UCLouvain

LOUVAIN
School of Management

Louvain School of Management

International Waste Trade: a particular focus on the impact of the Chinese Import Ban on the US plastic wastes exports.

Auteur : Tristan Bosser
Promoteur(s) : Pr. Per Agrell & Manuel Herrera Rodriguez
Année académique 2019-2020

LOUVAIN-LA-NEUVE | BRUXELLES | MONS | TOURNAI | CHARLEROI | NAMUR
Place des Doyens, 1 bte L2.01.01, 1348 Louvain-la-Neuve, Belgique | **www.uclouvain.be/lsm**

The objective of this master thesis is to give a comprehensive insight of the international trade of wastes and to explain the impact of the recent changes imposed by China on the US plastic wastes exports.

While some wastes can be usefully traded, such as metal wastes that have high recyclability properties, others, such as plastics, can have severe consequences on the environment and on human health as they are rarely fully recyclable and hence cause air, land and water pollution during the disposal process. Countries have however been trading all kind of wastes at an increasing pace since the 90s, with a disproportionate share of this flow being directed from developed to developing countries, often lacking the adequate infrastructure so safely recycle or dispose of these wastes flows. Countries with lower environmental regulations are indeed expected to import a higher proportion of wastes than others as it lowers the cost of disposal, raising questions on the fairness of such a trade given the underlying transfer of negative externalities from rich to poor countries.

However, in the recent years, import restrictions on plastic wastes imposed by China, the all-time biggest importer of wastes, have heavily disrupted this once profitable industry. Exporting countries, which have deeply relied on China to handle their wastes since the 90s, now have to find alternatives to dispose of their increasing pile of plastic wastes given that no countries are willing to accept it anymore. The plastic import ban imposed by China in 2018 as well as the introduction of plastic wastes under the scope of the Basel Convention in 2019 therefore mark a turning point in the plastic wastes trade by putting producing countries accountable for their own wastes, giving hope for a transition to a more sustainable and plastic-free society.

I would like to thank

My promotors, Pr. Per Agrell and Mr. Manuel Herrera Rodriguez, without whom this thesis would have never been possible.

The Université Catholique de Louvain, and particularly the Louvain School of Management for the infrastructure and the relentless motivation to go toward excellence.

My fellow students, who gave me the support and the ideas needed to overcome the issues encountered during my researches.

My family and friends, who helped by the education they gave me and by encouraging me during the toughest times.

My brother, Tanguy Bosser, whose advices were precious to properly conduct the empirical analysis.

Finally, I would like to thank everyone who takes the time to read this paper and that acknowledges the rising problematic of waste disposal.

Table of contents

1. Introduction 1

2. Global overview of the international waste trade 3

a) Dataset 3

b) Volume 4

c) Wastes traded 7

d) Trading countries 10

3. Literature review 15

a) Regulations of the international trade of wastes 15

b) Economic factors influencing the waste trade 19

c) The Chinese import ban 23

4. US plastic wastes exports 26

a) Dataset 26

b) Data exploration 26

i) Global trend 26
ii) Types of plastic wastes traded 27
iii) Countries of destination 29
iv) Ports used for export 32
v) Maritime routes 34

c) Empirical analysis 39

i) Model 40
ii) Results 44

5. Conclusion 48

Bibliography 50

Appendices 53

1. Introduction

Waste generation is increasing at a frightening pace around the globe. According to the World Bank, in 2016, the world's cities generated 2.01 billion tonnes of solid wastes, representing 0,74 kilogram per person per day. Furthermore, given the rapid population growth and urbanization that is foreseen, annual waste generation is expected to increase by 70% from its 2016 level to reach 3.40 billion tonnes in 2050.

Residents in developing countries, especially the urban poor, are not surprisingly more impacted by unsustainable wastes management practices compared to developed nations. In low-income countries, over 90% of wastes are often disposed of in unregulated dumps or openly burned, leading to serious environmental, health and safety consequences. These practices are contributing to climate change through methane, CO^2 as well as other harmful gases emissions and serve as a breeding ground for disease-spreading vectors.

In this context, the international trade of wastes might be considered as any other trade of goods or services, being a productive activity in the assumption of perfect markets. Wastes can indeed be considered as a raw material with an intrinsic value, and therefore as an input for the production of downstream goods. In this sense, when the importer is capable of safely handling and recycling the material, trading wastes can have positive impact on the environment by reducing the amount of virgin materials that needs to be sourced for finished goods or energy production and therefore fosters an efficient use of resources. Moreover, it also allows the exporting countries to avoid disposing their wastes using an inadequate infrastructure or technology and thus to avoid severe consequences on the surrounding environment. In a world where wastes could be shipped in an environmentally sound manner to countries perfectly equipped with the recycling infrastructure generating no negative externalities, we could therefore argue that free trade of wastes of all kinds can be beneficial for the welfare of the society as a whole.

However, only a minority of these wastes, such as metal scraps, can be almost fully recycled, while others, such as plastic wastes, are hardly fully reusable as they are often mixed with diverse types of other chemical components. Furthermore, recent studies are suggesting that

wastes tend to flow from more regulated countries to those with lower environmental policies which often lack the adequate infrastructure to properly and safely handle or recycle the material. This effect has been widely studied in the literature as the Waste Haven Effect and points out the inefficiencies underlying the current waste trade system and regulations that are in use**.** Given the lack of proper infrastructure of these countries, the waste stream heading to these destinations can lead to dramatic consequences because of the negative externalities induced during the recycling or the disposal processes. When unproperly handled, wastes treatment indeed causes air, land and water contamination, leading to harmful repercussions on human health and surrounding wildlife, but also to a fostered climate change due to greenhouse gases.

This paper will therefore aim at providing a complete overview of the international trade of wastes since the beginning of the 21st century by analyzing the volume of wastes traded as well as their origins and their destinations. Moreover, the legislations regulating the international waste trade and the existing economic theories aiming at explaining the dynamics observed will be presented. Subsequently, as China and the United States are respectively the biggest importer and exporter of wastes since data are recorded and given that plastic wastes are getting more and more problematic at the international level, a particular focus will be made on the impact of the Chinese plastic import ban on the US plastic wastes exports. Finally, a statistical analysis is conducted in order to assess if the recent changes in this industry have significantly influenced the factors explaining the patterns observed in the international trade of wastes.

2. Global overview of the international waste trade

a) Dataset

The dataset that is used in this section of the paper has been obtained from the UN International Trade Statistics Database (UN Comtrade), which is provided by the United Nations. This database contains detailed goods imports and exports statistics reported by statistical authorities of close to 200 countries or areas and classifies commodities according to the Harmonised System (HS) at the 6-digit level. The methodology introduced by Kellenberg (2012) is used in this paper to identify wastes among all these commodities, where a material is considered as a waste when "scrap" or "waste" is used in the commodity description.

This classification method allows us to identify 62 6-digit different HS categories of wastes for which data on bilateral trade from 198 countries between 2000 and 2018 can be extracted, for a total of 159 278 observations recorded. The commodity code as well as the description of these 62 different types of wastes and scraps can be found in Appendix 1. For each of these observations, information is given on the type of transaction (import, export, re-import or re-export), on the reporting country's name, the reporting country's code, the commodity code, the commodity description, the weight of the transaction in kilogram and finally the value traded in $US. The correlation between these two measurements, being weight and value, is 0,96 and therefore indicates that almost all the variations in value can be explained by variations in weight. The main explanation for this high correlation is the relatively high weight and low-value nature of waste and scrap commodities. This study will therefore focus on weight, as it is the most important metric from an environmental perspective. Nonetheless, the value traded will also be analyzed in order to explain the main pattern of the trade observed since 2000 given that not all wastes have the same value depending on their recycling or disposal complexity.

However, because data are self-reported and that they are compiled on a custom basis, the UN Comtrade dataset entails some limitations. First of all, some countries may not report some of their detailed trade statistics due to confidentiality, which can lead to missing information. Furthermore, countries do not necessarily report their trade statistics for each and every year and therefore the availability of the data is dependent on the reporting

national statistical authorities. This explains the missing values that can be observed for some countries and years.

Furthermore, the rule of origin established by each country is used to determine the country of origin for importing countries, while country of last known destination is used for exporting countries. Divergences in these rules combined with the self-reported character of trade records can lead to a total import being different from the total export for a given commodity and a given year. However, results presented in this paper are consistent with prior studies and therefore demonstrate that this database is suitable to conduct analysis.

b) Volume

Wastes have been internationally traded at an increasing pace for more than two decades and only shows little signs of slowing down since the last few years. Figure 1 shows the evolution of the international trade of wastes and scraps between 2000 and 2018.

Figure 1 : Evolution of the amount of wastes traded internationally between 2000-2018

Since 2000, more than 3,4 billion tons of wastes[1], including metal, chemical, electronic, plastic, medical or even organic wastes have been traded between countries. To give an idea about the magnitude of what 3,4 billion tons represent, imagine that the Eiffel Tower weighs 3200 tons. Therefore, to equal the weight of all wastes traded between 2000 and 2018, 343 633

[1] To compute the total weight of waste traded each year, we summed the weight of each export recorded that year.

Eiffel Towers are needed. Put end to end, this represents 111 338 km or… almost a third of the distance between our planet Earth and the Moon.

The chart makes indisputable the dramatic increase of the trade of wastes in the last two decades, starting at 88 million tons in 2000 to reach a total of 236 million tons exported in 2011. This is an increase of 267% compared to its level of 2000. Furthermore, according to Kellenberg (2015), 45.6 million tons of wastes have been traded in 1992, which therefore implies a 518% increase in less than two decades. However, this wastes and scrap market seems to be decreasing as in 2018, countries around the world exported 169 million tons of wastes, which represents a drop of around 67 million tons in 7 years.

Regarding the proportion of the total wastes flow being imported by developed and developing countries[2], we can see that between 2000 and 2009, developing countries were increasing their share of importation, reaching 51% of all imports in 2009. According to Kellenberg (2015), in 1990, developing countries were accounting for 18,7% of the world's wastes and scraps import, indicating that they tripled their share of wastes import in 20 years. However, their share of all wastes imports seems to stabilize around 45% since 2010, and even to decrease to 41% in 2018 following the Chinese plastic wastes import ban introduced during that year.

When we look at the evolution of the proportion being exported by developed and developing countries, figure 1 indicates that in 2000, developed countries were accountable for 73% of all the wastes and scraps exported. This figure is now reaching 85% in 2018, making developing countries only accountable for 15% of all the wastes being exported. This indicates that the increase of the waste trade market can mainly be explained by an increase of the wastes exports made by developed countries.

[2] The Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal defines developed countries as all Organization for Economic Cooperation and Development (OECD) and EU countries, developing countries are defined as all other countries not in the OECD or EU.

Figure 2 makes clear that developed countries are mainly accounting for the total increase in global waste trade, with total volume exported increasing by more than 296% between 2000 and 2011, going from 66 to 195 million tons.

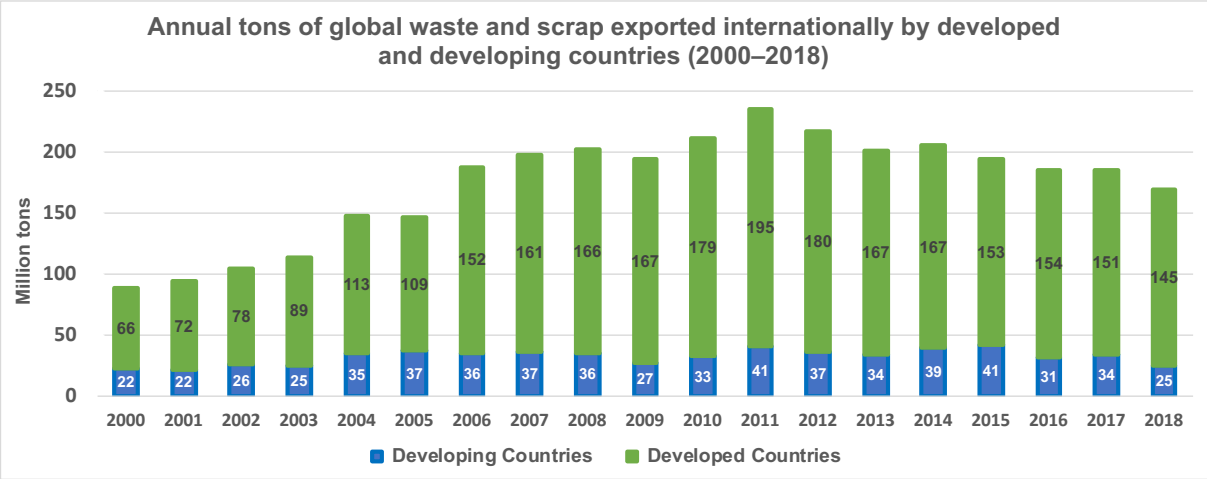


Figure 2: Annual tons of wastes traded internationally by developed and developing countries between 2000–2018.

Nevertheless, since 2011 exports made by developed countries have decreased by 26% to reach 145 million tons in 2018. Figure 3 displays the evolution of the market value[3] of the waste and scrap trade between 2000 and 2018.

Figure 3: Annual value in $US of wastes traded internationally (2000–2018).

[3] The market value of the waste and scrap traded for a given year is computed as the sum of the values recorded for each waste exportation that year.

The evolution of the market value is rather similar to the weight evolution presented in Figure 1, increasing by 713% between 2000 and 2011, going from 20.2 billion $US to 144,5 billion $US in 2011. From 2011 to 2016, the market has witnessed a decrease of 44% to reach 80,2 billion $US before increasing again to 104 billion $US in 2018.

c) Wastes traded

Table 1 displays the 15 most traded types of wastes in terms of weight between 2000 and 2018 and shows that some of them are more intensively traded.

Rank	Commodity code	Commodity name	% of total weight	Cumul. %
1	**720449**	**Ferrous waste & scrap (excl. of 7204.10-7204.41)**	**36,7%**	*36,7%*
2	**470710**	**Recovered (waste & scrap) unbleached kraft paper/paperboard**	**10,7%**	*47,4%*
3	**470790**	**Recovered (waste & scrap) paper/paperboard (excl. of 4707.10-4707.30)**	**6,9%**	*54,3%*
4	**470730**	**Recovered (waste & scrap) paper/paperboard made mainly of mech. Pulp**	**5,8%**	*60,1%*
5	**720441**	**Ferrous turnings, shavings, chips, milling waste, sawdust, filings**	**4,6%**	*64,7%*
6	**760200**	**Aluminum waste & scrap**	**3,8%**	*68,5%*
7	**391590**	**Waste, parings & scrap, of plastics n.e.s. in 39.15**	**3,7%**	*72,2%*
8	**740400**	**Copper waste & scrap**	**3,4%**	*75,6%*
9	**440130**	**Sawdust & wood waste & scrap**	**3,3%**	*79,0%*
10	**261900**	**Slag, dross (excl. granulated slag), scalings & oth. waste from mfr.**	**3,1%**	*82,0%*
11	**720429**	**Waste & scrap of alloy steel other than stainless steel**	**2,8%**	*84,8%*
12	**720421**	**Waste & scrap of stainless steel**	**2,5%**	*87,3%*
13	**391510**	**Waste, parings & scrap, of polymers of ethylene**	**2,1%**	*89,4%*
14	**720410**	**Waste & scrap of cast iron**	**2,1%**	*91,5%*
15	**470720**	**Recovered (waste & scrap) paper/paperboard mainly of bleached chem.**	**1,6%**	*93,1%*

Table 1: 15 most traded types of wastes in weight between 2000 and 2018.

According to this analysis, among the 62 types of wastes studied, the 15 most traded represent 93,1% of the weight of all wastes traded in the world. “Ferrous waste & scrap” represents 36,7% of all wastes traded in terms of weight, while “Recovered (waste & scrap) unbleached kraft paper/paperboard” and “Recovered (waste & scrap) paper/paperboard (excl. of 4707.10-4707.30)” accounts for respectively 10,7% and 6,9%. In other words, it means that the three most traded waste types accounted for more than 50% of the weight of wastes traded in the world between 2000 and 2018.

By taking a broader look at this table, we can group some of these commodities into broader categories of waste type. We can thus see that metal wastes, paper wastes, plastic wastes and other types of wastes account for respectively 55,9%, 25,0%%, 5,8%% and 6,4% of all traded wastes. Table 2 displays the 15 most traded wastes in terms of value.

Rank	Commodity code	Commodity name	% of total value	Cumul. %
1	**720449**	**Ferrous waste & scrap (excl. of 7204.10-7204.41)**	**22,5%**	*22,5%*
2	**470710**	**Copper waste & scrap**	**18,8%**	*41,3%*
3	**470790**	**Aluminum waste & scrap**	**11,0%**	*52,3%*
4	**470730**	**Waste & scrap of stainless steel**	**7,6%**	*60,0%*
5	**720441**	**Waste & scrap of gold, incl. metal clad with gold**	**5,9%**	*65,9%*
6	**760200**	**Waste & scrap of precious metal/metal clad with precious metal**	**5,0%**	*70,9%*
7	**391590**	**Recovered (waste & scrap) unbleached kraft paper/paperboard**	**3,9%**	*74,7%*
8	**740400**	**Waste, parings & scrap, of plastics n.e.s. in 39.15**	**3,4%**	*78,2%*
9	**440130**	**Ferrous turnings, shavings, chips, milling waste, sawdust, filings**	**2,7%**	*80,9%*
10	**261900**	**Recovered (waste & scrap) paper/paperboard (excl. of 4707.10-4707.30)**	**2,4%**	*83,2%*
11	**720429**	**Recovered (waste & scrap) paper/paperboard made mainly of mech. Pulp**	**2,1%**	*85,3%*
12	**720421**	**Waste & scrap of alloy steel other than stainless steel**	**2,0%**	*87,3%*
13	**391510**	**Waste, parings & scrap, of polymers of ethylene**	**1,9%**	*89,2%*
14	**720410**	**Waste & scrap of cast iron**	**1,3%**	*90,5%*
15	**470720**	**Waste oils other than those cont. polychlorinated biphenyls (PCBs)**	**0,9%**	*91,3%*

Table 2: 15 most traded types of wastes in value between 2000 and 2018.

As it can be seen, ferrous waste is still the most exported and imported type of waste with a share of 22,5% of all value traded between 2000 and 2018. Unlike in the weight ranking, we can see that copper, aluminum and stainless steel represent considerable shares of the total value traded, respectively accounting for 18,8%, 11,0%, 7,6% and 5,9%. Furthermore, we can see that metal wastes account for a larger proportion overall, with wastes containing gold, precious metal wastes and cast iron wastes being represented in the ranking, meaning that metal wastes seem to have a higher value/weight ratio. All in all, metal wastes represent 76,9% of all wastes traded in terms of value during that period, while paper and plastic wastes respectively account for 8,3% and 6,2%. Paper wastes thus still account for a large share but are much less represented compared to their proportion in weight.

Finally, to explain the main differences between the value and weight share of all waste types traded between 2000-2018, table 3 displays the value per kilogram for each of the most valued wastes.

Rank	Commodity Code	Commodity Name	$/Kg
1	711291	Waste & scrap of gold, incl. metal clad with gold	$308,62
2	810330	Tantalum waste & scrap	$ 59,07
3	711299	Waste & scrap of precious metal/metal clad with precious metal	$ 29,60
4	810297	Molybdenum waste & scrap	$ 24,11
5	300680	Waste pharmaceuticals	$ 13,37
6	810197	Tungsten (wolfram) waste & scrap	$ 13,36
7	810600	Bismuth & arts. thereof , incl. waste & scrap	$ 13,04
8	810930	Zirconium waste & scrap	$ 10,90
9	810530	Cobalt waste & scrap	$ 10,57
10	500390	Silk waste, carded or combed	$ 8,79
11	810830	Titanium waste & scrap	$ 5,42
12	750300	Nickel waste & scrap	$ 4,96
13	500310	Silk waste (incl. cocoons unsuit. for reeling, yarn waste & garnetted stock)	$ 3,93
14	740400	Copper waste & scrap	$ 2,70
15	810730	Cadmium waste & scrap	$ 2,63

Table 3:15 most valued types of wastes in $US per kilogram (2000-2018).

As it can be seen, wastes containing gold have a really high value per kilogram compared to other types of wastes, with an average of 308,62 $US/Kg for the 2000-2018 period. It is followed by tantalum wastes (used in electronics and medical implants), precious metal wastes and molybdenum wastes (used for various applications and in diverse alloys with steel) with a respective value of 59,07 $US, 29,60 $US and 24,11 $US per kilogram.

All in all, metal wastes represent 12 out of the 15 most valued wastes. The main explanation is that metal wastes can be recycled without losing their properties, making it a strong candidate for countries willing to import and recycle the material. Furthermore, virgin raw metal can be costly to source, depending on the type of metal, giving value to the existing material that just needs to be recycled.

Metal wastes can indeed be more easily recycled and have a relatively high mass/volume ratio, which explains that they represent more than half of all traded wastes. Furthermore, in many cases, recovered metals offer higher purity than the corresponding ore that is being mined. The recovering of these metals also requires less energy than their primary extraction. For example, according to Kellogg (1976), the ratio of energy for production of primary metal to energy for production of secondary metal (i.e. recycled metal) is of the order 36:1 for magnesium, 20:1 for aluminum and 6,2:1 for copper.

d) Trading countries

Table 4 displays the main exporters of wastes and scraps between 2000 and 2018. Moreover, data for the year 2018 alone are also presented in order to have a better understanding of the patterns that can be recently observed.

Rank	Exporter	Total exported 2000-2018	% of total 2000-2018	Cumul. % 2000-2018	Total exported 2018	% of total 2018	Cumul. % 2018
1	**USA**	**562,0**	**17,1%**	*17,1%*	**39,8**	**23,5%**	*23,5%*
2	**Germany**	**295,5**	**9,0%**	*26,1%*	**15,6**	**9,2%**	*32,7%*
3	**Japan**	**238,5**	**7,3%**	*33,4%*	**12,4**	**7,3%**	*40,1%*
4	**United Kingdom**	**224,4**	**6,8%**	*40,2%*	**7,7**	**4,6%**	*44,6%*
5	**France**	**195,6**	**6,0%**	*46,2%*	**9,2**	**5,5%**	*50,1%*
6	**Netherlands**	**171,5**	**5,2%**	*51,4%*	**10,5**	**6,2%**	*56,3%*
7	**Belgium**	**137,7**	**4,2%**	*55,6%*	**2,8**	**1,6%**	*57,9%*
8	**Russian Federation**	**134,1**	**4,1%**	*59,7%*	**6,1**	**3,6%**	*61,5%*
9	**Canada**	**120,1**	**3,7%**	*63,3%*	**4,5**	**2,7%**	*64,2%*
10	**Hong Kong**	**93,4**	**2,8%**	*66,2%*	**2,7**	**1,6%**	*65,7%*
11	**Australia**	**59,5**	**1,8%**	*68,0%*	**3,6**	**2,1%**	*67,9%*
12	**Czechia**	**48,9**	**1,5%**	*69,5%*	**3,3**	**1,9%**	*69,8%*
13	**Mexico**	**46,0**	**1,4%**	*70,9%*	**2,0**	**1,2%**	*71,0%*
14	**Poland**	**45,3**	**1,4%**	*72,3%*	**3,3**	**1,9%**	*72,9%*
15	**Denmark**	**42,8**	**1,3%**	*73,6%*	**2,2**	**1,3%**	*74,2%*

Table 4: 15 main wastes exporters for 2000-2018 and 2018 in million tons.

