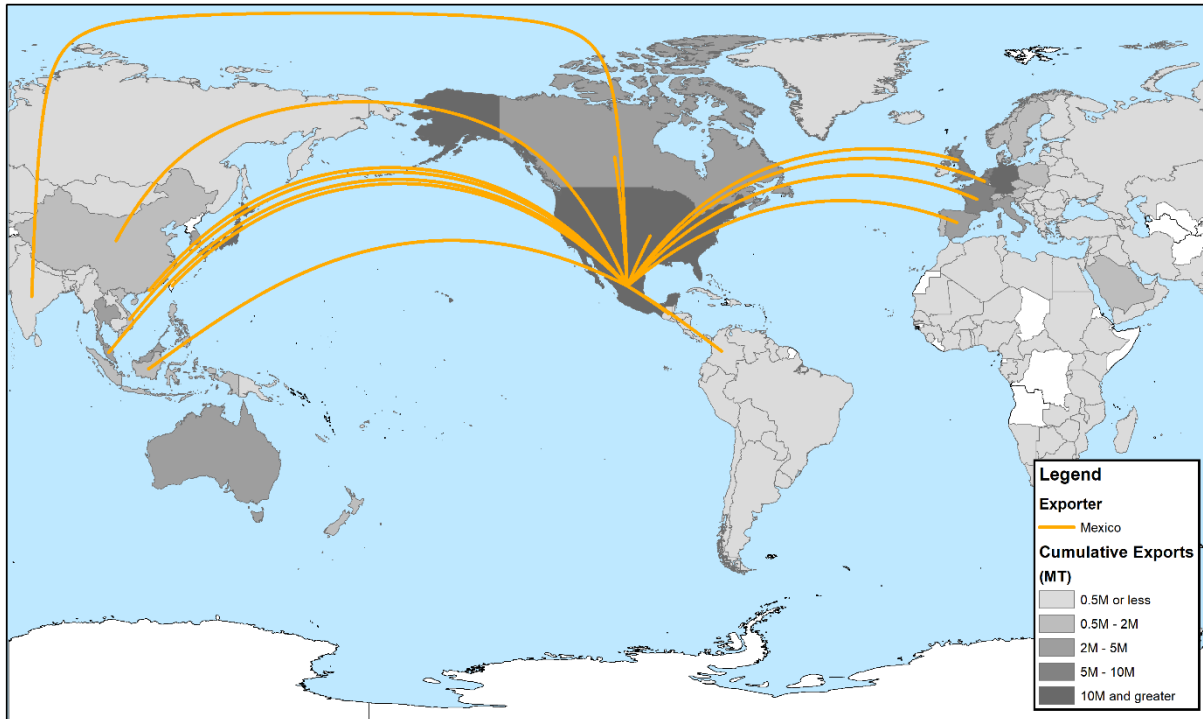
**fig. S8. Destination countries of U.S. exports of plastic waste in 2016 and cumulative plastic waste export tonnage (in million MT) 1988–2016.** Countries with no reported exported plastic waste values are white. Quantities for destination of exports in 2016 include PE, PS, PVC, PP, and PET (28-30). Cumulative exports represent by country exports of PE, PS, PVC, and Other Plastic (9-12).