It makes clear that the waste trade, on the export side, is rather concentrated as the main 15 exporters out of 198 recorded trading countries are accountable for 73,6% of the world total exports made during that period. As it can be seen, the main exporter is the USA, accounting

for 17,1% of all exported wastes, followed by Germany and Japan with respectively 9% and 7,3%. Among these 15 countries, only the Russian Federation and Hong Kong are not considered as developed countries, which is in line with the results presented in the previous section of this paper. Furthermore, by pooling together all the wastes exported by its country members, the European Union can be accounted for 38,6% of all waste exports between 2000 and 2018, which represents almost more than twice the proportion of the USA. It is also interesting to note that Hong Kong is considered as the 10th biggest exporter as it serves as an entry point for wastes subsequently exported to mainland China.

For the year 2018, we can see that the USA can be accounted for a bigger proportion of all wastes and scraps exports, recording a proportion of 23,5% that year. Similarly, Germany, The Netherlands, Australia, Czechia and Poland have also increased their share in 2018, but by a much lower magnitude. All the other 15 main exporters have reduced their share or have approximatively the same one as before, with the biggest decrease being recorded by Belgium with a drop of 2,6 pp. Table 5 displays the importer side of the trade and also gives evidence on the concentration of the imports of wastes.

Rank	Importer	Total imported 2000-2018	% of total 2000-2018	Cumul. % (2000-2018)	Total imported 2018	% of total 2018	Cumul. % 2018
1	**China**	**752,7**	**21,7%**	*21,7%*	**22,5**	**13,3%**	*13,3%*
2	**Turkey**	**311,9**	**9,0%**	*30,7%*	**22,1**	**13,1%**	*26,4%*
3	**Germany**	**207,5**	**6,0%**	*36,7%*	**11,8**	**7,0%**	*33,3%*
4	**Rep. of Korea**	**197,7**	**5,7%**	*42,4%*	**10,2**	**6,0%**	*39,3%*
5	**India**	**157,8**	**4,6%**	*46,9%*	**15,6**	**9,3%**	*48,6%*
6	**Belgium**	**143,2**	**4,1%**	*51,1%*	**5,2**	**3,1%**	*51,7%*
7	**Spain**	**134,3**	**3,9%**	*54,9%*	**4,5**	**2,6%**	*54,3%*
8	**Netherlands**	**129,3**	**3,7%**	*58,7%*	**7,8**	**4,6%**	*58,9%*
9	**Italy**	**123,5**	**3,6%**	*62,2%*	**3,3**	**2,0%**	*60,9%*
10	**France**	**102,3**	**2,9%**	*65,2%*	**3,3**	**1,9%**	*62,9%*
11	**Taiwan**	**92,6**	**2,7%**	67,9%	**5,7**	**3,4%**	66,2%
12	**USA**	**90,7**	**2,6%**	70,5%	**7,9**	**4,6%**	70,9%
13	**Indonesia**	**74,2**	**2,1%**	72,6%	**5,3**	**3,2%**	74,0%
14	**Hong Kong**	**69,2**	**2,0%**	74,6%	**1,3**	**0,7%**	74,8%
15	**Mexico**	**67,4**	**1,9%**	76,6%	**4,6**	**2,7%**	77,5%

Table 5: 15 main wastes importers for 2000-2018 and 2018 in million tons.

The 15 main importers are indeed accounting for 76,6% of all wastes and scraps imports made between 2000 and 2018. Among these, China is the main importer with a share of 21,7% and is followed by Turkey and Germany with a respective share of 9% and 6%. As for the exports, if we group all wastes and scraps imports made by the member states of the European Union, the EU would account for a share of 34,2% of all imports made between 2000 and 2018, which is 4,4% lower than its exports share. An intuition behind these findings could be that EU country members are trading wastes within the European Union. However, a more in-depth flow analysis must be conducted before making any further assertions. We can also see that among these 15 biggest wastes importers, 5 of them are not considered as developed countries, mainly China, India, Taiwan, Indonesia and Hong Kong. These evidences therefore tend to suggest that wastes and scraps trade flows are directed from developed countries (table 4) to developing countries and is in line with what can be read in the literature.

Regarding the share of imports during the year 2018, we can see a major difference compared to the one of 2000 to 2018. China has indeed decreased its share by 8,4 pp to reach 13,3% of all waste imports in 2018. This follows the introduction in 2018 of restrictions on the import of 24 types of wastes, especially most types of plastic wastes. As a consequence, it can be observed that the wastes flow previously heading toward China has been redirected to other countries, such as Turkey (+4,1 pp), India (+4,7 pp), Indonesia (+1.2 pp) and Taiwan (+0,7 pp) in 2018. This import restriction on plastic wastes, called the Chinese Import Ban or the “National Sword”, will be more in-depth presented in the next section of this paper.

Another analysis that can be made on the dataset is regarding the net balance of exports and imports made by trading countries. As it can be seen in table 4 and table 5, countries such as the USA, Germany, the UK, the Netherlands, Belgium, Hong Kong and Mexico are represented in both the ranking of the top 15 exporters and importers. Therefore, we can construct another ranking criterion which is the net trade balance, where negative values mean that wastes imports of a given country have outweighed its exports for a given time period. This measurement gives a better understanding of the situation of a country in the international trade of wastes. For example, let us imagine that a given country might indeed be a major importer of certain types of wastes that are recycled and transformed as an input for the industry of this country, while being at the same time a major exporter of other types of

wastes for which its recycling industry is not specialized. By doing so, and if this country has a rather balanced import and export flow, we could consider that trading wastes is beneficial to this country. However, if a given country is exporting much more than importing, it therefore means that it is moving its trash to other countries and thus transferring its negative externalities. On the other side, a country with a negative net balance is receiving all the negative externalities related to wastes recycling or disposal, assuming it is not perfectly equipped to safely handle this waste flow. Among the 198 recorded trading countries, 143 of them are net exporters for the period 2000-2018 and 55 of them are net importers. Furthermore, 28 of these 143 net exporters and 12 of the 55 net importers are developed countries. Table 6 displays the 15 biggest net exporters for both the 2000-2018 period as well as for the year 2018.

	2000 - 2018				2018			
Rank	**Country**	**Export**	**Import**	**Net balance**	**Country**	**Export**	**Import**	**Net balance**
1	**USA**	562,0	90,7	**471,3**	**USA**	39,8	7,9	**32,0**
2	**Japan**	238,5	24,7	**213,8**	**Japan**	12,4	0,9	**11,5**
3	**United Kingdom**	224,4	20,5	**203,8**	**United Kingdom**	7,7	0,4	**7,3**
4	**Russian Federation**	134,1	13,3	**120,8**	**France**	9,2	3,3	**6,0**
5	**France**	195,6	102,3	**93,3**	**Russian Federation**	6,1	0,8	**5,3**
6	**Germany**	295,5	207,5	**88,1**	**Canada**	4,5	0,7	**3,9**
7	**Canada**	120,1	60,1	**60,0**	**Germany**	15,6	11,8	**3,9**
8	**Australia**	59,5	1,9	**57,6**	**Australia**	3,6	0,1	**3,5**
9	**Netherlands**	171,5	129,3	**42,2**	**Netherlands**	10,5	7,8	**2,7**
10	**Romania**	38,8	2,0	**36,8**	**Czechia**	3,3	0,9	**2,4**
11	**Czechia**	48,9	14,2	**34,7**	**Denmark**	2,2	0,3	**1,9**
12	**Poland**	45,3	18,8	**26,6**	**Hong Kong**	2,7	1,3	**1,4**
13	**Ukraine**	31,2	6,4	**24,8**	**Poland**	3,3	2,0	**1,3**
14	**Hong Kong**	93,4	69,2	**24,2**	**Singapore**	1,6	0,4	**1,2**
15	**South Africa**	25,7	3,4	**22,3**	**Switzerland**	1,9	0,8	**1,1**

Table 6: 15 main net exporters of wastes for 2000-2018 and for 2018 in million tons.

Without much of a surprise, the USA is the major net exporter of wastes both time period, with a net balance representing more than twice the one of Japan and of the UK, being 2nd and 3rd. The ranking is rather similar to the one of the wastes exports, with the major difference being that Romania, Ukraine and South Africa are now represented in the top 15.

In this ranking, only the Russian Federation, Ukraine, Hong Kong and South Africa are not considered as developed countries. Table 7 displays the 15 biggest net importing countries for both the 2000-2018 period and for the year 2018.

	2000 - 2018				2018			
Rank	**Country**	**Export**	**Import**	**Net balance**	**Country**	**Export**	**Import**	**Net balance**
1	**China**	11,6	752,7	**-741,1**	**Turkey**	0,8	22,1	**-21,3**
2	**Turkey**	10,2	311,9	**-301,7**	**China**	1,4	22,5	**-21,1**
3	**Rep. of Korea**	23,8	197,7	**-173,9**	**India**	0,5	15,6	**-15,2**
4	**India**	16,8	157,8	**-141,0**	**Rep. of Korea**	1,3	10,2	**-8,9**
5	**Spain**	25,6	134,3	**-108,7**	**Indonesia**	0,5	5,3	**-4,9**
6	**Italy**	39,0	123,5	**-84,5**	**Taiwan**	0,9	5,7	**-4,8**
7	**Taiwan**	12,0	92,6	**-80,6**	**Spain**	1,5	4,5	**-2,9**
8	**Indonesia**	7,3	74,2	**-66,9**	**Egypt**	0,0	2,7	**-2,7**
9	**Luxembourg**	11,1	58,6	**-47,5**	**Mexico**	2,0	4,6	**-2,6**
10	**Vietnam**	2,6	44,8	**-42,1**	**Belgium**	2,8	5,2	**-2,4**
11	**Malaysia**	11,6	46,6	**-35,0**	**Malaysia**	0,6	3,0	**-2,4**
12	**Thailand**	13,8	47,5	**-33,7**	**Pakistan**	0,1	2,2	**-2,0**
13	**Egypt**	1,6	29,9	**-28,3**	**Belarus**	0,1	1,6	**-1,5**
14	**Belarus**	3,1	25,9	**-22,8**	**Thailand**	1,0	2,4	**-1,4**
15	**Mexico**	46,0	67,4	**-21,4**	**Austria**	2,0	3,3	**-1,3**

Table 7: 15 main net importers of wastes for 2000-2018 and for 2018 in million tons.

As it can be seen, China is still leading the ranking with a net importing balance of 741,1 million tons, followed by Turkey and Rep. of Korea with respectively 311,9 M tons and 197,7 M tons of net import. Comparing table 7 and table 5, displaying the biggest importers, we can see that Vietnam, Malaysia, Thailand, Egypt and Belarus are now part of the top 15 net importers between 2000 and 2018.

Looking at the year 2018 alone, it can be seen that Turkey is now outpacing China as the biggest net importer of wastes. Furthermore, India has a yearly net balance closer to the one of the two biggest countries than during the previous period, showing signs that it is importing wastes at an increasing pace. Furthermore, in 2018 Belgium and Pakistan are both represented as respectively 10^{th} and 12^{th} biggest net importers, while they were not in the ranking for the 2000-2018 period. This tends to show that these two countries changed their wastes trading pattern in the recent years.

3. Literature review

a) Regulations of the international trade of wastes

International regulations regarding the environment are called International Environmental Agreements (IEAs) and according to Kellenberg (2014), more than 1000 of them are operating today. Among them, the most notable in terms of regulating the international trade of wastes is the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal gathering 187 countries. This convention aims at *"protecting human health and the environment against the adverse effects resulting from the generation, management, transboundary movements and disposal of hazardous and other wastes"*[4]. Hazardous wastes are diverse and can be found in the Annexes I, II, III and IV if the Basel Convention. The Convention was introduced in 1992 and is the heritage of the increasing environmental awareness witnessed in the 70s and 80s where countries faced public resistance to the disposal of hazardous wastes within their border, leading to tightening environmental regulations in the industrialized world and escalating disposal costs. Therefore, what came as a solution to keep profit rising was to seek for cheap disposal alternatives in Eastern Europe and in the Developing World. This is therefore because of that emerging trend, where developed countries were seeking developing countries with low environmental regulations to trade their wastes, that the Basel Convention was adopted.

When the convention came into force in 1992, its main tool to reduce transboundary shipment was a restriction on hazardous wastes shipments across countries. Article IV of the convention, which is focused on the general obligations of the convention, states that (i) countries may ban hazardous waste imports, (ii) waste-exporting countries must respect the bans imposed by waste importers, (iii) importers must be alerted to shipments and must approve the shipments in writing before exportation, and (iv) ratified countries may not ship wastes to or from countries that have not ratified the Convention according to Kellenberg (2014).

[4] http://www.basel.int/TheConvention/Overview/tabid/1271/Default.aspx

The effects of points (i) and (ii) are quite clear and aim at reducing waste shipments across countries by enforcing bans, but points (iii) and (iv) have questionable effects. Indeed, while these points were aiming at stimulating transparency among trading countries and to give them incentives to ratify the Basel Convention, they might also foster the legitimation of trading wastes rather than reducing transboundary shipments. This assertation emerged because for a country that was not part of the Convention but that was willing to trade with a member country, the ratification of the Convention was the only way for that country to legally and legitimately trade wastes. Therefore, while the Convention has the objective to reduce the trade of wastes, points (iii) and (iv) were giving incentives to non-member countries to join the Convention in order to have the legitimacy to ship wastes in and out of their borders, restraining the Convention to achieve its primary objectives.

To cope with this problem, the Basel Convention Ban Amendment was introduced in 1995 and its final form was presented in 1998. This amendment prohibited ratifying A7 countries, considered as developed countries, (i.e. OECD or EU member countries) to trade hazardous wastes to non-A7 countries, considered as developing countries. The ban was therefore aiming at reducing transboundary shipments of wastes from rich to poor countries. Nevertheless, the Ban Amendment only came into force on the 5th of December 2019, more than 20 years after its introduction. Detractors of the ban have indeed claimed that the text of the Convention regarding the entry into force of the amendment (Article 17) was ambiguous, making the required numbers of parties to adopt an amendment unclear. A diplomatic settlement process created by Indonesia and Switzerland finally clarified the situation in 2010 during the COP10 and set the number of voting countries at 66 of those present in 1995. The ratification of Croatia on the 6th of September 2019 finally made possible the entry into force of the amendment.

However, Kellenberg (2014), in line with the literature around IEAs published in the last 30 years, finds evidence that the Basel Convention might be ineffective by doing little more than what ratifying countries would otherwise have done absent of the agreement. The authors indeed argue that the Basel Convention as well as the Ban Amendment do not seem to hinder the growth of transboundary shipments of wastes and only have a marginal effect on the exportation of hazardous wastes from developed to developing countries. One possible

explanation might be that participating A7 countries tend to circumvent the Ban Amendment by shipping waste to non-participants as intermediaries, before these countries trade those wastes to non-A7 countries. However, the author did not find relevant evidence validating their hypothesis and thus little explanations have been provided yet.

The Environmental Network for Optimizing Regulatory Compliance on Illegal Traffic (ENFORCE), which has as objective to *"through a network of relevant experts, to promote parties' compliance with the provisions of the Basel Convention pertaining to preventing and combating illegal traffic in hazardous wastes and other wastes through the better implementation and enforcement of national law"*[5], surveyed members of the Convention in order to identify the gaps that prevent the agreement to be fully effective according to Isarin (2014). The main outcome of this survey is the identification of an ongoing need for capacity building activities and the development of practical guidance and enforcement tools to combat illegal traffic under the Basel Convention. The main areas where capacity needs to be built concerns (i) the cooperation at the national and international level, (ii) the communication of practical guidance, (iii) guidance on wastes versus non-wastes, (iv) awareness raising and (v) information and intelligence exchange. Nevertheless, a strengthening of the legal and institutional frameworks in developing countries as well as improved inspection trainings and equipment were also identified as key elements potentially allowing a more effective enforcement of the Convention. These elements therefore tend to indicate that the lack of enforcement capabilities, clear communication between states and inspection capabilities might be the sources of the inefficiencies of the Convention, according to the wide array of countries that have completed the survey.

This lack of enforcement capabilities leads to the main barrier preventing IEAs to be fully effective: the free ridership problem. Most economic theories indeed demonstrate that, due to that phenomenon, IEAs can only achieve little more than what would have otherwise been observed if countries were voluntary acting. If waste disposal capacities and regulations were efficient in every country involved in waste trade, international agreements such as the Basel Convention would not be needed and the waste trade would be as efficient as any other

[5] http://www.basel.int/Partners/IGOs/INTERPOL/tabid/3885/Default.aspx

international trade in goods or services. However, given that waste disposal produces negative externalities and that some countries lack effective environmental regulations and enforcement capabilities, Kellenberg (2014) states that governments will always face incentives to freeride on other countries' reduction efforts.

Concerning The United States, the country signed the Basel Convention in 1990 but has not ratified it yet, making the agreement not legally binding yet. The U.S. Senate provided its advice and consent to ratification in 1992 following the signature, but there is a need for additional legislation to provide the necessary statutory authority to implement its requirements before the USA can ratify the Convention. Therefore, as a non-Party to the Convention, the USA can only participate in the different meetings organized by Convention Parties but is not allowed to vote.

Regarding plastic wastes, on the 10th May of 2019, during the 14th Meeting of the Conference of Parties to the Basel Convention, 187 nations voted to adopt amendments to Annexes II, VIII and IX of the Basel Convention. The objective of this vote was to clarify the scope of the Convention on the transboundary movements of plastic wastes and therefore to further improve its regulation. By including different plastic types to the Convention, it will therefore make it impossible for developed countries to ship plastic wastes to developing countries. Furthermore, the amendment, which will become effective on the 1st of January 2021, classifies the different types of plastic wastes according to their potential toxicity. Plastic wastes presumed to be hazardous, such as dirty mixed plastics, will therefore be subject to the prior informed procedure where the exporting country must have the approval of the importing country before shipping the material. Furthermore, given that the Basel Convention forbids trade between Parties and non-parties, any future exports or imports of this kind will, for the first time, be considered as illegal traffic. Other plastic wastes not classified as hazardous, with some exceptions that still need to be investigated by the parties, will be considered as requiring special consideration and will normally be subject to the prior informed consent.

At the regional level, we can cite the EU's Waste Shipment Regulation enforced in 1993 and updated in 2006, which sets out the control procedures for the export of non-hazardous

wastes for recovery (recycling) from the EU to non-OECD countries and therefore basically implements the provision of the Basel Convention in the EU Law to regulate country members. Several other agreements can also be mentioned such as the Protocol on Liability and Compensation aiming at improving regulatory measures and better protect people from hazardous wastes, the Bamako Convention imposing a ban on the importation of hazardous wastes in African country members or also the Lomé IV Convention and Cotonou Agreement mainly signed by the Caribbean and African countries to prevent themselves from becoming the open-air world garbage. However, these last three treaties were evaluated rather inefficient due to the lack of powerful enforcement and the marginal number of signatory countries.

b) Economic factors influencing the waste trade

To properly assess all the determinants of the global waste trade, Kellenberg (2012) presented a complete chart depicting the flow of wastes for a country i and their interaction with foreign states. Explanations can be found in figure 4 presented hereunder.

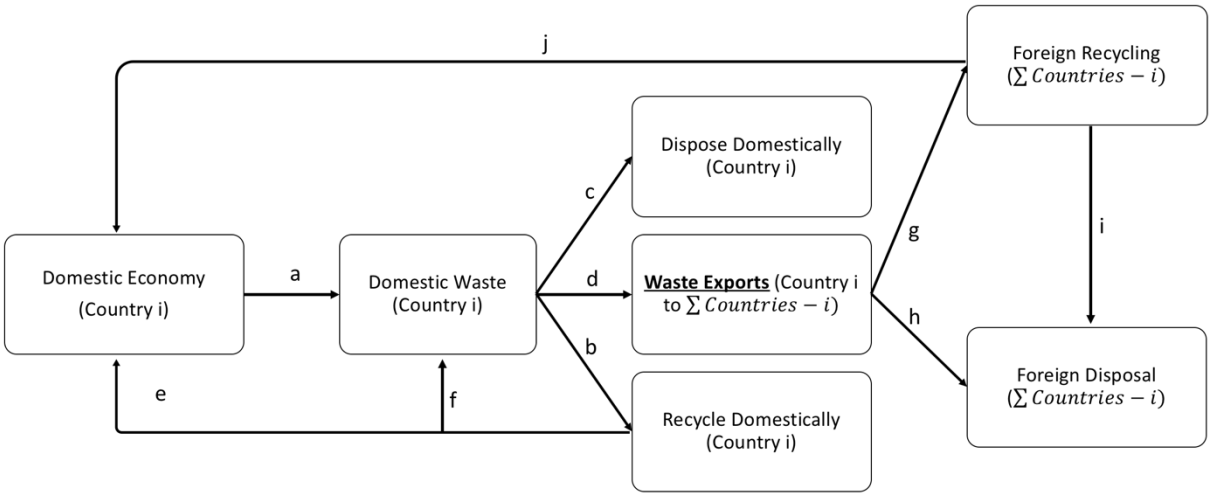


Figure 4: Determinants of the International Waste Trade.