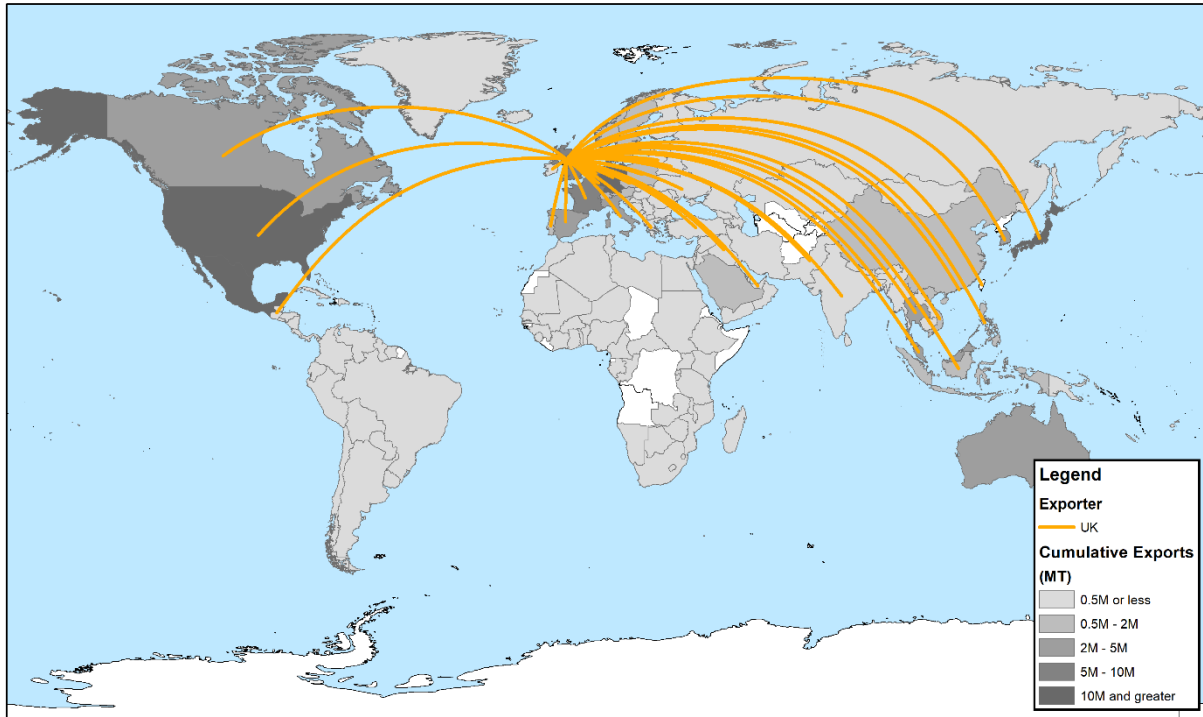
**fig. S9. Destination countries of Japanese exports of plastic waste in 2016 and cumulative plastic waste export tonnage (in million MT) 1988–2016.** Countries with no reported exported plastic waste values are white. Quantities for destination of exports in 2016 include PE, PS, PVC, PP, and PET (28-30). Cumulative exports represent by country exports of PE, PS, PVC, and Other Plastic (9-12).



**fig. S10. Destination countries of German exports of plastic waste in 2016 and cumulative plastic waste export tonnage (in million MT) 1988–2016.** Countries with no reported exported plastic waste values are white. Quantities for destination of exports in 2016 include PE, PS, PVC, PP, and PET (28-30). Cumulative exports represent by country exports of PE, PS, PVC, and Other Plastic (9-12).



**fig. S11. Destination countries of Mexican exports of plastic waste in 2016 and cumulative plastic waste export tonnage (in million MT) 1988–2016.** Countries with no reported exported plastic waste values are white. Quantities for destination of exports in 2016 include PE, PS, PVC, PP, and PET (28-30). Cumulative exports represent by country exports of PE, PS, PVC, and Other Plastic (9-12).



**fig. S12. Destination countries of UK exports of plastic waste in 2016 and cumulative plastic waste export tonnage (in million MT) 1988–2016.** Countries with no reported exported plastic waste values are white. Quantities for destination of exports in 2016 include PE, PS, PVC, PP, and PET (28-30). Cumulative exports represent by country exports of PE, PS, PVC, and Other Plastic (9-12).

**table S1. Ranking of World Bank economic groups based on cumulative exports and imports plastic waste (in MT) from 1988 to 2016 (9–12).**

<b>Cumulative Exports by Income Level</b>				
<b>Rank</b>	<b>Reporter</b>	<b>Trade Value (billion USD)</b>	<b>Mass (million MT)</b>	<b>% of Total</b>
<b>1</b>	HIC	70.9	186	87
<b>2</b>	UMI	9.56	19.7	9.2
<b>3</b>	LMI	3.46	6.12	2.8
<b>4</b>	Unspecified	1.15	2.63	1.2
<b>5</b>	LI	0.09	0.20	0.1
<b>Total</b>		<b>85.2</b>	<b>215</b>	<b>100</b>

<b>Cumulative Imports by Income Level</b>				
<b>Rank</b>	<b>Reporter</b>	<b>Trade Value (billion USD)</b>	<b>Mass (million MT)</b>	<b>% of Total</b>
<b>1</b>	HIC	46.6	115	49
<b>2</b>	UMI	59.7	112	47
<b>3</b>	LMI	2.84	6.19	2.6
<b>4</b>	Unspecified	0.98	2.41	1.0
<b>5</b>	LI	0.07	0.09	0.0
<b>Total</b>		<b>110</b>	<b>236</b>	<b>100</b>

\* HIC = High Income; UMI = Upper Middle Income; LMI = Lower Middle Income; LI = Low Income.