According to the author, domestic wastes are by-products generated from consumption and production activities in the Domestic Economy, represented by the arrow (a). Domestic wastes can be handled in three different ways: they can be (c) Disposed of Domestically within the country, which for most countries involves incineration and landfilling but can also be simply discarding the wastes into the environment for countries lacking efficient environmental regulations, (b) Recycled Domestically in the country or (d) Exported to foreign countries. In

the case the wastes are sent for recycling (b), it generates two different by-products. The recycled material is sent back into the Domestic Economy as represented by (e), but because wastes are rarely 100% recyclable, part of the wastes inevitably ends up back in the Domestic Waste through channel (f) in order to either be Recycled Domestically one more time (for other components) (b), to be Disposed of Domestically or to be Exported in a Foreign Country (c). Wastes can be exported for two reasons; either (g) to be recycled in the foreign country to extract raw material or (h) to be disposed of. The by-product of the recycling process in the foreign country can be locally disposed of (i) and the raw material extracted can be reintroduced in the foreign economy or in the Domestic Economy (j).

Several papers have focused on the exportation of wastes (d) to foreign countries and multiple determinants have been identified. Firstly, it is obvious that bigger economies with higher production and consumption levels are expected to produce and trade more wastes than small agricultural economies which consume fewer resources. According to Baggs (2009), the intuition is that bigger economies have a greater level of consumption and therefore produce more wastes as by-products, leading to a bigger potential for wastes exportation.

Regarding the importation of big economies, two main intuitions are presented by the authors. First, economies generating more wastes might also have developed a more effective wastes disposal infrastructure over time and thus have a higher recycling or disposal capacity. In the case of economies of scale for wastes disposal, larger economies might then have developed a comparative advantage in these activities, giving them incentives to import wastes from foreign countries. The second intuition is that bigger economies tend to have more advanced technologies and recycling programs. With this recycling technology, given that not all wastes are for disposal, these economies might have a greater demand for wastes in order to usefully recycle them into future products. Bigger economies might thus import a larger volume of these recyclable wastes as inputs for subsequent production.

Hence, supply and demand factors have a strong influence on the flow of waste (a). Secondly, the choice made by a country i to either recycle domestically (b), dispose of domestically (c) or to export their wastes to foreign countries (d) is influenced by multiple other factors than consumption level and recycling technology. The level of stringency regarding environmental

regulations in the domestic country might impose higher costs for disposal (c) or for recycling (b) and therefore gives strong incentives to export their wastes to foreign countries with less stringent environmental regulations. This phenomenon is called the waste haven effect and was first introduced in Baggs (2009) as the effect leading lower trade barriers to shift polluting industries to countries with less stringent environmental regulations. The author used GDP and income level as a proxy of countries' environmental regulations stringency.

Kellenberg (2012) further used these findings to understand the flows of wastes traded internationally and outlined the waste haven effect as a key determinant to explain hazardous wastes disposal patterns. The author indeed finds strong evidence of a waste haven effect guiding decisions taken by wastes producing countries. The study is based on empirical data from the UN Comtrade Database and country socioeconomic characteristics from the Global Competitiveness Report (CRG). It indicates that for every country undergoing a 1% deterioration in its domestic environmental regulations index vis-à-vis a foreign bilateral trading pair, an increase of 0.32% in wastes importation from that bilateral pair is expected to take place. When we consider that the average developing country has an environmental regulation index 39% lower than the average developed country, a significant effect is observed. In other words, according to the author, wastes tend to flow to countries with the lowest levels of environmental regulations.

However, multiple other factors influencing the international pattern of trade in hazardous and non-hazardous wastes have been studied in the literature. Kellenberg (2015) summarizes prior researches conducted on this topic and also outlines differences in terms of transport costs and the presence of organized crime as key determinants. Mazzanti, et al. (2013) indeed investigates the relationship among the distance between countries and differences in gate fees for wastes disposal as important explicating factors. Their hypothesis is the following: if the foreign gate fee for wastes disposal, plus the total transport cost to the foreign location, is inferior to the cost of disposing of the wastes locally combined with the domestic transport cost, then firms will have strong incentives to export their wastes. Their study is more focused on the importance of transportation costs, because given that wastes and scraps usually have a relatively low value/volume ratio, a small change in shipping costs can make the exportation or importation less attractive. This evidence emanate from the ascertainment that in the

majority of gravity models used to study the trade of wastes, distance, used as a proxy for transportation costs, has a more significant coefficient than for similar studies on regular trade.

In line with Mazzanti, et al. (2013), Kellenberg (2010) states that the waste haven effect is influenced by both the transport costs and the disposal costs. According to the author, the South is assumed to have lower disposal rates than countries in the North and therefore shipping wastes to these countries for disposal might be a cheaper alternative. However, if rates along the North-to-South are prohibitively high and outweigh the savings of foreign disposal, then the waste haven effect might not be observed.

This study thus presents a two-country North/South model of trade and finds evidence on the influence of trade deficit, physical characteristics of final goods and characteristics of the shipping market on the asymmetric transport costs between countries. The model presented departs from the previous literature in the sense that transport costs are not assumed to be constant but are rather modeled asymmetrically depending on the direction of the trade flow. Firms in the North and in the South are indeed specialized in different types of goods, respectively in goods with high value taking up a low volume of capacity (semiconductor, pharmaceuticals, chirurgical equipment, etc.) and in goods with a low value to physical volume ratio (furniture, television, toys, etc.). Therefore, with fixed transport capacity, it implies that the demand for shipping capacity is higher along the South to North route than the other way around, leading to inferior North to South shipping prices. Given that the decision of handling wastes domestically or to export them to the South depends on the disposal costs plus the transport costs, and that they are both inferior to those encountered in the North, this gives strong incentives for firms to trade their wastes along that route and to contribute to a waste haven effect. According to the author, the main factors increasing the difference in shipping price between the North to South and the South to North route are (i) high South to North/North to South physical volume traded ratio, (ii) high trade deficit induced by the North importing more from the South than the opposite (iii) increase in the supply of shipping capacity.

c) The Chinese import ban

China started to import plastic wastes in the 1990s when emerging markets in the country assessed that the material could be used profitably. Plastic wastes can indeed be recycled into pellets that can subsequently be introduced in the market to replace virgin material. The relatively low price of the plastic wastes and the low cost of recycling into raw material (under low environmental regulations), combined with the possibility to sell it as an input for goods manufacturing for exports, made plastic wastes trade a lucrative industry in China. This business was furthermore supported by exporting countries as shipping their wastes to foreign destinations allowed them to avoid the negative externalities linked to plastic recycling, incineration and landfilling.

Nevertheless, this particular relationship between China and exporting nations, mainly the U.S.A., Europe and Japan, has started to be disrupted starting 2013 with the introduction of the "Green Fence". That year, China introduced a temporary restriction on wastes imports that required significantly less contamination. This was intended firstly to increase the quality of the plastic wastes that China was importing and secondly to reduced illegal foreign smuggling. While these restrictions did foster the quality of the material imported, it also highlighted the fragility of most countries to the dependence on a single importer. Lots of exporters and scrap traders started to do a major part of the cleaning and sorting operations themselves to meet the very high standards that China was still willing to accept, requiring important investments. Furthermore, the exported volume of plastic wastes severely decreased and caused a major slowdown in the market. The ban did not however totally stop the informal and illegal flow of plastic wastes, but true quantities are unknown at this time.

The "Green Fence" was then followed on the 1st January 2018 by the "National Sword", a new policy introduced by China in order to drastically limit its wastes imports. From this day, China has shut its doors to 24 types of wastes, accusing exporting countries to ship dirty or hazardous wastes potentially threatening the health of Chinese citizens. Forbidden wastes are no longer allowed to be imported and the ones that are still accepted must meet specific material standards. The restriction banned eight types of plastic wastes, including plastic waste polymers of PE, PS, PVC and PET.

The ban completely disrupted the industry and broke the profitable market it had become, leading many Chinese recycling companies bankrupt. According to Brooks, Shunli Wang, & Jambeck (2018), the Western world was also left vulnerable with an increasing pile of plastic wastes, making countries seeking a way around by shipping to other destinations. According to Hook, et al. (2018), an estimated 111 million tonnes of plastic wastes will be displaced between the introduction of the ban in 2018 and 2030. Southeast Asian countries, mainly Thailand, Vietnam, Indonesia and Malaysia have seen the flow of plastic wastes redirected towards their borders and significantly increased their imports in 2018. Because these countries lack the appropriate infrastructure to handle such a flow, dirty wastes of plastic are often recycled in hazardous conditions, incinerated for energy recovery or simply landfilled and dumped in the open air.

On the other side of the globe, the USA has also been severely impacted by the ban. It disrupted the industry and US collecting and recycling companies often scrambled and failed to find new buyers for their wastes. Investigations showed that cities around the country were no longer recycling many types of plastic dropped into recycling bins. They were instead burned, stockpiled or landfilled within the US borders. The turmoil that was normally hidden from view, was now hitting the country. According to an analysis of the US export records, the equivalent of 19,000 shipping containers of plastic recycling per month, once exported abroad, are piling up in the country.

In the past, principalities in the USA could collect and sort plastic wastes before selling the material to Chinese importers who would transform it into virgin material. Now the tendency is reversed, municipalities have to pay for disposal services as no one is willing to buy the material anymore. China was indeed buying all kinds of plastic wastes, including valuable and highly recyclable material but also less valuable ones. Among the plastic wastes that have no value, mixed plastics is the worst one as it includes all plastics wastes that are mixed with different plastic types, making the material impossible to recycle. No domestic or foreign recycling company was therefore willing to accept mixed plastics once China had closed its border.

The Chinese ban revealed an uncomfortable truth about plastic recycling: much of this plastic was never possible to recycle at all. Geyer, et al. (2017) states that only 9% of all plastic ever produced has been recycled. Plastic recycling is indeed a relatively low profitable industry when the plastic wastes used as inputs have low recycling properties and that negative externalities have to be taken into account. In the USA, many counties have seen the costs of plastic disposal and recycling exploding in 2018 and 2019. As a result of this severe cost increase, many towns and cities in the USA are sending all their plastic wastes to landfill and incineration.

USA citizens have started to point out this issue, feeling they have been sorting their wastes to now been told it is useless. For years, people were had in mind that plastic was recycled, so they kept buying the product without further investigating the truth. Americans are nevertheless continuing to throw away million tonnes of plastic each year, even if they are currently running out of ways to dispose of it. According to specialists in the industry, this plastic consumption is not expected to decrease in the coming years, but the Chinese ban might well be the opportunity to put the responsibility on the corporations who are producing plastic.

4. US plastic wastes exports

a) Dataset

To make a particular focus on the plastic waste trade of the USA and the impact of the Chine import ban, a port level dataset is extracted from the United States Census Bureau website. This organization operates under Title 13 and Title 26 of the U.S. Code and has the mission to serve as the nation's leading provider of quality data about its people and economy.

The port level dataset contains detailed information about exports made by the different US ports, such as the date of transaction, the content of the transaction according to the 6-digit Harmonised System, the total export value in $US, the vessel total export value in $US, the vessel total export SWT in kilogram of the transaction and finally its destination country. Data has been extracted for the 2015 to 2019 period and a particular focus has been given to 4 types of plastic wastes: wastes and scraps of ethylene polymers, chloride vinyl polymers, styrene polymers and finally other plastic types, also called mixed plastics. These four types together are indeed introduced in the literature by Brooks, et al. (2018) and can therefore be used to comprehensively analyze the patterns of the plastic wastes trade. However, to cope with missing values that can be encountered for both the vessel total export value in $US and the vessel total export SWT in kilograms, only the total export value in $US will be used to analyze this trade. Even if from an environmental point of view, kilograms of plastic wastes traded would be a more adequate metric, the total value of the exports in $US can be used instead given the correlation of 0,98 between weight and value. In other words, almost all the variation in value can be explained by a variation in weight traded and therefore makes the total export value a suitable variable for this analysis.

b) Data exploration

i) Global trend

Figure 5 displays the evolution of the USA's exports of plastic wastes between 2015 and 2019.

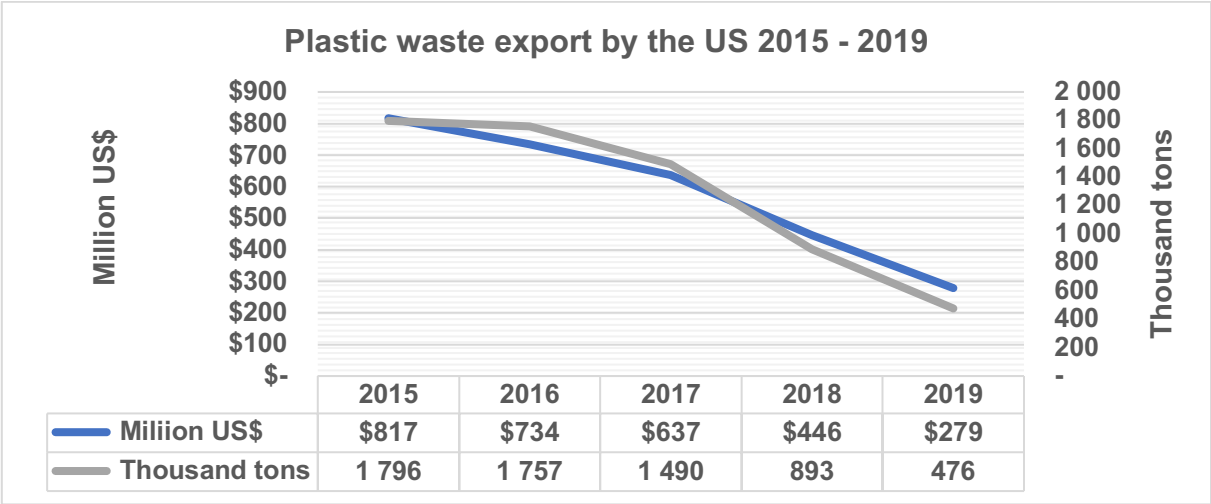


Figure 5 : USA exports of plastic wastes 2015 – 2019

.

As it can be seen, although being one of the main exporters of wastes in the 21st century, the country is drastically reducing its export of plastic wastes since 2015. In this time period, the country has indeed reduced its plastic wastes exports by almost 75%, both in terms of value and weight. This decreasing trend is the result of the Chinese plastic import restrictions and ban that were introduced since 2013, leading to a severe transformation of the industry.

ii) Types of plastic wastes traded

Figure 6 displays the different types of plastic wastes that have been exported by the USA since 2015.

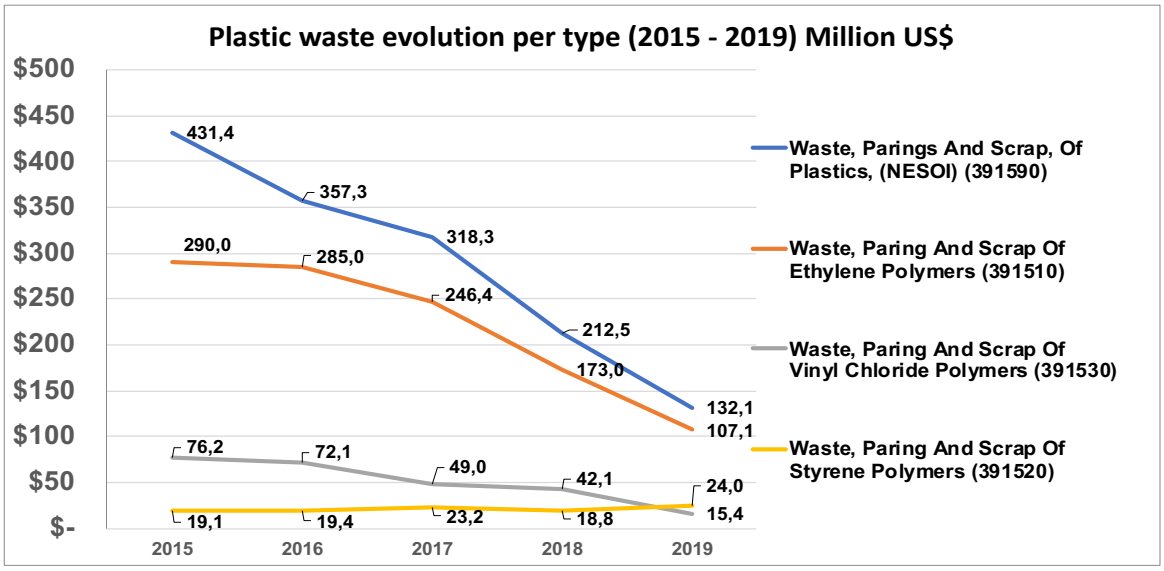


Figure 6 : Types of plastic wastes exported by the USA between 2015 and 2019.

As it can be seen, plastic wastes are divided into four different categories: (i) Plastic wastes NESOI, (ii) plastic wastes of ethylene polymers, (iii) plastic wastes of vinyl chloride polymers and (iv) plastic wastes of styrene polymers.

- **Plastic wastes NESOI (391590):** as NESOI stands for Not Elsewhere Specified or Indicated, this contains all the plastics wastes that have not been further described and therefore contains a mix of the different other plastic types. We can therefore expect to find all kinds of different plastic wastes under this HS code. This category represents 50% of all plastic wastes exported by the USA and is the one that is witnessing the biggest decrease since 2015. This type of plastic wastes, which we can name mixed plastics, is often considered as dirty given that it is rather complicated to recycle. The Chinese restrictions on plastic wastes imports were thus initially focused on reducing imports of mixed plastic wastes, explaining the decrease from 431,4 million $US in 2015 to 132,1 million $US in 2019.

- **Plastic wastes of ethylene polymers (391510):** this category regroups all the plastics wastes made out of ethylene polymers, also called polyethylene. Under this classification, we can find a wide variety of different ethylene polymer types according to Goodship (2007). Mainly (i) low-density polyethylene (LPDE) used for film and coating applications, such as carrier or bin bags, (ii) high-density polyethylene (HDPE) used for film and bottling applications such as non-transparent bottles or plastic furniture and finally (iii) polyethylene terephthalate (PET) that is commonly used to create transparent bottles or food packaging. Polyethylene wastes account for 38% of all the plastic wastes exported by the USA and have decreased by 63% since 2015, reaching 107,1 million $US in 2019.

- **Plastic wastes of vinyl chloride polymers (391530):** polyvinyl chloride (PVC) is mainly used to produce pipes for municipal and industrial applications, but is also used in construction and for healthcare containers. This type represents 20% of plastic wastes exports since 2015 and also witnessed a big decrease in the recent years. The export value indeed decreased from 76,2 million $US in 2015 to 15,4 in 2019, representing a drop of around 80%.

- **Plastic wastes of styrene polymers (391520):** styrene polymers, also called polystyrene (PS), are mainly used for food packaging applications but also as containers in the fast-food industry or shock insulant when used under their foamed form. Styrene polymer wastes account for only 4% of all plastic wastes exports but is the only category for which volume of export have increased in the last five years. As it can be seen in figure 6, polystyrene wastes increased from 19,1 in 2015 to reach 24,0 million $US in 2019.

iii) Countries of destination

Table 8 displays the main countries of destination for the US plastic wastes between 2015 and 2019, where blue colored cells are indicating that a given country has been importing more plastic wastes from the USA than the previous year. In this table, both the yearly amount being exported to a given country as well as the share of this country compared to the overall export quantity are displayed.

Rank	Country	2015	2016	2017	2018	2019	% 2015	% 2019
1	**China**	$ 315,0	$ 283,0	$ 190,7	$ 21,4	$ 8,4	**38,6%**	**3,0%**
2	**Hong Kong**	$ 227,7	$ 213,0	$ 130,9	$ 54,0	$ 29,6	**27,9%**	**10,6%**
3	**Canada**	$ 86,9	$ 74,6	$ 67,9	$ 69,2	$ 64,5	**10,6%**	**23,2%**
4	**India**	$ 58,1	$ 49,6	$ 58,3	$ 50,1	$ 33,0	**7,1%**	**11,8%**
5	**Malaysia**	$ 8,8	$ 8,0	$ 31,5	$ 58,0	$ 16,0	**1,1%**	**5,7%**
6	**Vietnam**	$ 15,0	$ 20,0	$ 49,4	$ 27,4	$ 7,3	**1,8%**	**2,6%**
7	**Mexico**	$ 18,5	$ 22,6	$ 25,6	$ 24,5	$ 19,2	**2,3%**	**6,9%**
8	**Taiwan**	$ 17,6	$ 9,0	$ 9,3	$ 20,9	$ 14,7	**2,2%**	**5,3%**
9	**Thailand**	$ 1,9	$ 1,4	$ 10,8	$ 43,4	$ 8,6	**0,2%**	**3,1%**
10	**Indonesia**	$ 23,0	$ 10,5	$ 8,3	$ 9,2	$ 10,7	**2,8%**	**3,8%**
11	**Korea, South**	$ 10,0	$ 1,8	$ 3,4	$ 14,1	$ 11,4	**1,2%**	**4,1%**
12	**El Salvador**	$ 6,0	$ 4,6	$ 5,1	$ 6,6	$ 5,6	**0,7%**	**2,0%**
13	**Turkey**	$ 0,8	$ 2,0	$ 4,2	$ 6,1	$ 7,5	**0,1%**	**2,7%**
14	**Belgium**	$ 1,7	$ 4,6	$ 4,3	$ 4,4	$ 3,4	**0,2%**	**1,2%**
15	**Australia**	$ 2,5	$ 5,4	$ 5,7	$ 3,4	$ 0,8	**0,3%**	**0,3%**
16	**Spain**	$ 1,3	$ 2,3	$ 4,2	$ 3,0	$ 3,2	**0,2%**	**1,2%**
17	**Dominican Republic**	$ 2,4	$ 2,9	$ 1,9	$ 1,6	$ 2,0	**0,3%**	**0,7%**
18	**Guatemala**	$ 2,8	$ 2,2	$ 1,7	$ 2,1	$ 1,4	**0,3%**	**0,5%**
19	**Colombia**	$ 0,1	$ 1,4	$ 6,3	$ 1,2	$ 0,8	**0,0%**	**0,3%**
20	**Ecuador**	$ 0,1	$ 0,1	$ 1,3	$ 3,8	$ 3,0	**0,0%**	**1,1%**

Table 8: 20 main export destination countries for US plastic wastes since 2015 million $US.

First of all, we can once again see that exports of plastic wastes by the USA are quite concentrated to a few destinations, as for 2015 the 7 biggest importers were accounting for 90% of all exports from the USA. However, in 2019 exports are much less concentrated as this time the 20 biggest importing countries account for 90% of all exports made by the USA. By grouping these countries per continent, we can see that 9 of them are located in Asia and account for 82,9% of all imports in 2015 and 50,2% 2019, 6 are located in South America and account for 3,7% and 11,5% in 2015 and 2019, 3 are located in Europe representing 0,5% in 2015 and 5,1% in 2019. The two other countries are Canada, accounting for 10,6% in 2015 and 23,3% in 2019 and Australia which accounts for 0,3% both in 2015 and 2019.

As it can be seen, patterns that could be observed in the plastic wastes flow in 2015 are not anymore valid today. The Chinese import restrictions introduced since 2013 and the plastic wastes import ban of 2018 severely disrupted this economy and wastes flows had to be redirected. China was indeed, combined with Hong Kong, which is used as an entry port for the country, importing more the 65% of the US plastic wastes exports in 2015 while this ratio dropped to 13% for the year 2019. In terms of value, China and Hong Kong went from importing 512 million $US worth of plastic wastes in 2015 to only 38 million $US in 2019. Even though plastic wastes exports by the USA have also decreased during that time period, the magnitude of this reduction is not totally equal to the one observed in China's imports. As it can be seen in table 9, From 2015 to 2018, China and Hong Kong decreased their plastic wastes imports from the USA by 467 million $US while the USA decreased their exports by 371 million $US. This therefore means that around 96 million $US worth of plastic wastes that would have normally been shipped to China had to be redirected to other countries.

The blue colored cells in table 8 indicate that in 2016, 2017 and 2018 respectively 8, 11 and 10 countries increased the amount they were importing from the USA, while only 2 countries did in 2019. This tends to show that these countries were used as destinations for plastic wastes flows that would otherwise have been directed to China. Among these countries, Malaysia, Vietnam and Thailand were the ones where the increase in plastic wastes imports from the USA has been the most significant.

Surprisingly, looking at the year 2019, import volume for most countries seems to have reached a level approximately equal to those of 2015, even much lower in some cases. Only Malaysia, Turkey and Thailand imported around 7 million $US worth of plastic wastes from the USA more than their level of 2015. On the other hand, India, Canada, Indonesia and Vietnam reduced their imports by respectively 25, 22, 12 and 8 million $US worth of plastic wastes between 2015 and 2019.

		2015	2016	2017	2018	2019
China & Hong Kong	Imports from USA	$ 542,7	$ 496,1	$ 321,7	$ 75,4	$ 38,0
	vs PY		*$ (46,7)*	*$ (174,4)*	*$ (246,2)*	*$ (37,4)*
USA	Exports to all countries	$ 816,8	$ 733,9	$ 636,9	$ 446,5	$ 278,6
	vs PY		*$ (82,9)*	*$ (97,0)*	*$ (190,4)*	*$ (167,9)*

Table 9: Evolution of plastic wastes imports by China from the USA against exports to all countries by the USA in million $US (2015 - 2019).

Figure 7 displays the evolution of the US plastic wastes exports by classifying these destination countries as developed and developing countries.

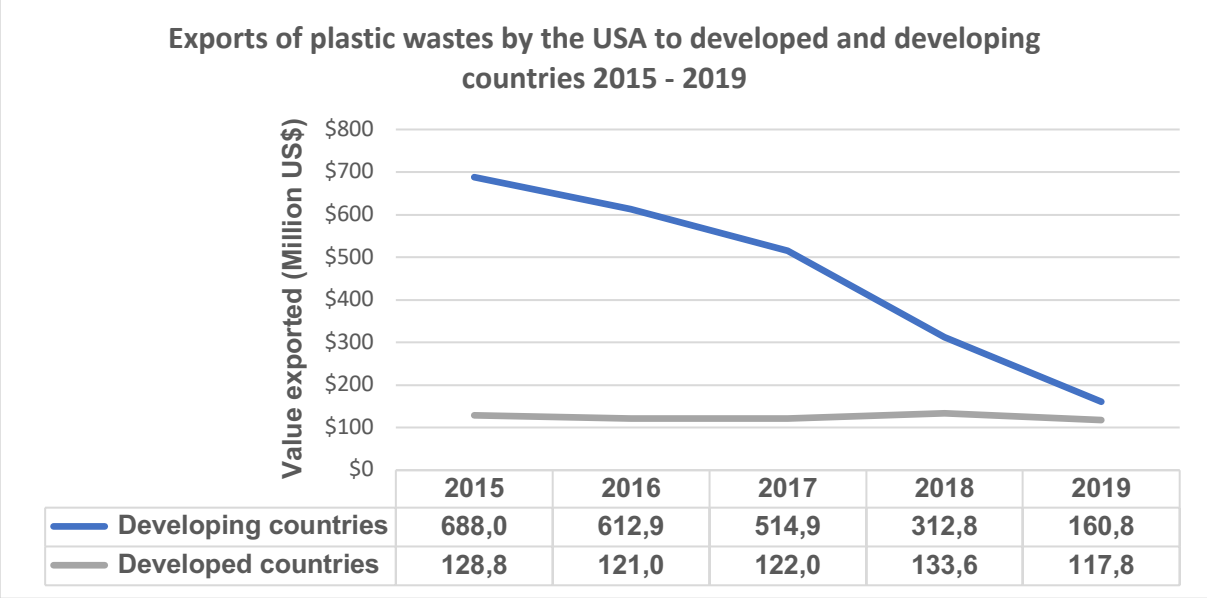


Figure 7: Exports of plastic wastes to developed and developing countries 2015 – 2019.

As I can be seen, exports of plastic wastes to developing countries in 2015 were much more extensive than those to developed countries. The USA was indeed shipping around 85% of their plastic wastes to developing countries and only 15% to OECD and European countries.

These results are thus in line with what we have seen so far in the literature, confirming the evidence that rich countries tend to send their wastes to countries of the South. However, when we look at the pattern of the US plastic wastes exports until 2019, a considerable decrease in the shipments directed to developing countries can be observed, while those to developed countries have only slightly decreased during that time period. These two effects combined lead to a radically different pattern in 2019 compared to 2015, as developing countries are now accounting for 58% of the US plastic wastes exports against 42% for the developed countries. These results are in line with those presented in the previous section, mainly when comparing figure 1 and figure 7, and tend to indicate a radical change in the plastic waste trade.

iv) Ports used for export

Table 10 displays the yearly amount in million $US exported by the 15 main plastic wastes exporting US ports and their share for the years 2015 and 2019. Blue colored cells indicate that a given port has increased its exports of plastics wastes compared to the previous year.

Rank	Port	2015	2016	2017	2018	2019	% 2015	% 2019
1	**Los Angeles, CA**	$ 309,3	$ 248,5	$ 196,8	$ 103,9	$ 47,1	**37,9%**	**16,9%**
2	**New York City, NY**	$ 75,4	$ 80,1	$ 69,3	$ 58,9	$37,6	**9,2%**	**13,5%**
3	**San Francisco, CA**	$ 58,7	$ 40,7	$ 34,3	$ 23,7	$11,8	**7,2%**	**4,3%**
4	**Charleston, SC**	$ 48,1	$ 49,1	$ 50,1	$ 31,0	$18,3	**5,9%**	**6,6%**
5	**Houston-Galveston, TX**	$ 47,8	$ 46,6	$ 42,9	$ 35,4	$20,6	**5,9%**	**7,4%**
6	**Seattle, WA**	$ 42,1	$ 43,1	$ 38,9	$ 21,0	$ 7,3	**5,1%**	**2,6%**
7	**Savannah, GA**	$ 40,2	$ 39,7	$ 36,0	$ 28,2	$14,5	**4,9%**	**5,2%**
8	**Norfolk, VA**	$ 34,1	$ 45,3	$ 36,8	$ 24,0	$15,4	**4,2%**	**5,5%**
9	**Detroit, MI**	$ 31,6	$ 28,5	$ 22,9	$ 23,1	$22,4	**3,9%**	**8,1%**
10	**Buffalo, NY**	$ 23,5	$ 15,2	$ 15,1	$ 17,3	$15,0	**2,9%**	**5,4%**
11	**Ogdensburg, NY**	$ 16,4	$ 16,5	$ 18,3	$ 17,9	$20,6	**2,0%**	**7,4%**
12	**Laredo, TX**	$ 11,9	$ 12,9	$ 14,1	$ 9,8	$ 6,9	**1,5%**	**2,5%**
13	**Miami, FL**	$ 11,6	$ 8,1	$ 5,5	$ 4,2	$ 3,1	**1,4%**	**1,1%**
14	**Baltimore, MD**	$ 9,5	$ 4,0	$ 3,6	$ 3,0	$ 2,0	**1,2%**	**0,7%**
15	**Tampa, FL**	$ 7,7	$ 6,8	$ 6,3	$ 3,2	$ 2,0	**0,9%**	**0,7%**

Table 10: 15 main plastic wastes exporting ports 2015 - 2019.

As it can be seen, plastic wastes exports in the US are relatively concentrated as the 7 main ports, out of 39, account for around 75% of all exports in 2015. Not surprisingly, the port of

Los Angeles, the biggest container port of the USA, is leading the ranking. However, this port has witnessed a particularly drastic drop in its plastic wastes exports within the last 5 years with a decrease of around 262 million $US. Here again, the main explanation is the plastic import ban introduced by China, as in 2015, 90% of the plastic wastes exports of the Los Angeles port were heading to Hong Kong and China.

By grouping the 39 US ports by their geographic location in the USA, we are able to define 4 different categories of ports. We can indeed categorize each of them as being on the West Coast, on the East Coast, as being an inland port or as being an overseas territory, which we will define as "Others". As it can be seen in table 11, exports of wastes from the West Coast of the USA have decreased more significantly than in other locations in the country.

Geographic Location	2015	2019	% in 2015	% in 2019
West Coast	$ 413,8	$ 76,3	50,67%	27,42%
East Coast	$ 292,4	$ 118,5	35,81%	42,55%
Inland Ports	$ 101,0	$ 77,0	12,37%	27,67%
Others	$ 5,2	$ 3,8	0,64%	1,37%

Table 11: Exports of plastic wastes by geographic location in the USA 2015 - 2019 (Million $US).

On the West Coast, exports have indeed decreased by 82% in five years, compared to a decrease of 59% and 24% respectively for the East Coast and for inland ports. For West and East Coast ports, the significant decrease can be explained by their dependence on China's imports of plastic wastes, as this destination was accounting for respectively 85% and 62% of the exports of these locations. Therefore, with the Chinese ban, the West Coast has been more severely impacted than its Eastern counterpart, which was more diversified, especially with 20% of its exports going to India. However, what is interesting to note is that Inland ports, which are mainly located around the big lakes in the North of the USA and along rivers making the border with Mexico, have registered a decrease of only 24%. The main explanation behind this observation is that Canada and Mexico have only slightly decreased their imports of wastes in the last 5 years. All in all, this explains the shift observed in table 11 between 2015 and 2019 regarding the percentage of USA plastic exports that can be accounted for each location.

v) Maritime routes

Having now a better understanding of the origin points and the destination countries of the US plastic wastes exports, a more in-depth analysis of the maritime routes involved can be conducted. Table 12 displays the main maritime routes used for plastic wastes exports by regrouping the different ports according to their location and the countries by the continent they are located in. This simplification is meant to better highlight the more commonly used maritime routes, but a more in-depth analysis will be presented in the following points. Blue colored cells indicate that a given maritime route has witnessed an increase in the value transported compared to the previous years.

Maritime routes	2015	2016	2017	2018	2019	% 2015	% 2019
West Coast - Asia	$ 403,3	$ 322,3	$ 259,3	$ 133,8	$ 55,2	**49,4%**	**19,8%**
East Coast - Asia	$ 269,8	$ 270,1	$ 234,2	$ 170,6	$ 95,2	**33,0%**	**34,2%**
Inland Ports – North & Central America	$ 94,3	$ 83,4	$ 77,7	$ 75,8	$ 70,1	**11,5%**	**25,2%**
East Coast - North & Central America	$ 11,3	$ 8,5	$ 6,7	$ 6,2	$ 5,8	**1,4%**	**2,1%**
West Coast - North & Central America	$ 9,5	$ 12,0	$ 16,2	$ 20,8	$ 15,2	**1,2%**	**5,5%**
East Coast - Europe	$ 7,2	$ 8,3	$ 8,6	$ 8,2	$ 7,1	**0,9%**	**2,5%**
East Coast - Oceania	$ 2,4	$ 5,4	$ 5,5	$ 3,1	$ 0,6	**0,3%**	**0,2%**
East Coast - Africa	$ 1,0	$ 0,4	$ 1,0	$ 1,1	$ 4,9	**0,1%**	**1,8%**
East Coast - South America	$ 0,8	$ 2,2	$ 4,1	$ 6,5	$ 4,9	**0,1%**	**1,8%**
West Coast - Europe	$ 0,6	$ 4,1	$ 4,0	$ 5,3	$ 4,7	**0,1%**	**1,7%**

Table 12: Main maritime routes used for US plastic wastes exports 2015 – 2019.

The main maritime route in 2015 was the one linking the West Coast and Asia, accounting for almost 50% of the US plastic wastes exports that year. However, the Chinese plastic wastes import ban had a big impact on this route and thus reduced its usage for US plastic wastes exports by 86%. In 2019, the value transported through this line was only 55 million $US compared to 403 million $US in 2015 and only accounts for around 20% of the exports in 2019.

The second most used route is the one between the East Coast and Asia, which also experienced a significant decrease between 2015 and 2019. Nevertheless, this route is now the busiest one for US plastic wastes exports. The value transported along this maritime route decreased by 65% in the last five years, making it less impacted by the Chinese ban than its Western counterpart. The explanation behind this smoother decrease is that in the US plastic

wastes trade, ports on the East Coast are principally used for exports to India and Hong Kong which did not reduce their imports as much as China did.

The third main maritime route taken in 2015 is however quite different, as it involves inland ports and shipments across lakes toward Canada and across rivers to Mexico. It is also interesting to see that among the three main maritime routes used for plastic wastes exports, the Inland Ports – North America is the one that decreased the less since 2015 and now represents around 25% of the exports of this material.

Arrows in figure 8 represent the maritime routes taken by shipping boats exporting US plastic wastes to several different locations across the globe.

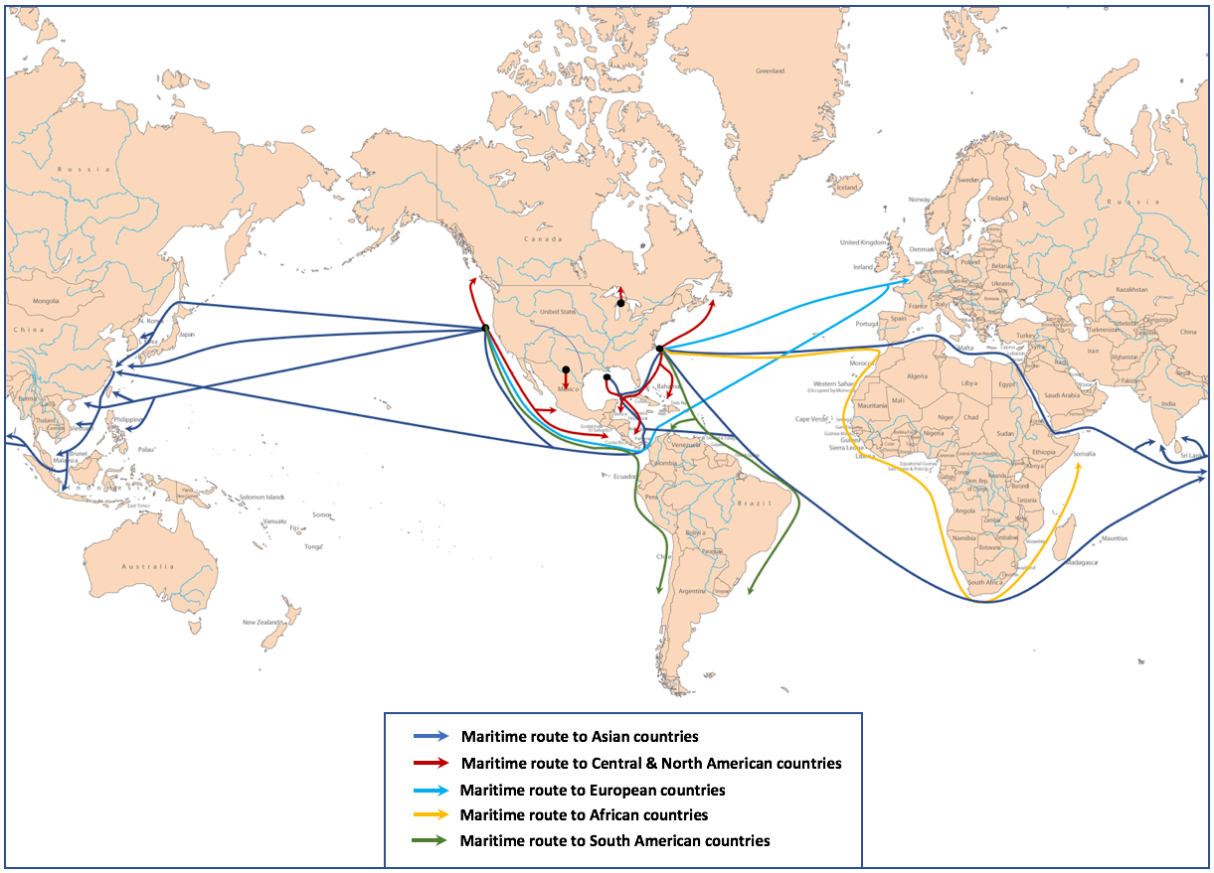


Figure 8: Main maritime routes for plastic wastes exports by the USA 2015-2019.

- *Maritime routes to Asia*

As displayed in table 12 the US - Asia maritime routes mainly used for plastic waste trade (dark blue arrows in figure 8) account for 82% and 55% of the US plastic wastes exports in 2015 and 2019.

From the West Coast of the USA to Asian countries, shipping boats are mainly leaving from three principal ports: Los Angeles, San Francisco and Seattle. However, their route is mainly defined according to their destination points in Asia. When shipping boats are going to the port of Shanghai, the world busiest port, they will cross the Pacific Ocean and the East China Sea to arrive directly to their destination. However, if boats are first going to Japan or South Korea, they will first pass above Japan and cross the Sea of Japan. Nevertheless, the shipping route is somehow different in the case the container ships are directed to South East Asian countries or India. For these countries, boats will cross the Pacific Ocean and the Philippine Sea to arrive in the South China Sea. From there, boats can be directed towards Vietnam, Indonesia, Philippines, Thailand and Malaysia or go into the Java Sea to moor in Java. The route can also continue further by crossing the Strait of Malacca in order to reach India or Sri Lanka. It is also possible that shipping boats first follow the route to Shanghai to subsequently reach South East Asian countries by sailing along the Chinese coast.

When coming from the East Coast of the USA, mainly from the ports of New York, Houston-Galveston, Charleston and Norfolk, shipping boats principally take three maritime routes. The first option is to cross the Caribbean Sea, either by going along the West Coast or by crossing the Gulf of Mexico in order to reach the Panama Canal. Once the canal is crossed, boats can reach Asia by either going North along the coast to reach the principal maritime route leaving from the Western side of the USA or by crossing the Pacific Ocean to directly reach Asia.

The second option is to cross the Atlantic Ocean to reach the Mediterranean Sea through the Strait of Gibraltar. Afterward, shipping boats cross the Suez Canal to reach the Strait of Hormuz and the Arabian Sea. Once there, boats can either go to India and Sri Lanka or continue their route through the Strait of Malacca to reach South East Asian countries and China.

Finally, the third option for shipping lines is the go South along the South American Coast to subsequently cross the Atlantic in order to reach the Cape of Good Hope. Once there, boats then cross the Indian Ocean to reach South East Asia.

- *Maritime routes to North America*

As displayed in table 12 the US – North America maritime routes mainly used for plastic wastes trade (red arrows in figure 8) account for 14% and increased up to 32% of the US plastic wastes exports in 2015 and 2019. These countries can be grouped as two principal destinations, mainly (1) Canada and (2) Mexico with countries of Central America.

Canada is the main North American country to which plastic wastes are exported and three principal maritime routes are used. The main one is using inland ports by crossing the lakes Michigan, Huron, Erie and Ontario located in the North of the USA. The two other routes are the ones going alongside the West Coast or the East Coast of the USA.

The pattern is similar for exports to Mexico, as the three main options are either by going alongside the East coast of the USA and through the Gulf of Mexico, to go alongside the West coast or to cross inland rivers that define the border between the two countries. Finally, for exports to countries located in Central America, the two maritime routes are the ones going alongside the East and the West coast of the USA.

- *Maritime routes to Europe*

As displayed in table 12, the main maritime routes from the USA to Europe for plastic wastes trade (light blue arrows in figure 8) account for 1% and 4% of all plastic wastes exported by the USA in 2015 and 2019.

As it can be seen, the way from the USA to Europe is quite direct. If shipping boats are leaving the East Coast of the USA, they will directly cross the Atlantic Ocean and the English Channel to arrive in the North Sea. Once there, boats can reach the three biggest European ports, being

Rotterdam, Antwerp and Hamburg. If boats are leaving the West Coast of the USA, they first need to cross the Panama canal and then cross the Atlantic Ocean to reach Europe.

- *Maritime routes to Africa*

As displayed in table 12, the main maritime routes from the USA to Africa to trade plastic wastes (yellow arrows in figure 8) account for less than 1% and 1,8% of all the volume exported by the USA in 2015 and 2019.

The main route is originating from the East coast of the USA and crosses the Atlantic Ocean to reach the coast near Morocco. Once there, ships continue their route alongside the coast of Africa to reach the country they are heading to. However, to serve the East Coast of the African continent, shipping boats pass along the Cape of Good Hope and sail North along the coast.

- *Maritime routes to South America*

As displayed in table 12, the main maritime routes from the USA to South America to ship wastes (green arrows in figure 8) account for less than 1% and around 2,5% of all plastic wastes exported by the USA in 2015 and 2019.

To reach these countries departing from the USA, boats from the East Coast of the USA sail South in order to reach the coast of Venezuela and then continue alongside the shore to serve countries further in the South. For boats coming from the West coast of the USA, a similar pattern is observed as they sail south to reach the coast of Ecuador and then continue their route to reach countries further in the South. In some cases, shipping boats from the West Coast and the East Coast of the USA cross the Panama Canal to reach countries on the opposite side of South America, but according to the data, this seems a really exceptional maritime route for plastic wastes exports.

c) Empirical analysis

The objective of this empirical analysis is to assess if the findings in the literature regarding the main factors influencing the international waste trade are also valid for the plastic wastes exports made by the United States of America between 2015 and 2019. As it can be read in the previous section of this paper, the main factors influencing the flow of wastes between countries are (i) the size of the two economies as a proxy of consumption level and presence of advance recycling technologies, (ii) the distance between the two countries as a proxy of transport cost and (iii) the difference in environmental regulation stringency between the two countries. These findings were presented by Kellenberg (2012) for 62 different kinds of wastes traded between 92 countries for the year 2004.