Based on 2015 Gross National Income.

\* N/A refers to unclassified countries or regions

\* Source: UN Comtrade



**table S2. Ranking of World Bank regional groups based on cumulative exports and imports of plastic waste (MT) from 1988 to 2016 (9–12).**

<b>Cumulative Exports by Region</b>				
<b>Rank</b>	<b>Region</b>	<b>Trade Value (billion USD)</b>	<b>Mass (MMT)</b>	<b>% of Total</b>
1 <sup>2</sup>	EAP	34.8	95.8	44
2	ECA	27.6	69.3	32
3	NA	14.3	30.6	14
4	LAC	5.52	12.6	5.9
5	Unspecified	1.15	2.63	1.2
6	MENA	1.03	2.48	1.2
7	SAR	0.63	0.81	0.4
8	AFR	0.19	0.45	0.2
<b>Total</b>		<b>85.2</b>	<b>215</b>	<b>100</b>

<b>Cumulative Imports by Region</b>				
<b>Rank</b>	<b>Region</b>	<b>Trade Value (billion USD)</b>	<b>Mass (MMT)</b>	<b>% of Total</b>
1	EAP	83.3	177	75
2	ECA	15.7	37.9	16
3	NA	6.94	12.3	5.2
4	SAR	1.43	3.7	1.6
5	Unspecified	0.98	2.4	1.0
6	LAC	1.02	2.0	0.8
7	MENA	0.54	0.8	0.3
8	AFR	0.38	0.4	0.2
<b>Total</b>		<b>110</b>	<b>236</b>	<b>100</b>

<sup>1</sup>AFR = Africa; EAP = East Asia & Pacific; ECA = Eastern & Central Asia; LAC = Latin American & the Caribbean; MENA = Middle East & North Africa; NA = North America; SAR = South Asia

<sup>2</sup>If taken collectively, countries within the World Bank Organization for Economic Co-operation and Development (OECD) countries would contribute the most to exports at 64%.

<sup>3</sup>Unspecified regions refer to nations or regions within the UN Comtrade trade data that are not classified by the World Bank

\* Source: UN Comtrade

**table S3. Ranking of countries based on cumulative exports and imports of each plastic waste polymer classification from 1988 to 2016 (9–12).**

Top 10 Exporters								
Ranking	Other Plastics		PE		PS		PVC	
	Reporter	Cummulative Net Weight (MMT)	Reporter	Cummulative Net Weight (MMT)	Reporter	Cummulative Net Weight (MMT)	Reporter	Cummulative Net Weight (MMT)
1	Hong Kong SAR	34.4	Hong Kong SAR	13.6	Hong Kong SAR	3.78	Hong Kong SAR	4.35
2	United States	15.1	Germany	12.3	Japan	3.29	United States	2.49
3	Japan	12.6	United States	8.38	United States	0.76	Japan	1.29
4	Mexico	9.06	United Kingdom	5.75	Germany	0.65	Germany	0.84
5	Netherlands	4.34	Japan	5.05	United Kingdom	0.43	France	0.55
6	Germany	3.88	Belgium	3.55	France	0.36	United Kingdom	0.49
7	France	3.59	France	3.05	Mexico	0.30	Mexico	0.37
8	Canada	2.87	Netherlands	3.01	Belgium	0.14	Singapore	0.26
9	Thailand	2.79	South Korea	0.88	Philippines	0.13	Netherlands	0.25
10	Belgium	2.59	Mexico	0.79	Netherlands	0.12	Canada	0.24
	<b>Total</b>	<b>91.2</b>	<b>Total</b>	<b>56.4</b>	<b>Total</b>	<b>9.96</b>	<b>Total</b>	<b>11.1</b>
Top 10 Importers								
Ranking	Other Plastics		PE		PS		PVC	
	Reporter	Cummulative Net Weight (MMT)	Reporter	Cummulative Net Weight (MMT)	Reporter	Cummulative Net Weight (MMT)	Reporter	Cummulative Net Weight (MMT)
1	China	51.1	China	37.7	Hong Kong SAR	6.04	China	13.6
2	Hong Kong SAR	41.3	Hong Kong SAR	14.0	China	3.97	Hong Kong SAR	3.14
3	United States	7.13	Netherlands	3.26	Germany	0.32	Germany	0.69
4	Netherlands	2.84	Belgium	2.37	Italy	0.21	Other Asia, nes	0.54
5	India	2.66	Germany	2.26	United States	0.16	Canada	0.38
6	Germany	2.09	Canada	1.24	France	0.15	Pakistan	0.35
7	Italy	2.08	Malaysia	1.05	Canada	0.14	United States	0.32
8	Canada	2.07	Italy	0.89	Netherlands	0.11	South Korea	0.32
9	Sweden	1.65	United States	0.89	Spain	0.09	India	0.28
10	Belgium	1.60	Austria	0.68	Austria	0.09	Mexico	0.27
	<b>Total</b>	<b>115</b>	<b>Total</b>	<b>64.4</b>	<b>Total</b>	<b>11.3</b>	<b>Total</b>	<b>19.9</b>