However, plastic wastes trade dynamics have undoubtedly changed within the last five years. Chinese import restrictions have completely disrupted the market and radically changed the patterns observed in plastic wastes flows. Good examples of this disruption are displayed in table 8 and 16, where in 2019 developing countries did not import a significantly higher share from the USA than developed countries did when comparing this ratio to the one of 2015. Therefore, questions can arise regarding the factors that can explain the patterns recently observed. Given the recent change in the industry, it is therefore interesting the asses if the factors mentioned above explaining the patterns of the international trade of all kinds of wastes are consistent with the plastic wastes exports made by the USA. Furthermore, results presented by the author are based on waste trade data from 2004 and might therefore not be consistent anymore with the dynamics observed in recent years.

All in all, this empirical analysis will focus on studying the significance of the size of the economy as well as the distance and the difference in environmental regulation stringency between the USA and the importing country. Furthermore, other factors will be included as in Kellenberg (2012), such as common language or contingency to assess if their significance differs from the previous study.

i) Model

- *Variables employed*

The empirical model and the approach to test the waste haven hypothesis as well as the influence of other factors presented by Kellenberg (2012) will be used in this paper. According to the author, who based his paper on the gravity model first introduced by Tinbergen (1964), bilateral trade in wastes between two countries i and j, T_{ij}, is supposed to be negatively related to the distance between the two countries and positively related to the size of the two economies, G_i and $G_j$measured in units of GDP. Furthermore, T_{ij} is also set to be influenced by K other bilateral factors ξ_{ij} such as the environmental regulation gradient between countries, the colonial ties, the membership to free trade agreements, the recycle wage gradient, the GDP per capita gradient, the membership to the Basel ratification, the contiguity of the two countries, the common language ties between the two countries and the classification as developed or developing country. Finally, bilateral waste trade is assumed to be influenced by a constant α_0. All these factors together lead to equation (1) below:

$$T_{ij} = \alpha_0 G_i^{\beta_1} G_J^{\beta_2} D_{ij}^{\beta_3} \prod_{k=4}^{K} \xi_{ij}^{\beta_k} \quad (1)$$

Where we assume that $\beta_1 > 0$, $\beta_2 > 0$ and $\beta_3 < 0$, which represent the relationship between the dependent and the explanatory variables.

However, the port level dataset departs from the UN Comtrade dataset used by Kellenberg (2012) as it focuses on exports made by the USA to all countries. Therefore, given that the purpose of this paper is to study the factors influencing the plastic waste trade of the USA with foreign countries, equation (1) can be written as follow:

$$T_i = \alpha_0 G_i^{\beta_1} D_i^{\beta_2} \prod_{k=4}^{K} \xi_i^{\beta_k} \quad (2)$$

Where we assume that $\beta_1 > 0$, $\beta_2 < 0$.

In equation (2) we do not take the USA GDP into account as it will be the same for each observation, only the size of the foreign economy, G_i, is used as well as the distance between

the USA and country i, D_i. Furthermore, the same simplification can be done for the K other factors, ξ_i.

Here, T_i will be approximated by using the Total Exports Value in $US of plastic wastes exported by the USA to a country i in 2015 and in 2019. This metric can be used as a proxy for the quantity of plastic wastes exported as the correlation between the Total Exports in $US and the Vessel Total Exports SWT in Kg is 0,98. Regarding the explanatory variables, for G_i, GDP data was obtained from The World Bank website. For D_i, data over the distance between the USA and other countries as well as other geographic variables such as contiguity or colonial ties were obtained from the dist_cepii.dta data file on the CEPII website, which is also used in Kellenberg (2012). For environmental regulations stringency, the environmental index used by the author, which was extracted from the Global Competitiveness Survey, is no longer available. The survey has indeed evolved over time and now takes other criteria into consideration, implying that a similar environmental indicator must be used. A valid substitute to assess the environmental stringency of a country was therefore obtained using the 2018 Environmental Performance Index (EPI) extracted from the EPI website. This index is an aggregate indicator from 0 to 100 giving different weights to multiple sub-metrics, such as the air quality, the air pollution, the CO_2 emissions or the wastewater treatments. The EPI therefore gives a strong indication of the environmental regulations stringency of a country and can be used as an input for the model. Furthermore, to globally assess the sustainability of a given country, the 2019 Sustainable Development Goals Indicator, which is provided by the United Nations, is also included as an explanatory variable. This indicator is composed of 231 sub-metrics, such as poverty level, health condition, electricity access or drinking water availability and assigns a score from 0 to 100 to each country.

- *Variables transformation*

In order to be able to construct a model with the aforementioned variables, some transformation operations first need to be conducted for both 2015 and 2019. First of all, missing values have been put aside for both the dependent and the explanatory variables in order to clean the dataset. However, outliers such as Canada or Mexico were not removed as they were containing valuable information. All in all, this gives a dataset of 80 different

observations in 2015 and 85 in 2019. A correlation analysis was also conducted in order to avoid collinearity of the variables. However, given that the Pearson's Correlation Coefficient (PCC) assumes the normality of the variables, which is not valid for our dataset, and that the sample size is not large enough to follow the Central Limit Theorem, no conclusion can be drawn from this value. Nevertheless, the PCC still provides valuable insight of the relationship between the variables of the dataset.

Once these cleaning operations were conducted, the variables themselves were transformed in order to be able to build the model. First of all, the EPI and the SDGI variables were centered to simplify the understanding of the model output. Furthermore, after having plotted the GDP, the distance and the plastic wastes traded variables, a significant skewness to the right could be observed. Therefore, as widely used in the literature and presented by Hall (1992) among other transformations meant to correct skewed data, a logarithmic transformation was applied on these three variables to approach a Normal distribution.

- *Building the model*

The statistical model used in this paper in order to assess the significant factors influencing the plastic wastes exports made by the USA will slightly depart from the one used by Kellenberg (2012). We will indeed here use a Multiple Linear Regression (MLR) to evaluate how these factors are related to the amount traded by a given country and assess their statistical significance. The general model including all the variables is the following (3):

$$\text{Log}\,\widehat{T}_i = \hat{\beta}_0 + \hat{\beta}_1 \,\text{Log}\, G_i + \hat{\beta}_2 \,\text{Log}\, D_i + \hat{\beta}_3 EPI_i + \hat{\beta}_4 SDGI_i + \hat{\beta}_5 D_{1,i} + \hat{\beta}_6 D_{2,i} + \hat{\beta}_7 D_{3,i} + \hat{\beta}_8 D_{4,i} \qquad (3)$$

Where $D_{1,i}$, $D_{2,i}$, $D_{3,i}$ and $D_{4,i}$ are dummy variables respectively indicating if the country i is a developed or a developing country, if it has a border with the USA, if it has a colonial tie with the USA and finally if it is an English speaking country. The different $\hat{\beta}$ are the coefficients of each explanatory variable and represent their relationship with the dependent variable, where a positive (negative) value for a given variable indicates that $\text{Log}\,\widehat{T}_i$ is positively (negatively) related to that variable.

(a) 2015

However, running this model including all the explanatory variables for the year 2015 does not give significant results. The dataset might indeed present collinearity between the variables and some explanatory variables might not be correlated with the dependent one. To cope with these issues, a forward selection is used to build iteratively the model. This process allows us to include variables that have a significant relationship with the dependent variable while leaving the unrelated ones aside. The first variable to be included in the model is $\text{Log}\, G_i$ as it is the most significant factor with a p-value < 0,001 and a Variance Inflation Factor (VIF), which provides an index that measures how much the variance of an estimated regression coefficient is increased because of collinearity, of 1. Keeping the $\text{Log}\, G_i$ variable in the model, the following variable to be included in the MLR is $SDGI_i$ with a p-value < 0,009 and a VIF of 1,18, therefore indicating that this variable is significatively related to $\text{Log}\, T_i$. Following the same procedure, $\text{Log}\, D_i$ is added to the model given that its relationship with the dependent variables is significant, with a p-value < 0,006 and a VIF of 1,39. The last variable to be included in the MLR is EPI_i, with a p-value < 0,044 and a VIF of 1,39. Afterward, no more variables can be included in the regression as they all present high a p-value or a high VIF.

Finally, as a given variable that does not show a significant relationship with the dependent variable can be significant by interacting with another variable, interaction terms are created in order to further improve the model. However, none of these interaction terms created give significant results. Therefore, the final model for the year 2015 is the following (4):

$$\widehat{\text{Log}\, T_i} = \hat{\beta}_0 + \hat{\beta}_1 \text{Log}\, G_i + \hat{\beta}_2 SDGI_i + \hat{\beta}_3 \text{Log}\, D_i + \hat{\beta}_4 EPI_i \quad (4)$$

(b) 2019

For 2019, the same procedure as for 2015 is followed. The MLR is first executed including all the explanatory variables, but shows no significant results. Therefore, the same forward building process is used to create the most accurate model.

The first variable to be included in the model is $\text{Log}\, G_i$ as it is the most significant factor with a p-value < 0,001 and a VIF of 1. EPI_i is subsequently added to the model given that it presents a p-value < 0,0061 and a VIF of 1,13. Furthermore, $\text{Log}\, D_i$, with a p-value < 0,003 and a VIF of

1,13, is finally included in the MLR. Arriving at this stage of the forward building process, no further variables can be included in the model given that no p-value shows a significant relationship with the dependent variable. Finally, as for 2015, interaction terms are created to fine-tune the MLR, but they do not show significant improvements. Accordingly, the MLR for 2019 is the following (5):

$$\text{Log}\,\widehat{T_i} = \beta_0 + \beta_1\,\text{Log}\,G_i + \beta_2\,\text{Log}\,D_i + \beta_3 EPI_i + \epsilon_i \quad (5)$$

ii) Results

To be able to assess the evolution of the different factors of the MLR between 2015 and 2019, the SDGI variable, even if significant, will be put aside for the 2015 model. By doing so, it allows us to have the same model for 2015 and 2019 and therefore makes the comparison between the factors of the two MLR's possible. Furthermore, the SDGI and the EPI were both used as a proxy for environmental regulations stringency which can make the inclusion of both in the same model redundant. For both models, the linearity, the homoscedasticity and the normality assumptions of the residuals are verified, hence making them valid.

- *2015 model*

Table 13 displays the different values for the betas (parameter estimate) as well as their significance.

2015 Model					
Variable	**Parameter estimate**	**DF**	**Standard error**	**t Value**	**Pr > |t|**
Intercept	**0,77229**	1	4,65177	0,17	**0,8686**
Log GDP	**1,02991**	1	0,13506	7,63	**<,0001**
Log Distance	**-1,6989**	1	0,48983	-3,47	**0,0009**
EPI	**-0,08277**	1	0,01896	-4,37	**<,0001**

Table 13: Results of the MLR for the 2015 model.

Hence the MLR for 2015 can be written as follow (5):

$$Log\,\widehat{T_i} = 0{,}77229 + 1{,}02991\,Log\,G_i - 1{,}6989\,Log\,D_i - 0{,}08277\,EPI_i \quad (6)$$

We can therefore see that the amount of plastic wastes shipped to a foreign country i by the USA in 2015 is positively related to the size of the of the country i, but negatively related to the distance USA - country i and to the Environmental Performance Index of country i.

The interpretation of each coefficient is different depending on the transformation conducted. First of all, it is important to note that the intercept has a p-value of 0,86 and is therefore not significant. It hence implies that this model cannot be used for prediction purposes but only to assess the influence of each variable on T_i. Regarding the influence of the size of the economy i on the dependent variable, the results in table 13 indicate that a 1% change in the GDP for country i is expected to influence the amount of plastic wastes shipped to this country, T_i, by +1,02991%. For the distance between country i and the USA, an increase (decrease) in the distance of 1% would be expected to induce a 1,6989% decrease (increase) in the amount of wastes imported by this country. Finally, for the EPI, a change of this variable by 1 unit is expected to cause a change of 8,27% in T_i.

These results are hence in line with what can be read in the literature and tend to show that these factors play a significant role to explain the patterns of the plastic waste trade in 2015. Furthermore, the negative relationship between the EPI and T_i indicates that the waste haven effect was still effective in 2015 given that a deterioration of one unit of the index for a country i is expected to induce an increase of 8,27% of its imports of plastic wastes from the USA. In other words, it means that the USA is shipping its plastic wastes to countries with low environmental regulations where disposal costs tend to be cheaper.

- *2019 model*

Table 14 displays the results for the 2019 MLR.

2019 Model					
Variable	**Parameter estimate**	**DF**	**Standard error**	**t Value**	**Pr > |t|**
Intercept	**3,13626**	1	4,04942	0,77	**0,4409**
Log GDP	**0,92323**	1	0,11469	8,05	**<,0001**
Log Distance	**-1,59095**	1	0,42167	-3,77	**0,0003**
EPI	**-0,06981**	1	0,01666	-4,19	**<,0001**

Table 14: Results of the MLR for the 2019 model.

As for 2015, the MLR for 2019 can written as follow (7) :

$$Log\,\widehat{T_i} = 3{,}13626 + 0{,}92323\,Log\,G_i - 1{,}59095\,Log\,D_i - 0{,}06981\,EPI_i \quad (7)$$

Here again, the amount of wastes shipped by the USA to a foreign country is positively related to the size of this country's economy, but negatively related to the distance separating it from the USA and negatively related to its Environmental Performance Index. As it was the case for the 2015 model, the intercept has a p-value superior to 5% and therefore this model can only be employed to estimate the influence of each explanatory variable on T_i and is not suitable to make predictions.

According to the results in table 14, a 1% change in the GDP for a country i would be expected to influence this country's plastic wastes imports from the USA by +0,92323%. Furthermore, a change of 1% in the distance between country i and the USA, according to the model, would cause a variation of -1,59095% of T_i. Finally, if the EPI of country i changes by 1%, the plastic wastes imports made by this country are expected to change by +6,981%. The results for 2019 are hence still consistent with what was presented by Kellenberg (2012) and are similar to those observed in 2015.

- *Evolution of the parameters between 2015 and 2019*

As displayed in table 15, the coefficient for each variable of the two MLR's has changed during the last five years.

Variable	Parameter estimate 2015	Parameter estimate 2019	Difference
Intercept	0,77229	3,13626	-
Log GDP	1,02991	0,92323	-0,10668
Log Distance	-1,69890	-1,59095	0,10795
EPI	-0,08277	-0,06981	0,01296

Table 15: Evolution of the parameters between 2015 and 2019.

The GDP variable seems to have a smaller effect on T_i in 2019 than it was the case in 2015, with a decrease of -0,10668 during the 5 years period, showing signs that the USA has been shipping to smaller economies in 2019. The same observation can be made for the Distance

variable, with a decrease of respectively 0,10795 for the same period. This hence shows that the amount of plastic wastes shipped to a country i is less sensitive to the distance between the USA and this country, suggesting that greater distances are traveled before container ships reach their destinations. However, this finding is surprising as Canada, a close neighbour of the USA, has imported a significantly higher share of plastic wastes than it did in 2015.

Regarding the Environmental Performance Index, results are similar. Between 2015 and 2019, the influence of this variable has indeed decreased by 0,01296. In other words, it means that a decrease of 1 unit of the EPI of a country i is expected to induce an increase of T_i that is 1,296% lower in 2019 that it would have been the case in 2015. Even if the waste haven effect still explains the dynamics of the plastic wastes trade, this result is however indicating that its influence has reduced in the last five years. These findings are consistent with the observations made in the previous sections, where China and countries in South East Asia such as Vietnam or Indonesia, which have a relatively lower EPI than the average, have reduced their imports of plastic wastes between 2015 and 2019. This result is encouraging as it shows that the USA has shipped its plastic wastes to destinations with an EPI higher in 2019 than in 2015, implying that these wastes have been handled in better conditions.

5. Conclusion

With globalization, wastes of all kinds have been traded around the world at an increasing pace for more than two decades, with the USA and China accounting respectively for the biggest share of all the exports and imports. This trade could be considered as having a positive effect on the global quality of life around the globe assuming perfect market conditions, as it would allow wastes to flow from countries less equipped to properly handle these wastes to economies with more advanced technologies and capacity. Furthermore, shipping wastes to foreign destinations for recycling purposes can also reduce the volume of virgin material that needs to be sourced in order to meet our consumption levels and can hence limit Human's impact on planet resources. However, these assumptions are not always valid and can make the international trade of wastes a devastating process for both the environment and human health, given that destination countries often lack the adequate infrastructure to properly handle imported wastes. Numerous studies indeed show that wastes tend to flow to countries with lower environmental regulations, which are often not properly equipped to safely recycled or dispose of the material, leading to severe environmental problems for these countries. Furthermore, while some wastes, such as metal or paper, have high recycling properties and can as a result be reused as inputs for the production of downstream goods, others, such as plastic wastes, do not show the same properties and generate significant negative externalities during the disposal or recycling process. For this category of wastes, exports to foreign countries can thus be summarized as transferring the negative externalities, such as air, land and water pollution involved in the disposal process in order to avoid them in the exporting country, raising questions on the fairness of this trade.

However, China, the biggest wastes importer of all time, has gradually restricted its imports of plastic wastes since 2013 to reach an almost complete ban in 2018, called the "National Sword". This new policy has completely disrupted the plastic waste trade and left the USA, which was directing 65% of all its plastic wastes exports to China and Hong Kong in 2015, with a growing pile of trash. In 2018, plastic wastes flows have first been redirected to countries in South East Asia, particularly in Vietnam, Malaysia or Indonesia where low environmental regulations and the proximity with China made these countries attractive for plastic wastes

exports. Southeast Asian countries, lacking adequate disposal and recycling infrastructure, have witnessed the dramatic impact of plastic wastes imports in poor scrapping conditions. However, these countries quickly reacted and their import levels in 2019 are now lower than they were in 2015. As a consequence, the USA has to find a solution to dispose of its increasing volume of plastic wastes piling up within its border, as its major export destination, Canada, only imports a fraction of what the USA is producing.

The disruption caused by the Chinese Import Ban on the US exports of plastic wastes hence raises questions over the evolution of the influence that factors, such as the size of the importing country's economy, its distance from the USA and its Environmental Performance Index (EPI), have on the amount of plastic wastes it is importing. Results for both 2015 and 2019 are consistent with what is presented in the literature, as the volume of wastes imported by a country is positively related to its GDP, but negatively related to its distance from the USA and to its Environmental Performance Index. Furthermore, by comparing the same model for the 2015 and 2019 data, we can see that the influence of these factors has evolved over time. Most importantly, a decrease of 1 unit in the EPI of a country i is expected to induce an increase of its plastic wastes imports that is 1,296% lower in 2019 that it would have been in 2015. These results tend to suggest that the waste haven effect, although still being one of the main factors explaining the patterns observed in the international trade of wastes, seems to have a reduced influence on the plastic wastes exports decisions taken by the USA than it was in 2015.

To conclude, the plastic wastes exports of the USA, and more globally the international plastic wastes trade is reaching a turning point. The Chinese import ban as well as the introduction of plastic wastes under the scope of the Basel Convention are putting this industry under pressure. Plastic wastes producing countries are now running out of export options and trash is starting to accumulate within their borders, raising the attention of their citizens. We can therefore hope to be at a crucial moment, where people realize the shocking truth that is hidden behind their garbage can and decide to take actions towards the plastic producing industries to live in a more sustainable world.

Bibliography

Baggs, J. (2009). International Trade in Hazardous Waste. *Review of International Economics, 17(1)*.

Basel Action Network. (2019, Mai 10). *Basel Convention Agrees to Control Plastic Waste Trade*. Consulté le Mai 5, 2020, sur Basel Action Network: https://www.ban.org/news/2019/5/10/basel-convention-agrees-to-control-plastic-waste-trade

Bogmans, C., & Withagen, C. (2010). The Pollution Haven Hypothesis, a Dynamic Perspective. *Revue Economique, 61*.

Brooks, A. L., Shunli Wang, S., & Jambeck, J. R. (2018). The Chinese import ban and its impact on global plastic waste trade. *Science Advances*.

Copeland, B. R. (1991). International Trade in Waste Products in the Presence of Illegal Disposal. *Journal of Environmental Economics and Management, 20*.

European Environmant Agency. (2019). *The plastic waste trade in the circular economy.*

Flanders, W. D., DerSimonian, R., & Freedman, D. (1992). Interpretation of linear regression models that include transformations or interaction terms. *Annals of Epidemiology, 2*(5).

Geyer, R., Jambeck, J. R., & Lavender Law, K. (2017). Production, use, and fate of all plastics ever made. *Science Advances*.

Goodship, V. (2007). Plastic recycling. *Science Progress, 90*.

Hall, P. (1992). On the Removal of Skewness by Transformation. *Journal of the Royal Statistical Society: Series B (Methodological), 54*(1).

Hook, L., & Reed, J. (2018, Octobre 25). *Financial Times.* Consulté le Avril 23, 2020, sur https://www.ft.com/content/360e2524-d71a-11e8-a854-33d6f82e62f8

Isarin, N. (2014). Overview of the Challenges and Needs of Parties and Various Stakeholders in Preventing and Combating Illegal Traffic in Line with the Requirements of the Basel Convention . ENFORCE.

Joyce, C. (2019, Aout 20). *U.S. Recycling Industry Is Struggling To Figure Out A Future Without China*. Consulté le Avril 12, 2020, sur npr: https://www.npr.org/2019/08/20/750864036/u-s-recycling-industry-is-struggling-to-figure-out-a-future-without-china?t=1587719618756

Kellenberg, D. (2010). Consumer Waste, Backhauling, And Pollution Havens. *Journal of Applied Economics, 13*(2).

Kellenberg, D. (2012, Janvier 11). Trading wastes. *Journal of Environmental Economics and Management*.

Kellenberg, D. (2014, May 29). Waste of Effort? International Environmental Agreements. *The association of Environmental and Ressource Economists*.

Kellenberg, D. (2015, Juin 6). The Economics of the International Trade of Waste. *Annual Review of Resource Economics*, pp. 109-125.

Kellogg, H. (1976). The role of recycling in conservation of metals and energy. *Journal of Metals, 29*(32).

Leung, H. (2019, Juin 2). *Time.* Consulté le Avril 25, 2020, sur Time: https://time.com/5598032/southeast-asia-plastic-waste-malaysia-philippines/

Manfredi, S., Tonini, D., & Christensen, T. H. (2011). Environmental assessment of different management options for individual waste fractions by means of life-cycle assessment modelling. *Resources, Conservation and Recycling, 55*.

Mazzanti, M., & Zoboli, R. (2013). International waste trade: impacts and drivers. Dans M. M. Alessio D'Amato, *Waste Management in Spatial Environments.*

McCormick, E., Murray, B., Fonbuena, C., Kijewski, L., Saraçoğlu, G., Fullerton, J., . . . Simmonds, C. (2019, Juin 17). *Where does your plastic go? Global investigation reveals America's dirty secret*. Consulté le Avril 13, 2020, sur The Guardian: https://www.theguardian.com/us-news/2019/jun/17/recycled-plastic-america-global-crisis

McCormick, E., Simmonds, C., Glenza, J., & Gammon, K. (2019, Juin 21). *Americans' plastic recycling is dumped in landfills, investigation shows*. Consulté le Avril 10, 2020, sur The Guardian: https://www.theguardian.com/us-news/2019/jun/21/us-plastic-recycling-landfills

Parker, L. (2019, Mai 10). *Shipping plastic waste to poor countries just got harder*. Consulté le Avril 10, 2020, sur National Geographic: https://www.nationalgeographic.com/environment/2019/05/shipping-plastic-waste-to-poor-countires-just-got-harder/

Parker, L. (2019, Mars 25). *The world agrees there's a plastic waste crisis—can it agree on a solution?* Consulté le Avril 9, 2020, sur National Geographic: https://www.nationalgeographic.com/environment/2019/03/un-environment-plastic-pollution-negotiations/

Parker, L., & Elliott, K. (2018, Juin 20). *Plastic Recycling Is Broken. Here's How to Fix It.* Consulté le Avril 12, 2020, sur National Geographic: https://www.nationalgeographic.com/news/2018/06/china-plastic-recycling-ban-solutions-science-environment/

Tinbergen, J. (1964). Shaping the World Economy: Suggestions for an International Economic Policy. *American Journal of Agricultural Economic, 46*(1).

Villalba, G., Segarra, M., Chimenos, J., & Espiell, F. (2004). Using the recyclability index of materials as a tool for design for disassembly. *Ecological Economics, 50*.

Villalba, G., Segarra, M., Fernàndez, A., Chimenos, J., & Espiell, F. (2002). A proposal for quantifying the recyclability of materials. *Resources, Conservation and Recycling, 37*.

Villalba, G., Segarra, M., Fernandez, A., Chimenos, J., & Espiell, F. (2002). A proposal for quantifying the recyclability of materials. *Resources, Conservation and Recycling, 37*.

Villanueva, A., & Wenzel, H. (2007). Paper waste – Recycling, incineration or landfilling? A review of existing life cycle assessments. *Waste Management, 27*.

Zero Waste Europe. (2018). *Changing trends in plastic waste trade.*

Appendices

Appendix 1: Waste code and description according to the 6-digit HS

Commodity Code	Commodity Description
251720	Macadam of slag/dross/sim. industrial waste
252530	Mica waste
261900	Slag, dross (excl. granulated slag), scalings & oth. waste from mfr.
262110	Ash & residues from the incineration of municipal waste
271091	Waste oils cont. polychlorinated biphenyls (PCBs)
271099	Waste oils other than those cont. polychlorinated biphenyls (PCBs)
300680	Waste pharmaceuticals
382510	Municipal waste
382530	Clinical waste
382541	Halogenated waste organic solvents
382549	Waste organic solvents other than halogenated waste organic solvents
382550	Wastes of metal pickling liquors, hydraulic fluids, brake fluids, etc.
382561	Wastes from chem./allied industries, mainly cont. organic constituents
382569	Wastes from chem./allied industries, n.e.s. in Ch.38
382590	Residual prods. of the chem./allied industries, n.e.s. in Ch.38
391510	Waste, parings & scrap, of polymers of ethylene
391520	Waste, parings & scrap, of polymers of styrene
391530	Waste, parings & scrap, of polymers of vinyl chloride
391590	Waste, parings & scrap, of plastics n.e.s. in 39.15
400400	Waste, parings & scrap, of rubber (excl. hard rubber)
411520	Parings & oth. waste of leather/composition leather, not suit. for mfr.
440130	Sawdust & wood waste & scrap
450190	Waste cork; crushed/granulated/ground cork
470710	Recovered (waste & scrap) unbleached kraft paper/paperboard
470720	Recovered (waste & scrap) paper/paperboard mainly of bleached chem.
470730	Recovered (waste & scrap) paper/paperboard made mainly of mech. Pulp
470790	Recovered (waste & scrap) paper/paperboard (excl. of 4707.10-4707.30)
500310	Silk waste (incl. cocoons unsuit. for reeling, yarn waste & garnetted stock)
500390	Silk waste, carded or combed
510320	Waste of wool/of fine animal hair, incl. yarn waste
510330	Waste of coarse animal hair
520210	Yarn waste (incl. thread waste), of cotton
520299	Cotton waste other than yarn waste
550510	Waste (incl. noils, yarn waste & garnetted stock) of synth. fibers
550520	Waste (incl. noils, yarn waste & garnetted stock) of art. Fibers
711291	Waste & scrap of gold, incl. metal clad with gold
711299	Waste & scrap of precious metal/metal clad with precious metal
720410	Waste & scrap of cast iron
720421	Waste & scrap of stainless steel
720429	Waste & scrap of alloy steel other than stainless steel
720430	Waste & scrap of tinned iron/steel

720441	Ferrous turnings, shavings, chips, milling waste, sawdust, filings
720449	Ferrous waste & scrap (excl. of 7204.10-7204.41)
740400	Copper waste & scrap
750300	Nickel waste & scrap
760200	Aluminum waste & scrap
780200	Lead waste & scrap
790200	Zinc waste & scrap
800200	Tin waste & scrap
810197	Tungsten (wolfram) waste & scrap
810297	Molybdenum waste & scrap
810330	Tantalum waste & scrap
810420	Magnesium waste & scrap
810530	Cobalt waste & scrap
810600	Bismuth & arts. thereof , incl. waste & scrap
810730	Cadmium waste & scrap
810830	Titanium waste & scrap
810930	Zirconium waste & scrap
811020	Antimony waste & scrap
811213	Beryllium waste & scrap
811222	Chromium waste & scrap
854810	Waste & scrap of primary cells, primary batteries

Appendix 2: Quantity of all wastes traded (thousands of tons)

Commodity code	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
720449	84029	91354	99460	108373	133468	124837	133465	137356	146428	139496	154050	162636	160311	148009	139794	125337	128885	135552	124189
470710	11200	12843	13663	16728	20551	25325	33168	38511	41133	45809	45735	50655	55147	52362	50458	53532	53759	48651	52685
470790	11740	12243	12951	15192	18280	19581	27175	29652	27715	28688	28414	29954	29931	29156	31078	29776	30708	28427	24965
760200	7739	7164	8882	8580	10027	10971	12832	14076	14488	12745	14917	17129	16843	16249	16979	16601	16734	17189	18466
720441	11825	12746	12528	13741	15734	14636	19386	19619	18969	14781	16954	18742	18843	17452	19177	16600	16812	15577	16522
470730	10845	12672	12805	15628	19221	19229	24393	26316	26835	24420	25794	28566	25814	24086	22269	22069	21301	17271	12137
740400	8005	8193	8451	9015	11721	11971	12892	13922	13340	10536	12790	13762	14236	15499	16942	12978	11510	12190	10986
720429	3935	4214	4434	5747	9967	7721	12145	11572	11220	9375	10311	13582	13514	9956	11892	10154	16861	10987	9719
720421	6271	5380	6454	6521	7975	8523	10969	11036	10242	7836	10423	10696	10229	9927	10640	9544	9533	9962	9391
391590	6231	6198	6409	6329	11003	11491	13390	14755	15486	16633	18283	18111	18266	16202	18218	17251	16165	13401	7763
720410	3915	3761	4289	5534	7468	7774	12432	10747	10176	6950	8360	9693	8735	7737	6591	5185	5649	6601	7539
470720	3539	3470	3514	3622	4028	4174	5834	6164	5782	6613	6980	7842	7335	6811	6239	6159	6559	6374	6721
261900	6632	7233	7147	7641	9426	10409	9638	11644	12839	8924	11941	17141	16167	17076	14253	10587	11398	9411	6412
391510	2138	2586	3211	5096	5339	5996	7431	8380	8578	8835	9550	10033	10224	9503	11347	10384	9246	7796	5607
720430	2906	2743	3239	2693	4603	4438	4746	5911	6008	4775	5665	7380	6973	5684	6074	5907	4063	5340	5182
400400	580	771	970	1177	1251	1170	1156	1072	1300	2691	1661	1741	1974	2061	2568	2345	2497	2526	3285
382510	0	0	217	432	565	725	989	627	617	886	895	1466	1627	1782	2336	2748	2864	3341	2534
251720	3810	3542	3082	3078	3553	3571	4232	3865	4075	2222	1982	1986	2050	2622	4096	3042	1947	2013	2102
854810	531	576	629	576	970	1345	1869	1672	1284	1202	1755	3198	2385	2453	2574	2383	1980	1815	1874
271099	29	27	1019	753	852	947	1812	1793	1195	1675	2055	2789	1975	1860	2113	9728	2231	4118	1461
382590	0	0	200	276	302	266	361	283	423	597	591	1097	639	1129	1103	923	1158	1233	1323
780200	511	559	501	493	511	527	659	759	731	697	663	622	616	621	965	1404	1670	803	783
711299	0	0	69	62	138	95	137	170	221	186	209	320	330	417	537	592	703	633	777
790200	710	625	670	613	694	753	909	730	516	510	674	671	716	819	876	745	751	746	717
262110	0	0	1267	823	1384	930	1061	2122	1187	1084	865	1070	2119	1129	1195	1268	1191	1130	669
391530	754	848	805	904	1672	2107	2427	2391	3109	3304	3056	2350	1770	1416	1502	1212	1182	1006	644
382569	0	0	56	119	175	201	195	197	186	224	537	692	721	424	720	1204	1294	1171	630
391520	754	758	920	877	1212	1245	1155	1130	1091	1060	1313	1112	1129	1127	1019	862	932	979	598
520299	504	512	522	652	715	629	752	744	610	530	755	594	634	5523	576	623	640	836	533
550510	744	620	665	740	813	646	640	666	604	496	604	593	539	524	513	492	500	530	466
750300	224	197	386	206	194	204	277	303	247	182	261	231	255	227	280	244	260	243	322
382561	0	0	18	27	79	47	62	69	112	459	444	853	213	168	184	118	237	146	265
450190	123	118	114	134	124	122	132	120	109	108	100	122	146	156	157	145	137	114	208
800200	47	55	55	34	59	83	112	144	144	271	252	266	253	214	203	122	111	154	162
810830	0	0	49	40	64	94	79	70	67	43	59	75	75	74	99	109	110	149	146
520210	201	219	180	252	268	256	334	314	247	202	263	234	244	259	209	177	186	200	117
810420	95	122	123	128	129	120	114	126	131	90	248	116	109	105	103	112	102	105	104
411520	0	0	225	234	387	310	264	269	252	208	193	205	182	155	180	151	135	115	101
382549	0	0	17	46	48	42	32	22	29	22	94	113	94	163	146	142	90	78	84
382550	0	0	8	10	21	12	15	59	81	42	64	76	75	95	63	116	322	85	65
252530	19	18	17	32	33	38	44	43	124	35	36	52	43	56	64	40	45	54	62
711291	0	0	8	6	7	90	8	8	7	22	19	24	31	28	35	151	44	90	51
810197	0	0	24	15	21	26	22	22	26	17	23	32	29	30	48	32	31	38	37
550520	57	50	47	52	42	42	56	61	46	43	49	53	50	42	36	31	33	36	30
811222	0	0	12	15	20	22	32	46	47	59	45	43	28	27	20	23	23	22	26
810530	0	0	10	14	14	10	7	11	14	8	9	12	11	10	12	9	12	15	23
810600	20	15	22	22	22	24	45	23	19	14	18	20	15	17	21	17	21	22	23
510320	58	49	49	43	40	37	34	34	26	20	29	29	27	26	24	24	21	19	22
271091	483	0	87	19	26	24	32	76	55	30	116	122	152	492	298	24	30	72	13
810297	0	0	6	9	8	10	11	13	11	9	13	14	12	11	14	12	11	12	13
811020	0	0	0	2	22	2	4	4	4	4	6	5	7	8	7	6	5	4	4
810330	0	0	15	1	1	1	1	2	2	1	3	4	2	3	3	3	3	4	3
810930	0	0	1	1	1	1	1	2	2	2	6	2	1	2	2	2	3	2	2
382541	0	0	3	7	8	7	7	8	6	8	15	10	22	17	24	27	27	6	2
382530	0	0	6	2	1	1	2	1	3	1	1	1	3	1	18	2	3	3	1
510330	2	1	2	2	2	1	3	3	2	1	2	2	2	2	2	1	1	1	1
811213	0	0	0	0	1	1	3	1	0	0	0	0	0	1	1	2	1	19	0
440130	8465	9724	12381	11181	14049	16523	20711	22315	23302	23764	28665	32358	502	347	47	33	23	0	0
810730	0	0	0	0	0	0	1	1	0	0	0	0	1	1	0	0	1	0	0
300680	0	0	2	5	5	5	8	1	0	0	0	0	1	0	0	0	0	0	0
500390	12	9	11	12	8	6	10	1	0	0	0	0	0	0	0	0	0	0	0
500310	12	9	6	6	10	6	7	0	0	0	0	0	0	0	0	0	0	0	0

Appendix 3: Quantity imported by each country (thousands of tons)

Country	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
China	14201,5	21990,7	20882,0	25898,5	32272,9	39302,7	38803,0	42501,0	45183,6	56598,8	48773,2	54499,3	55388,5	53063,6	47479,2	46554,2	45576,2	41298,6	22480,9
Turkey	7576,9	5146,2	10109,4	13109,6	13052,2	13456,2	15603,5	17596,6	17988,2	15786,1	19385,9	21642,0	22583,5	19949,5	19460,9	16743,7	18437,0	22183,3	22103,1
India	2801,3	4024,5	4327,8	4455,6	9517,2	7200,4	5832,4	5613,2	6928,4	8310,4	7543,2	9432,9	11814,4	9610,6	10605,3	11562,8	11588,7	10999,8	15644,7
Germany	6816,7	7446,9	8256,4	8192,4	9887,7	10891,3	12274,0	12948,5	9739,2	8791,8	13364,7	14835,1	12571,6	12294,2	12343,2	11457,6	11348,1	12258,6	11762,3
Rep. of Korea	9263,0	8899,7	9714,3	8729,3	10857,0	9444,9	8219,2	10185,1	10788,5	10501,0	11005,5	11952,9	13571,2	12868,2	11622,7	9412,0	9799,2	10689,9	10184,3
USA	992,0	961,2	1257,2	945,4	1175,9	1446,5	7572,7	6672,5	6166,7	4989,9	6335,9	6950,6	6315,3	6189,3	5622,6	5727,3	6281,6	7238,7	7860,2
Netherlands	5478,3	5211,4	5537,2	6535,8	7079,8	7268,1	8006,9	7163,5	7518,7	3805,9	7249,8	8669,3	6639,3	6763,4	7643,5	6195,7	6752,3	7982,3	7817,9
Taiwan	3355,0	3415,8	4120,3	4602,7	4257,1	4504,1	5687,9	6899,0	6846,4	4968,1	6407,1	6358,6	6251,4	5713,0	454,4	4385,6	4252,4	4462,3	5688,5
Indonesia	3777,0	4005,5	3610,8	3016,4	3646,2	3227,8	3245,4	3583,7	4071,9	3822,7	4160,2	4643,3	4408,4	4823,9	4596,3	2903,4	3264,8	4043,1	5327,2
Belgium	5246,5	5395,9	6085,4	6736,8	8038,8	7168,6	8401,1	9395,4	9260,9	9421,6	9751,3	9740,0	7755,1	7659,0	7590,3	6763,0	7005,3	6623,8	5210,0
Mexico	3611,0	3222,0	3449,0	3325,9	5303,7	3381,8	3317,2	3886,6	3047,4	2549,1	2808,8	3077,7	3052,8	2974,6	3326,6	3763,7	4268,2	4407,9	4608,7
Spain	7043,8	7356,1	6557,2	7488,3	8393,6	8158,7	9034,4	8249,3	8250,1	6252,4	7880,8	6539,2	6126,1	7002,7	7054,2	7424,3	6355,7	4668,5	4468,5
Italy	6249,9	6621,6	6235,9	6835,9	8300,4	8033,2	8382,8	7984,7	8152,9	5561,7	7485,4	9089,1	6493,9	6167,6	6442,7	5556,4	5439,1	1132,1	3334,2
Austria	1863,7	2042,0	2217,8	2373,5	2703,3	2954,9	3595,9	3954,9	4206,9	3409,2	3600,6	3826,0	2291,4	2593,8	3119,4	3098,8	2974,7	2548,1	3324,4
France	6239,1	5707,8	5645,5	5781,6	6549,0	5874,5	6319,3	6199,1	6113,8	5210,9	5852,4	6018,1	5469,2	4997,7	5338,1	5076,0	4586,0	1995,2	3294,7
Malaysia	1975,2	2623,5	4060,1	300,4	2533,9	2280,8	4294,8	3962,9	3557,5	2045,6	2725,9	2560,8	2389,2	2550,1	1533,1	1055,4	1159,0	2031,0	2959,1
Egypt	512,1	438,5	626,0	316,2	568,7	793,9	1763,7	981,7	2502,5	900,3	1757,5	2300,7	2106,9	5658,2	2144,3	867,9	865,0	2041,2	2730,0
Thailand	1736,7	2441,0	1959,7	2437,5	2847,0	2681,6	2557,7	3090,0	3976,8	2513,7	2588,7	3060,9	2798,7	1989,9	2460,6	1785,4	1532,9	2630,5	2435,3
Pakistan	0,0	0,0	0,0	671,8	764,8	1474,6	1544,4	2358,9	2092,8	2522,2	2053,7	1896,5	2087,9	2073,8	2816,4	3581,1	4358,4	2229,8	2185,6
Portugal	353,4	281,8	387,3	552,1	577,3	1114,4	1243,5	1233,2	1299,8	1166,2	1111,0	1447,0	1327,7	1564,8	1740,0	1613,5	1704,4	628,6	2106,5
Poland	196,6	128,0	119,7	143,1	402,0	486,3	529,2	730,2	1102,7	1067,3	1164,1	1420,9	1169,5	1443,1	1459,3	1698,4	1806,7	1724,7	1997,7
Sweden	1629,2	1543,5	1678,8	1816,9	1894,9	1983,9	2299,9	2150,0	2326,7	2734,7	3541,3	3848,7	1976,9	1968,1	2052,5	2124,1	1675,6	1838,8	1682,4
Belarus	1224,5	832,2	906,9	1242,0	1335,5	1257,1	1573,8	1530,0	1533,9	1333,0	1690,3	1658,3	1467,3	1353,4	1311,6	1402,5	1266,8	1399,9	1573,3
Hong Kong	2126,7	1961,0	2400,2	2772,8	3290,7	4112,4	5133,5	4995,7	5448,5	5611,5	5683,4	4791,0	3879,1	3063,8	3602,6	3352,0	3315,6	2422,5	1251,6
Greece	350,3	829,5	1235,2	1186,9	1275,8	1655,0	1703,9	1814,3	1585,7	1220,2	1119,9	1160,7	600,5	464,4	629,7	616,0	1001,2	1042,1	1135,9
Slovenia	575,9	581,4	628,7	690,5	902,5	977,4	1090,2	1056,6	1138,4	1016,0	1312,0	1379,3	1057,5	1043,3	1146,8	1129,1	1162,3	240,6	964,0
Japan	1607,9	1278,0	1243,0	1141,1	986,7	1118,7	1172,4	1378,1	1725,9	1038,2	1572,2	1699,7	1278,0	1535,1	1679,7	1201,8	1271,4	892,4	922,8
Czechia	318,3	503,0	507,1	640,7	751,3	564,7	740,9	751,5	759,0	674,2	781,0	996,5	902,0	943,6	991,3	884,8	911,4	736,6	852,0
Russian Federation	447,9	187,9	182,4	489,7	237,9	198,5	278,1	436,5	449,0	245,7	68,3	84,6	126,1	238,2	433,5	375,1	7114,1	924,4	803,0
Switzerland	828,7	747,3	888,5	1011,9	1139,7	1044,7	1360,5	1110,6	1082,0	841,1	1099,1	1315,2	1092,6	1225,4	1222,6	1328,9	1426,5	674,8	802,2
Hungary	177,1	213,6	222,5	241,1	347,4	435,4	520,5	638,3	493,4	274,0	706,2	762,9	630,1	730,5	633,3	675,4	703,0	827,9	772,7
Canada	586,3	599,4	630,3	4050,6	4849,3	4728,6	4835,8	4786,2	4727,7	4110,0	5576,1	4914,4	4643,3	3731,1	4318,6	675,7	1036,8	617,9	651,7
Luxembourg	3441,4	3882,1	4470,6	3997,4	4679,9	2603,9	3653,1	3512,9	3053,6	2236,4	2917,0	2906,1	2859,4	2498,7	2574,7	2802,9	3228,5	2737,5	577,9
Peru	22,0	45,0	41,6	110,4	198,3	171,3	138,7	106,5	220,1	211,3	411,0	256,2	45,3	458,4	400,5	484,1	441,8	599,2	573,2
Ukraine	152,8	120,2	114,0	165,3	192,4	814,9	205,3	235,1	365,9	248,3	262,3	439,9	426,7	581,0	384,5	368,2	325,9	426,5	533,6
Slovakia	389,8	536,2	640,4	528,4	395,7	442,0	405,8	447,3	365,9	415,9	351,0	228,4	393,5	482,7	387,4	246,1	244,8	447,0	525,4
Morocco	43,0	30,9	42,2	59,9	69,1	99,0	94,0	211,2	321,3	386,7	237,3	482,6	532,3	439,9	559,7	738,3	421,8	641,7	516,5
United Kingdom	963,5	699,5	778,9	815,5	874,7	1123,4	1055,9	1343,3	1766,9	1110,5	1712,7	2485,1	838,7	917,3	970,9	982,6	808,2	843,9	444,1
Brazil	70,2	46,7	49,8	101,3	114,6	193,2	178,3	256,3	225,4	153,4	260,1	190,6	138,5	132,3	139,8	133,7	145,6	139,3	442,1
Bulgaria	124,6	8,5	94,5	124,0	154,2	193,9	215,5	345,6	316,5	254,3	351,1	330,9	233,4	226,5	268,6	278,3	273,2	325,2	375,0
Singapore	368,4	289,0	226,8	374,2	427,8	323,9	513,9	475,3	484,7	330,7	377,2	436,9	408,8	302,0	218,4	150,6	169,3	182,7	353,3
Romania	17,3	14,9	14,8	25,7	15,1	12,3	21,3	32,5	46,5	24,3	108,9	103,7	158,2	161,9	146,0	160,9	278,2	344,1	337,9
United Arab Emirates	0,0	0,0	0,0	0,0	0,0	219,5	0,0	275,4	282,1	0,0	0,0	0,0	369,5	376,0	460,0	231,0	259,9	245,7	337,6
Ecuador	25,2	5,4	4,3	14,2	37,0	17,2	16,3	19,4	22,1	32,4	86,2	152,3	156,2	274,0	312,9	250,3	226,7	345,5	335,5
Lithuania	63,2	81,6	160,6	101,5	172,8	210,1	270,1	315,4	280,1	262,9	314,8	423,2	226,3	179,3	184,8	175,4	179,6	219,5	334,9
Norway	848,9	882,5	957,7	983,2	912,7	760,0	703,4	744,7	505,0	372,0	585,1	598,8	569,5	539,2	472,4	441,4	515,4	479,0	308,0
Denmark	674,0	806,1	967,0	938,2	1460,5	1508,7	1424,1	1206,7	1552,0	2749,2	2108,3	2849,9	616,8	624,8	794,4	731,0	441,3	378,5	301,9
Croatia	125,1	135,8	124,2	142,8	144,0	162,9	144,4	169,9	154,6	101,1	159,1	186,8	99,8	148,2	232,0	210,2	272,6	0,0	259,1
South Africa	109,6	102,3	123,0	166,8	115,9	120,8	97,6	129,8	163,2	125,3	237,5	240,8	185,3	178,6	228,9	220,6	361,7	250,8	247,1
Latvia	231,2	195,6	201,0	207,1	219,9	224,0	341,0	430,6	507,7	264,4	550,0	561,2	1201,2	601,1	522,0	730,8	189,3	188,9	246,8
North Macedonia	8,5	16,3	25,4	65,7	136,0	273,7	286,5	317,7	271,7	18,7	310,2	358,0	196,4	106,5	194,4	104,6	124,4	262,5	225,9
Serbia	0,0	0,0	0,0	0,0	0,0	49,7	24,8	32,5	73,4	37,9	93,0	98,8	152,2	244,6	241,4	221,2	174,3	161,7	224,7
Kuwait	0,3	0,1	0,3	2,2	26,7	0,0	5,5	2,1	4,0	0,0	25,2	8,6	0,0	32,2	180,0	4,9	5,7	372,9	194,7
Uzbekistan	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	118,0	194,5
Estonia	275,9	45,1	33,0	107,7	150,7	271,4	374,7	204,8	159,4	118,3	132,9	97,4	274,8	189,3	133,7	91,6	101,3	144,1	188,2
Philippines	499,0	498,3	506,8	647,2	555,8	332,9	365,8	273,0	194,5	143,7	177,6	926,5	129,1	108,7	118,4	144,3	257,7	132,7	182,9
Colombia	193,5	143,4	165,8	191,3	203,7	306,9	444,2	450,0	327,9	165,2	137,4	155,5	192,2	215,0	141,1	158,3	186,7	162,2	169,4
Saudi Arabia	64,5	16,7	23,1	26,6	23,5	120,4	158,8	200,9	255,2	185,4	256,2	208,6	275,3	87,5	433,8	417,0	184,7	185,8	159,5
Oman	1,5	1,0	15,1	7,2	239,6	122,0	40,0	16,0	42,9	154,8	217,8	158,7	144,0	145,6	172,3	117,1	98,1	160,5	148,5
Finland	847,1	798,8	716,2	1037,3	1142,0	1046,2	1346,4	1024,2	1102,2	1052,6	1260,6	1191,6	190,7	658,6	892,2	213,0	258,3	116,9	126,6