**table S4. Estimated percentage of imported plastic waste to be managed in China from 2010 to 2016 (4, 9–12, 14).**

Year	Population <sup>1</sup>	Waste Generation Rate (kg/person/day) <sup>2</sup>	% Plastic in Waste Stream <sup>2</sup>	Plastic Waste Generated (MT)	Imported Recycled Waste (MT) <sup>3</sup>	Total Waste to Manage (MT)	% of Plastic Waste that is Imported
2010	1,338,000,000	1.1	11.0	59,092,770	8,009,674	67,102,444	11.9%
2011	1,344,000,000	1.1	11.0	59,357,760	8,384,190	67,741,950	12.4%
2012	1,351,000,000	1.1	11.0	59,666,915	8,877,767	68,544,682	13.0%
2013	1,357,000,000	1.1	11.0	59,931,905	7,881,304	67,813,209	11.6%
2014	1,364,000,000	1.1	11.0	60,241,060	8,254,247	68,495,307	12.1%
2015	1,371,000,000	1.1	11.0	60,550,215	7,354,229	67,904,444	10.8%
2016	1,379,000,000	1.1	11.0	60,903,535	7,347,176	68,250,711	10.8%
						<b>Average:</b>	<b>11.8%</b>

<sup>1</sup> Population data from World Bank

<sup>2</sup> Waste Generation Rate from Jambeck, et al. 2015

<sup>3</sup> UN Comtrade Data for PE, PS, PVC, and Other plastics

**table S5. Projected displaced plastic waste based on 100, 75, and 50% restriction scenarios for Chinese imports of plastic waste after the implementation of the new Chinese import ban policy.**

Year	Projected Chinese Imports (MT)	Displaced Plastic Waste - 100% Ban (MT)	Displaced Plastic Waste - 75% Ban (MT)	Displaced Plastic Waste - 50% Ban (MT)
2018	122,278,670	15,809,461	11,857,096	7,904,731
2020	138,088,132	31,618,923	23,714,192	15,809,461
2025	177,611,786	71,142,577	53,356,933	35,571,289
2030	217,135,440	110,666,231	82,999,673	55,333,116

**table S6. Ranking of top countries that exported plastic waste to China in 2016 (MT) (13).**

Ranking	Reporter	Income Level	Region	Imported Plastic Waste (MT)	% of Total Imports
1	Hong Kong	HIC	EAP	1,778,898	24.9%
2	Japan	HIC	EAP (OECD)	842,104	11.8%
3	United States	HIC	NA (OECD)	693,444	9.7%
4	Thailand	UMI	EAP	431,783	6.1%
5	Germany	HIC	ECA (OECD)	390,106	5.5%
6	Belgium	HIC	ECA (OECD)	323,308	4.5%
7	Philippines	LMI	EAP	320,105	4.5%
8	Australia	HIC	EAP (OECD)	293,122	4.1%
9	Indonesia	LMI	EAP	189,273	2.7%
10	Canada	HIC	NA (OECD)	189,161	2.7%
<b>Top 10 Total</b>				<b>5,451,304</b>	<b>76.4%</b>
<b>World Total</b>				<b>7,134,966</b>	