Ireland	201,6	145,2	121,3	108,5	90,1	107,2	127,8	154,1	130,6	120,1	137,7	130,8	102,8	109,8	108,5	30,7	20,8	34,2	116,5
Jordan	10,2	5,2	16,0	32,0	56,0	33,1	5,5	5,5	14,7	8,5	21,7	79,4	67,9	43,7	62,8	48,7	64,4	102,2	108,1
Aruba	0,0	0,0	0,0	0,0	0,0	8,0	0,0	0,0	0,0	90,2	91,0	95,9	91,2	1,4	92,5	93,8	90,2	95,9	91,5
Australia	160,5	228,7	114,0	110,6	112,4	95,6	148,0	171,4	121,6	25,5	60,7	31,8	76,3	32,8	60,4	48,6	112,9	78,9	91,3
El Salvador	41,1	57,2	83,3	116,6	105,3	98,1	134,1	120,5	125,7	117,8	134,6	102,3	169,2	169,4	102,2	156,1	90,8	75,3	74,8
Uganda	0,1	0,3	1,6	0,6	0,5	1,5	1,1	16,3	20,2	23,4	32,2	30,6	31,0	25,9	36,1	45,0	49,1	175,8	69,8
Argentina	18,2	20,4	50,9	22,6	40,2	66,6	64,8	97,2	69,7	46,8	70,5	58,2	33,2	41,0	64,7	87,1	51,9	34,6	56,3
Nicaragua	3,2	2,5	3,6	3,6	4,1	2,3	2,3	3,0	1,9	1,1	1,9	1,6	2,2	1,8	1,4	1,1	1,3	1,3	44,6
Azerbaijan	3,3	7,9	0,1	4,0	1,0	0,9	10,9	3,6	29,4	58,3	20,4	13,3	109,3	13,3	22,5	16,6	10,6	5,5	43,5
Bosnia Herzegovina	0,0	0,0	0,0	31,3	60,6	152,3	243,4	339,2	246,8	37,4	22,7	18,6	11,9	14,8	15,7	27,6	26,9	17,5	42,2
Madagascar	3,8	3,9	3,0	3,7	2,9	1,8	0,6	0,7	1,0	1,1	0,9	2,5	4,5	1,0	38,4	59,2	63,8	60,6	42,0
Nigeria	6,6	3,8	2,6	3,1	0,0	0,0	24,4	47,3	67,9	53,3	153,1	23,5	27,6	14,9	124,1	0,0	118,6	120,5	40,5
Kazakhstan	21,9	46,6	62,8	50,0	58,8	50,4	26,9	20,0	20,8	18,1	16,2	98,3	65,9	32,3	14,5	18,0	27,3	41,2	35,5
Iceland	1,0	0,9	1,5	1,1	1,1	2,0	2,0	2,5	2,9	2,4	13,0	10,4	20,5	19,5	31,7	33,6	31,6	31,6	34,6
Costa Rica	11,8	17,4	10,2	14,1	22,4	33,4	41,7	46,6	36,3	24,5	37,8	42,3	25,6	37,1	41,9	45,7	38,5	30,9	27,8
Zambia	0,5	1,2	3,9	6,2	7,2	8,1	11,3	2,4	1,6	1,1	0,7	1,0	0,8	2,1	1,7	1,8	0,0	5,3	27,3
New Zealand	20,0	22,4	22,6	22,4	25,9	28,7	29,8	27,6	44,6	30,0	25,5	26,8	25,2	23,6	23,1	21,8	18,7	19,6	27,2
Kenya	7,5	9,5	13,5	5,6	9,7	11,3	13,9	15,0	12,4	9,5	5,5	0,0	0,0	23,5	0,0	0,0	0,0	16,0	26,9
Chile	619,9	48,6	83,9	46,4	128,4	134,4	69,5	138,9	127,7	148,3	141,4	123,4	90,9	106,1	127,5	78,7	74,5	42,0	24,3
Botswana	1,9	1,4	4,6	2,6	1,1	8,5	4,1	3,7	3,9	7,3	9,5	8,5	5,9	4,4	2,3	3,3	2,7	18,9	23,7
Paraguay	1,6	1,8	1,9	0,8	0,6	0,7	0,9	4,7	5,7	3,3	6,1	13,5	4,1	3,3	7,9	13,8	7,3	16,1	23,4
Bahrain	4,8	8,5	23,3	31,2	18,0	30,2	18,4	22,7	64,9	26,5	25,3	22,7	26,7	25,8	19,7	25,5	35,1	32,2	22,7
Israel	58,5	72,6	36,2	37,5	29,9	37,9	34,1	56,1	64,5	40,0	36,1	101,8	47,1	46,7	38,8	28,2	12,9	9,0	22,4
Qatar	17,3	19,2	18,0	0,6	0,2	150,7	104,8	86,7	83,4	0,0	45,7	0,0	0,0	64,3	69,5	196,0	150,9	96,9	21,1
Myanmar	0,0	2,3	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	1,4	2,5	7,4	13,1	7,6	37,1	21,1	16,3	18,9
CV¥te d'Ivoire	0,7	8,2	10,3	1,1	1,2	1,2	1,7	3,4	5,0	45,6	5,2	6,4	10,7	9,3	20,3	21,1	12,8	16,3	14,7
United Rep. of Tanzania	6,6	10,5	6,4	5,9	7,0	8,9	6,6	8,4	21,2	27,1	27,2	21,8	9,5	13,5	13,4	14,6	13,2	9,4	14,5
Ghana	3,0	3,8	2,5	3,3	0,0	9,1	43,9	3,9	3,3	4,5	4,8	10,5	8,4	17,1	0,0	0,0	49,8	12,8	14,0
State of Palestine	0,0	0,0	0,0	0,0	0,0	0,0	0,0	4,7	1,8	1,7	8,9	16,5	2,5	2,9	4,0	3,3	2,8	6,3	11,1
Rep. of Moldova	0,4	2,6	6,2	26,6	21,8	28,8	39,4	58,3	11,6	0,5	1,3	2,7	0,5	0,6	1,1	0,9	2,8	2,4	11,0
Benin	0,0	0,0	0,0	0,0	0,0	0,0	0,3	2,1	4,3	3,7	4,7	3,1	5,2	5,5	19,0	3,1	6,8	5,6	9,7
Uruguay	13,1	7,1	5,9	6,7	15,3	20,1	20,8	38,9	169,7	119,5	153,9	120,2	7,5	8,1	12,1	13,2	9,2	6,5	9,0
Zimbabwe	0,0	25,2	42,8	0,0	20,0	30,7	10,2	95,3	6,8	1,7	1,5	4,0	3,3	2,0	2,0	3,2	2,7	4,5	7,2
Kyrgyzstan	1,7	0,5	4,1	39,7	4,2	1,7	5,1	6,9	11,6	3,8	3,5	0,4	0,8	2,1	13,6	1,6	1,6	4,2	4,9
Afghanistan	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	4,3
Senegal	2,0	1,9	1,8	2,2	10,7	1,9	2,4	65,9	78,3	4,5	41,6	4,8	5,9	46,9	43,7	4,9	49,4	3,6	4,2
Bolivia	1,4	3,4	3,6	2,4	2,5	5,0	4,1	7,2	9,1	5,5	6,3	10,3	6,6	7,7	16,4	7,7	12,4	13,3	3,9
Namibia	0,6	0,8	0,6	0,6	1,0	0,8	1,1	1,2	1,3	1,4	1,6	1,4	1,1	0,6	0,4	0,8	1,0	3,5	3,4
Lebanon	8,2	26,5	9,7	6,4	6,5	12,0	13,5	34,2	38,4	23,5	29,2	25,3	9,0	2,6	3,3	3,8	2,1	2,5	3,2
Burkina Faso	0,9	1,2	0,7	1,9	0,5	0,7	0,0	1,0	0,5	0,8	0,8	0,9	1,4	1,7	2,2	2,1	2,1	3,2	2,9
Angola	0,0	0,0	0,0	0,0	0,0	0,0	0,0	4,8	0,0	6,5	2,5	2,3	33,7	2,4	0,9	73,7	0,2	0,4	2,7
Guyana	0,0	0,0	0,0	0,0	0,0	0,1	0,0	0,8	2,6	1,7	1,0	4,0	2,0	2,0	2,0	2,0	0,6	0,4	2,4
Malta	1,9	1,8	1,1	1,5	1,1	1,0	1,2	2,4	3,2	3,1	2,6	2,3	0,9	0,7	0,8	3,0	0,8	0,2	2,1
Mozambique	442,4	0,1	0,2	0,2	3,2	1,9	1,2	0,9	3,1	0,9	1,0	86,7	2,3	3,4	5,7	0,0	3,4	3,9	2,1
Georgia	0,3	0,9	0,4	4,0	1,5	2,3	0,6	1,2	50,7	2,7	15,0	2,1	5,0	3,7	5,4	2,3	0,4	0,8	1,9
Albania	2,5	3,3	7,7	6,5	7,1	90,0	64,4	157,5	117,0	170,2	302,5	321,2	216,8	216,1	0,4	145,6	36,7	0,0	1,5
Cyprus	0,8	1,1	1,1	16,4	1,1	1,3	0,9	1,0	1,3	2,2	3,5	1,8	0,3	0,4	1,4	11,4	0,9	0,8	1,5
Fiji	0,0	0,0	0,5	2,0	0,1	0,2	0,1	26,4	0,1	0,3	26,9	27,0	0,9	27,7	2,1	0,9	1,3	1,8	1,0
Montenegro	0,0	0,0	0,0	0,0	0,0	0,0	100,6	139,7	139,3	55,7	20,6	29,3	11,8	16,8	3,1	14,2	4,9	6,0	1,0
Brunei Darussalam	0,0	0,5	0,6	5,6	5,6	0,0	1,8	1,5	1,8	0,7	1,3	6,2	1,5	0,9	2,5	3,4	0,9	0,6	0,8
Solomon Isds	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,1	0,0	0,0	0,1	0,1	0,1	0,8
Andorra	0,0	0,1	0,0	0,0	0,0	0,0	0,0	5,4	4,4	0,0	0,1	0,1	0,0	0,0	0,0	0,0	0,0	0,0	0,8
Mongolia	0,3	0,2	0,0	1,0	3,6	3,3	0,8	0,3	0,0	0,0	0,0	0,0	0,0	0,2	0,4	3,4	0,4	0,1	0,6
Barbados	0,6	0,2	0,2	0,4	0,2	0,6	10,2	0,1	25,5	0,1	0,1	0,2	0,1	0,2	0,1	0,1	0,1	0,1	0,3
Maldives	0,0	0,2	0,0	0,0	0,0	0,0	0,0	0,0	0,1	0,0	0,0	0,0	0,3	0,1	0,1	0,2	0,2	0,1	0,3
Mauritius	0,5	0,8	1,3	0,3	1,5	2,4	1,4	1,5	0,5	1,4	1,8	1,7	2,6	1,9	0,9	0,6	0,9	0,4	0,3
Belize	0,0	0,0	0,1	0,2	0,2	0,3	0,4	0,2	0,4	0,3	0,2	1,3	1,1	0,9	2,5	0,8	0,1	0,3	0,2
Armenia	0,1	0,0	0,0	0,9	0,6	0,5	0,9	1,8	1,6	0,8	1,2	2,3	1,2	1,5	1,9	1,0	1,1	1,3	0,2
Burundi	0,1	0,2	0,1	0,0	0,0	0,0	0,0	0,0	0,0	0,2	0,0	0,6	1,2	1,5	0,8	0,6	0,8	0,5	0,2
Cabo Verde	0,0	0,0	0,0	0,0	0,0	0,1	0,2	0,5	0,0	0,4	0,0	0,0	0,0	0,0	0,0	0,1	0,0	0,0	0,2
Gambia	0,5	0,0	0,2	0,2	0,1	0,0	0,0	0,0	0,3	0,0	0,4	1,1	0,6	0,5	0,3	0,3	0,3	0,1	0,2
Seychelles	0,0	0,1	37,8	0,0	0,0	0,1	0,2	0,0	2,7	0,0	303,8	266,4	284,9	196,8	309,4	329,5	380,7	0,0	0,1
Greenland	0,0	0,0	0,1	0,0	0,0	0,1	0,0	0,1	0,1	0,1	0,0	0,1	0,0	0,0	0,0	0,1	0,0	0,4	0,1
Palau	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,1	0,8	0,1	0,1	0,0	0,0	0,0	0,1	0,0	0,1	0,0	0,1

Antigua and Barbuda	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,9	0,0	0,1
Samoa	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,1	0,0	0,1	0,1	0,0	0,0
Suriname	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,1	0,1	0,2	0,3	0,3	0,2	0,0	0,0	0,0
Bermuda	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,4	0,4	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Saint Vincent and the Grenadines	0,0	0,0	0,0	0,0	0,0	0,1	0,1	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Sao Tome and Principe	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,1	0,0	0,0
Guinea	0,0	0,0	0,0	0,0	0,1	0,3	0,1	0,0	0,2	0,0	0,0	0,0	0,0	1,4	0,5	0,7	0,0	0,0	0,0
Trinidad and Tobago	1,0	1,0	15,9	0,8	1,7	3,0	16,8	16,1	16,4	5,0	113,0	35,0	22,2	12,1	2,1	2,1	0,0	0,0	0,0
Cuba	37,4	21,2	15,7	8,2	10,5	10,4	14,5	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Ethiopia	3,8	3,8	2,6	6,7	3,3	3,0	5,1	4,1	5,7	5,9	4,0	5,0	5,2	15,5	18,4	25,3	5,3	0,0	0,0
Eswatini	60,6	75,1	73,6	74,6	34,5	5,4	15,6	15,9	0,0	0,0	0,0	0,0	0,0	29,1	46,6	49,6	39,5	39,7	0,0
Faeroe Isds	0,0	0,1	0,1	0,2	0,4	0,2	0,1	0,4	0,1	0,1	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Honduras	4,2	6,5	8,0	5,5	5,6	4,3	6,9	9,0	0,0	10,7	10,7	14,1	12,4	0,0	6,1	6,9	7,1	4,7	0,0
Mali	0,1	0,0	0,3	0,1	0,3	0,2	0,1	1,1	0,1	0,0	6,1	3,9	5,3	0,0	0,0	0,0	5,0	4,5	0,0
Central African Rep.	0,0	0,0	0,0	0,0	0,2	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Bahamas	20,9	7,5	3,5	3,2	0,7	0,8	23,3	5,3	1,7	2,2	3,5	13,8	8,1	7,4	5,0	5,7	0,0	0,0	0,0
Turks and Caicos Isds	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,1	0,1	0,0	0,0	0,0	0,0	0,0	0,0
Djibouti	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,2	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Sierra Leone	0,5	0,0	0,5	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	1,4	0,4	0,4	0,6	0,0
Panama	15,0	10,7	18,3	15,9	16,0	17,0	14,1	16,2	20,7	15,6	18,8	16,0	0,7	0,5	1,1	1,6	3,3	0,0	0,0
Mayotte	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Papua New Guinea	123,1	23,4	101,0	80,4	18,5	0,0	0,0	0,0	0,0	0,0	0,0	18,2	5,4	0,0	0,0	0,0	0,0	0,0	0,0
Cambodia	5,4	5,2	5,4	4,0	5,1	8,9	5,3	6,2	1,3	0,4	0,5	0,2	0,0	0,3	0,2	0,4	1,4	0,0	0,0
Fmr Sudan	0,2	1,7	1,0	3,5	1,3	1,6	2,0	1,7	3,0	7,7	81,3	8,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Bangladesh	98,6	156,1	106,8	105,0	143,0	459,1	714,7	984,3	712,6	666,2	422,0	460,6	338,7	372,6	0,0	1233,9	0,0	0,0	0,0
Cook Isds	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Togo	0,3	0,3	0,4	0,4	0,6	0,3	0,0	0,4	0,8	2,9	3,8	4,3	7,2	4,2	3,7	1,9	2,2	3,3	0,0
French Polynesia	0,0	0,0	0,0	0,0	0,1	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Iran	44,1	60,7	79,8	107,2	403,0	169,7	126,7	0,0	0,0	0,0	94,1	83,1	0,0	42,0	67,1	0,0	25,7	60,0	0,0
FS Micronesia	0,0	0,0	0,0	0,1	0,1	0,1	0,1	0,3	0,1	0,2	0,2	0,1	1,1	0,1	0,0	0,0	0,0	0,0	0,0
Iraq	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Gabon	0,0	0,0	0,0	0,1	0,1	0,6	1,2	0,8	1,1	5,5	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Nepal	0,0	0,0	0,0	9,7	0,0	0,0	0,0	0,0	0,0	26,8	31,9	22,3	41,9	41,5	22,5	26,8	34,0	19,4	0,0
New Caledonia	4,1	0,0	0,0	0,0	0,1	0,1	0,2	0,3	0,4	0,6	0,2	0,5	0,2	0,1	0,1	1,5	0,0	0,0	0,0
Guatemala	114,4	156,7	324,2	138,9	214,6	124,2	65,4	131,9	113,9	61,3	120,2	145,8	130,4	104,9	109,6	69,8	73,7	145,1	0,0
Mauritania	0,1	0,3	0,5	0,4	0,5	1,7	0,6	0,3	5,7	0,8	0,9	0,7	1,0	0,4	0,2	0,0	0,4	0,5	0,0
Guinea-Bissau	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Kiribati	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,1	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Dominica	0,0	0,0	0,0	0,0	0,0	0,0	0,1	0,0	0,1	0,0	0,0	0,0	0,1	0,0	0,0	0,0	0,0	0,0	0,0
Anguilla	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Sri Lanka	1,1	5,2	33,6	74,5	59,1	55,7	22,3	17,3	13,7	12,3	21,9	22,0	22,2	12,1	16,9	23,8	26,9	20,9	0,0
Malawi	0,5	0,6	0,3	0,2	0,2	0,1	0,1	0,2	0,2	0,1	0,5	0,3	0,8	0,9	0,5	0,9	0,3	0,6	0,0
Sudan	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	9,9	0,0	0,0	4,5	0,0	4,7	0,0
Rwanda	0,0	0,0	0,0	0,0	0,0	0,1	0,3	0,3	1,0	0,3	0,4	1,1	2,2	2,6	3,5	2,8	3,9	0,0	0,0
Cameroon	0,2	0,5	0,5	0,6	0,2	0,2	0,4	0,8	1,3	1,7	0,9	0,6	0,6	0,6	0,5	0,8	4,9	1,4	0,0
Saint Kitts and Nevis	0,0	0,0	0,1	0,1	0,1	0,1	0,1	0,2	0,2	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Syria	0,0	10,1	7,9	20,6	14,2	5,7	16,6	5,4	10,5	8,2	28,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Saint Lucia	0,0	0,0	0,0	0,0	0,1	0,0	0,0	0,0	0,0	0,0	0,0	0,1	0,1	0,1	0,0	0,0	0,0	0,0	0,0
Timor-Leste	0,0	0,0	0,0	0,0	0,5	0,9	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,4	0,0	0,0	0,0	0,2	0,0
Eritrea	0,0	0,0	0,0	0,8	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Tonga	0,0	0,1	0,0	0,0	0,0	0,0	0,0	0,0	0,7	0,3	4,7	0,1	0,0	0,1	0,1	0,0	0,0	0,0	0,0
Niger	0,1	0,1	0,3	0,2	0,1	0,1	0,1	0,2	0,2	0,4	0,3	0,9	0,2	0,1	0,3	0,2	0,2	0,0	0,0
Tunisia	22,3	40,6	11,0	13,6	10,8	26,1	22,5	22,1	22,5	20,5	19,1	17,5	30,7	35,9	34,5	34,4	54,3	52,9	0,0
Algeria	55,0	5,7	6,4	3,5	9,1	4,3	11,3	7,5	5,6	7,1	8,6	7,8	7,6	9,8	9,9	14,1	15,3	9,0	0,0
Turkmenistan	0,5	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Montserrat	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Tuvalu	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
China, Macao SAR	0,8	2,0	3,4	4,4	5,2	48,1	95,6	18,8	18,0	11,9	3,4	2,4	0,9	0,0	60,3	60,1	64,4	0,0	0,0
Libya	0,0	0,0	0,0	0,0	0,0	0,0	0,0	1,5	0,3	0,9	0,1	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Comoros	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,1	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0

Congo	0,0	0,0	0,0	0,0	0,0	0,0	0,0	1,8	1,6	4,3	4,1	1,4	2,1	1,9	2,4	0,0	0,0	3,0	0,0
Jamaica	0,4	0,1	0,7	2,5	177,8	0,3	0,2	0,4	0,1	0,1	0,1	0,1	0,2	0,2	0,1	0,2	0,3	0,3	0,0
Vanuatu	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Dominican Rep.	0,0	0,0	3,5	5,6	5,7	10,3	14,5	29,5	36,2	8,6	17,0	10,3	10,0	12,0	8,8	11,4	11,8	22,7	0,0
Venezuela	156,6	142,9	97,4	90,4	111,3	72,4	62,0	60,9	83,8	78,2	94,5	81,8	64,1	42,2	0,0	0,0	0,0	0,0	0,0
Neth. Antilles	0,0	0,0	0,0	0,0	0,0	0,2	0,2	0,2	0,6	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Wallis and Futuna Isds	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Viet Nam	224,5	483,3	439,8	432,9	458,8	538,5	869,1	1880,5	3116,0	1930,2	3961,6	3859,8	3281,5	3768,9	4116,2	3966,4	4746,2	6713,5	0,0
Lesotho	0,2	0,8	1,8	3,4	3,7	0,0	0,0	0,0	1,7	1,9	1,7	0,9	0,5	1,1	4,5	0,5	0,0	0,9	0,0
Yemen	0,0	0,0	0,0	0,0	4,7	4,4	4,1	5,6	6,0	5,5	6,1	3,7	6,8	6,7	6,5	3,5	0,0	0,0	0,0
Grenada	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Bhutan	0,0	0,0	0,0	0,0	0,0	12,1	8,7	1,1	52,1	96,2	108,8	81,6	842,2	0,0	0,0	0,0	0,0	0,0	0,0
Serbia and Montenegro	81,0	42,4	121,0	0,0	49,7	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Lao People's Dem. Rep.	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	1,0	1,1	1,8	7,4	15,1	18,4	26,2	0,0	0,0

Appendix 4: Quantity exported by each country (thousands of tons)

Country	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
USA	1803,2	2042,7	2087,1	2300,2	2950,5	4244,1	35818,5	39785,8	45520,7	47242,1	45681,4	52438,0	47606,3	43266,2	40120,6	37841,7	35198,0	36216,0	39829,6
Germany	13644,2	15614,0	14372,5	12484,3	13294,0	14878,4	16234,3	15059,5	15121,7	14178,6	18104,8	20401,7	17763,1	15378,8	17240,0	14948,5	16031,7	15168,7	15624,1
Japan	3882,1	8472,9	9269,8	9304,3	11589,1	13388,3	13806,9	12886,8	11484,1	16616,5	13134,2	12162,1	16006,4	15465,1	14352,7	14391,1	15145,1	14763,4	12427,3
Netherlands	5714,5	5774,9	6237,7	6758,6	7857,0	8244,0	9490,9	9680,3	9688,2	7112,3	10809,0	12033,5	10895,9	10175,5	9778,4	9901,0	10343,5	10511,7	10482,9
France	7415,3	6894,7	7844,4	8498,0	9662,6	9835,4	11223,8	11539,6	11184,3	10697,7	12182,3	13559,7	12351,5	12092,8	12489,5	11204,9	10882,8	6766,5	9246,7
United Kingdom	5860,9	6172,6	7430,9	10277,1	11041,3	10628,9	12750,6	12708,2	13768,0	12832,9	14231,2	14796,8	13719,5	12885,8	13828,7	14598,9	15747,5	13357,6	7737,1
Russian Federation	7307,3	5996,5	5998,0	7272,5	13154,8	13576,0	10184,7	8645,1	6833,7	3383,4	5081,9	5823,6	5296,7	5250,7	6654,6	5957,8	5819,0	5825,1	6080,7
Canada	1349,9	1353,4	1298,0	4853,4	5872,9	6705,1	7314,9	8382,8	7209,4	8805,2	9734,5	9773,3	8049,7	7675,2	7809,7	5942,1	6205,2	7199,3	4524,7
Australia	1280,1	1566,8	1493,9	1614,3	1788,1	2731,8	2713,2	3052,2	3447,4	3809,0	3659,0	3830,4	4445,6	4265,9	4429,3	4080,0	3707,6	3973,7	3636,0
Italy	598,8	617,1	858,3	991,7	1184,3	1418,8	1548,5	2101,2	2543,7	2835,5	2956,3	2942,3	3367,2	2961,6	2692,3	2257,2	1149,5	2634,7	3361,8
Czechia	1389,1	1380,5	1469,4	1583,3	2426,9	2345,9	2180,2	2492,4	2785,6	2419,9	2962,4	3316,4	3137,0	3033,3	3212,1	3005,1	3015,0	3465,2	3271,8
Poland	1202,7	1486,1	1936,4	2173,2	2442,7	2019,6	2141,5	2182,5	2541,0	1960,8	2540,0	3127,4	2786,0	2903,2	2954,2	2466,8	2470,7	2744,3	3266,5
Belgium	6618,0	6193,1	5964,3	6697,8	8151,1	8094,4	8337,8	8257,5	8797,3	8304,5	8284,2	8860,9	7778,4	7395,9	7767,2	6291,3	6549,8	6564,9	2794,6
China, Hong Kong SAR	1885,4	1737,5	3409,4	4203,9	4819,4	5345,8	6269,8	6694,9	6894,4	6681,1	6816,9	6202,3	5795,5	3975,3	5465,4	5155,4	5214,2	4191,4	2653,8
Sweden	1057,7	1113,6	1372,7	1237,0	1331,7	1524,0	1600,9	2039,4	2433,1	2450,6	2386,7	2853,0	2393,5	2365,6	2633,3	2448,5	2462,3	2613,8	2487,0
Denmark	1167,9	1269,6	1727,8	2097,4	2248,8	2132,5	2273,6	2565,6	2835,7	2409,4	3056,7	2704,7	2408,9	2243,8	2684,8	2235,6	2361,3	2142,1	2232,6
Austria	1544,2	1631,1	1667,6	2008,0	2330,9	2412,8	2494,8	2869,7	2904,9	2447,7	2624,4	2670,3	2037,5	1791,0	2030,0	1963,2	2280,4	2219,3	2032,1
Mexico	678,1	638,8	781,4	1170,7	11472,3	1464,5	1593,5	3338,0	2231,9	1733,8	2124,1	2333,1	3713,6	2510,7	2512,9	1842,3	1681,7	2157,5	2015,7
Switzerland	1185,5	1299,5	1457,5	1588,6	1869,7	2051,2	2275,5	2264,3	2290,5	2223,5	2513,5	2535,8	2001,9	1991,3	2056,2	1929,6	2162,3	1705,7	1879,9
Singapore	937,7	954,9	781,8	1154,0	1298,9	1325,7	1282,2	1410,8	1452,3	1280,1	1453,0	1522,4	1728,6	1877,6	1737,7	1719,1	1639,4	2294,3	1554,7
Spain	341,9	332,6	510,8	499,9	814,1	1064,4	945,8	1128,3	1509,2	1822,7	1654,5	1972,8	2103,6	1927,5	2271,2	2079,1	2188,7	928,4	1547,6
Hungary	739,1	584,3	660,5	753,1	1052,8	941,2	1141,7	1117,4	1268,1	1032,0	1459,2	1753,4	1505,8	1459,1	1379,9	1207,3	1289,8	781,6	1408,0
China	286,5	194,2	130,2	169,9	227,4	200,1	563,1	229,2	433,9	267,1	598,6	150,3	92,6	281,7	735,8	1084,9	1021,4	3596,2	1363,1
Rep. of Korea	354,4	359,9	491,1	860,3	862,2	1002,2	1376,3	1610,6	1616,2	1691,3	1443,2	1529,9	1715,8	1294,2	1370,4	1601,2	1735,2	1574,7	1284,1
Slovakia	379,9	473,2	566,4	690,1	645,1	624,4	1015,0	1264,9	1222,1	661,5	659,5	932,1	698,7	830,3	929,6	892,5	728,0	906,2	1151,5
Norway	484,7	465,0	548,1	597,0	628,1	674,2	918,2	866,1	872,2	854,4	1027,4	1125,4	1040,8	1108,3	1238,5	793,1	1328,4	1135,1	1130,1
Romania	2395,4	1716,9	2123,6	2438,4	2488,4	1744,3	2018,2	2133,1	2155,2	2876,7	2990,5	3645,4	2167,2	2163,6	1640,4	954,9	949,7	1085,0	1127,1
Kazakhstan	59,7	2136,4	1330,5	578,5	2013,9	2261,2	1827,1	1662,6	1866,6	906,2	917,7	1236,7	821,2	752,9	239,9	1385,5	649,7	886,7	1091,8
Thailand	169,2	171,1	319,4	434,5	453,1	672,4	528,4	706,1	669,7	742,1	1010,7	1017,2	1040,6	1084,6	1099,5	987,5	790,5	903,4	1032,0
Lithuania	443,3	578,5	740,5	657,2	786,3	774,6	919,0	908,3	948,1	811,2	969,7	1099,5	711,6	644,4	725,8	660,0	742,6	1011,1	1022,0
New Zealand	273,3	311,3	338,6	435,7	464,5	558,7	640,9	713,2	763,6	773,3	698,6	438,9	686,9	1136,7	731,9	730,7	1037,2	84,2	931,8
Taiwan	577,6	569,7	409,2	497,0	511,3	629,5	731,6	663,4	692,4	691,3	763,0	775,0	596,4	657,2	315,7	690,6	684,1	673,8	914,8
Portugal	466,0	568,7	624,7	698,4	753,3	964,4	1161,1	1244,5	1187,8	1324,8	1663,6	1625,3	931,5	897,3	880,5	634,0	735,7	730,0	890,1
Saudi Arabia	136,7	135,3	155,5	335,9	270,8	361,2	612,5	1086,9	661,5	358,0	517,7	603,5	750,9	790,4	757,1	611,9	828,9	1126,7	803,0
Turkey	95,4	139,2	235,9	453,5	714,6	557,8	661,4	410,9	295,0	372,5	534,3	747,7	733,2	794,3	833,8	449,6	713,8	647,8	781,5
South Africa	1570,0	1239,3	825,3	755,1	531,6	1308,9	814,6	1233,4	1674,4	1451,2	1736,8	1923,2	2377,2	2167,3	2017,1	1549,6	945,1	766,7	781,3
Ireland	220,2	288,2	417,2	532,1	777,6	854,8	917,9	1046,3	1067,3	1016,9	759,8	1081,1	848,4	818,4	848,2	831,5	574,7	660,7	771,8
Philippines	146,5	239,1	340,3	516,2	824,5	1037,0	1026,3	937,1	976,7	638,8	813,8	903,2	541,2	494,5	1352,8	1261,1	960,5	589,2	737,4
Slovenia	173,9	210,0	233,7	262,5	338,6	388,2	514,7	614,9	580,4	595,9	784,9	1024,7	624,3	627,3	685,3	671,1	693,5	2710,3	715,3
Latvia	282,6	313,9	346,1	513,7	574,6	793,8	961,7	994,2	946,3	939,5	1276,5	1505,5	594,8	557,0	591,1	633,4	518,6	681,6	691,9
Finland	598,8	607,0	698,5	655,4	681,8	798,3	756,6	887,3	858,2	772,9	907,1	946,3	500,9	679,4	655,3	591,1	566,4	546,0	628,3
Estonia	819,0	709,7	586,0	695,0	629,5	938,2	1207,3	1083,7	1115,7	927,5	1177,9	1186,3	778,5	625,1	532,2	397,9	478,7	671,4	609,3
Croatia	190,5	234,3	305,6	386,1	483,6	524,2	698,5	746,6	681,8	682,7	735,5	942,6	691,7	592,1	555,3	494,8	566,1	0,0	601,2
Bulgaria	420,3	41,0	507,9	622,6	815,4	842,0	797,7	760,1	838,5	601,4	1096,8	1014,4	887,2	737,4	518,9	386,2	387,4	559,9	574,8
Malaysia	193,8	101,0	2632,9	75,8	312,8	475,1	1690,8	915,3	382,9	494,3	586,1	588,0	486,2	442,7	451,0	317,2	389,8	537,7	556,8
United Arab Emirates	0,0	0,0	0,0	0,0	0,0	787,1	0,0	1600,2	1737,5	0,0	0,0	0,0	2060,0	1081,4	2100,8	1940,2	2271,5	1970,2	521,4
Israel	95,7	98,0	131,9	150,2	364,7	268,2	440,2	383,1	537,9	287,7	670,9	612,7	512,6	362,3	491,1	298,4	349,1	525,8	479,9
Brazil	35,2	46,2	52,7	150,1	174,6	122,0	222,2	154,2	198,4	170,5	142,4	328,0	539,0	539,0	739,1	841,4	727,5	702,2	478,5
Chile	38,3	43,1	57,8	0,1	0,2	0,1	0,2	0,2	0,2	0,2	336,7	460,0	339,7	316,8	462,0	359,4	339,6	375,5	461,0
India	16,8	48,1	32,1	388,2	389,2	527,4	613,1	1054,0	1249,2	1169,6	464,7	2378,5	1910,5	1999,6	1263,8	1105,6	832,6	907,4	457,1
Lebanon	170,5	201,4	249,9	364,2	585,6	556,4	456,6	579,9	427,9	387,6	559,0	599,2	405,0	487,9	311,4	237,9	292,7	460,4	453,1
Indonesia	131,1	141,2	175,4	196,2	193,2	259,4	327,3	287,2	301,8	216,2	379,8	463,9	706,0	670,6	581,7	536,9	582,9	651,6	452,1
Ukraine	5423,3	4627,1	3933,0	1944,4	2529,1	1389,2	869,5	974,3	967,4	1193,9	898,7	1216,2	875,7	769,3	1026,0	1257,8	298,4	571,6	390,3
Greece	127,9	119,7	122,2	174,5	267,7	245,5	396,2	280,2	292,8	552,6	508,5	454,5	490,5	430,1	434,9	416,7	429,6	535,3	332,2
Serbia	0,0	0,0	0,0	0,0	0,0	204,8	354,3	529,8	461,3	440,5	552,4	517,6	505,2	449,8	401,7	300,6	284,8	408,8	307,4
Kuwait	36,0	33,2	36,6	48,9	59,1	0,0	507,5	852,4	624,0	349,8	555,0	660,1	0,0	410,9	407,2	339,9	287,1	350,9	301,2
Bosnia Herzegovina	0,0	0,0	0,0	104,8	238,9	192,1	210,0	238,2	296,9	358,2	484,1	636,3	344,8	312,6	295,7	225,5	200,9	291,4	298,4
Oman	30,2	32,5	14,9	80,3	102,1	115,9	46,8	34,3	72,2	194,1	159,0	191,0	145,8	178,0	70,7	40,0	56,5	325,0	295,8
Costa Rica	64,9	58,4	65,2	75,3	114,6	165,8	197,9	265,0	207,5	137,3	254,4	329,9	325,0	291,9	315,6	204,8	207,5	244,9	292,3
Bahrain	78,1	81,5	193,8	112,3	146,7	185,7	145,1	180,7	134,8	101,3	183,0	274,4	196,8	227,5	195,4	152,9	186,5	255,9	275,4

Luxembourg	566,5	470,8	671,2	937,1	1468,7	578,6	675,4	1787,8	650,8	444,7	499,2	404,5	402,5	296,0	286,2	261,2	251,0	244,0	223,2
Malta	24,6	21,5	23,7	47,6	24,6	13,6	24,7	33,7	36,1	38,5	46,7	65,7	61,4	53,1	76,6	56,3	70,3	73,2	181,5
Colombia	26,9	27,4	128,5	42,2	55,6	55,0	93,8	100,0	98,2	114,1	185,6	193,3	159,9	208,4	159,6	117,7	103,0	144,4	167,9
Iceland	39,9	67,6	57,6	56,7	67,0	57,2	52,4	101,7	101,5	66,4	75,1	77,5	62,5	84,3	89,2	78,3	91,0	72,6	165,4
North Macedonia	48,2	9,9	11,5	28,5	75,9	102,4	117,4	142,9	0,0	84,0	100,7	122,0	135,5	126,2	120,3	102,1	117,3	125,0	152,7
Nicaragua	16,2	17,0	23,3	26,2	48,9	56,8	63,2	98,5	102,8	68,0	100,4	119,7	111,1	117,0	122,7	104,2	109,4	131,1	148,9
Cyprus	35,2	47,2	58,8	81,0	70,1	80,9	92,5	99,1	107,4	121,8	161,0	205,5	203,9	167,7	138,8	128,1	125,6	136,0	141,4
Kyrgyzstan	92,5	127,7	215,7	303,6	382,5	263,7	186,0	154,0	135,5	69,4	119,1	171,0	109,8	84,4	128,1	115,9	64,9	127,0	139,6
Pakistan	0,0	0,0	0,0	89,2	103,5	117,1	128,8	117,1	94,3	185,8	705,4	468,2	469,3	2717,8	4925,6	2030,4	1048,4	710,2	136,5
Jordan	28,7	28,6	26,7	36,6	52,3	55,0	69,7	82,7	80,8	33,7	92,6	108,1	62,3	80,1	94,6	89,8	311,7	144,8	131,8
State of Palestine	0,0	0,0	0,0	0,0	0,0	0,0	0,0	1,0	14,5	31,4	44,9	11,4	116,5	119,2	115,8	68,6	61,3	114,5	129,7
Paraguay	32,7	23,0	28,9	32,2	92,7	161,3	138,1	151,5	123,7	79,1	113,9	114,1	114,4	115,0	125,9	106,4	75,2	103,1	123,7
Morocco	214,8	214,1	246,8	317,0	454,5	370,6	232,6	199,6	256,4	89,9	204,9	146,8	202,7	257,3	213,6	196,7	201,9	184,5	105,3
El Salvador	31,9	26,8	37,6	37,0	48,8	54,8	62,5	106,4	132,3	80,2	129,8	150,0	124,1	122,0	123,4	97,2	104,2	112,7	103,8
Ghana	5,7	2,7	0,0	5,5	0,0	11,7	19,4	39,3	54,0	17,2	11,4	18,0	40,0	31,0	0,0	0,0	28,5	28,2	98,3
Bolivia (Plurinational State of)	10,6	12,0	13,1	12,7	117,4	29,8	25,8	35,8	27,0	14,0	45,7	60,7	56,8	59,9	69,2	54,6	40,9	68,9	89,7
Qatar	24,7	20,8	24,4	9,0	6,0	22,9	26,5	26,7	7,5	6,8	24,4	33,1	0,0	46,0	64,8	7371,0	38,5	55,4	78,8
Belarus	189,4	193,4	167,2	149,2	208,1	241,6	253,6	229,6	185,9	184,0	214,6	246,5	98,5	91,0	92,9	104,9	107,4	95,4	74,7
Georgia	816,0	765,0	841,8	1004,4	822,0	538,7	437,6	486,6	453,3	380,5	418,3	341,3	140,5	37,1	20,6	16,2	15,8	34,4	74,3
Mozambique	56,3	5,6	13,3	18,8	21,6	49,5	71,6	48,6	54,9	28,0	38,1	36,7	35,9	24,4	82,6	0,0	17,8	53,9	71,0
Brunei Darussalam	0,0	3,2	4,7	5,2	6,8	0,0	71,4	15,9	17,9	6,7	37,2	49,2	30,4	61,6	53,5	29,1	55,5	59,6	67,2
Montenegro	0,0	0,0	0,0	0,0	0,0	0,0	16,6	20,3	21,6	24,7	45,3	89,6	60,6	72,9	67,1	32,0	25,4	46,2	59,0
Myanmar	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	27,8	1,5	23,5	11,7	6,3	10,6	55,0	54,6
Peru	10,5	10,0	9,3	13,3	20,3	15,4	22,5	23,2	21,1	27,0	32,1	44,3	29,4	128,5	61,7	23,4	59,8	51,2	52,2
Botswana	14,4	15,9	18,0	17,6	29,3	43,1	49,9	58,6	44,7	37,9	40,7	50,3	53,4	52,6	45,0	38,1	28,9	33,7	37,1
Kenya	3,2	5,6	5,3	16,6	14,2	20,9	16,7	14,7	13,0	10,7	12,5	0,0	0,0	23,7	0,0	0,0	0,0	43,8	36,9
Uruguay	19,4	24,2	27,7	21,0	18,3	23,8	26,5	26,6	18,2	16,1	21,1	31,3	23,2	22,3	23,4	30,9	33,3	31,0	36,6
Benin	1,6	1,1	4,4	9,7	26,8	37,6	35,5	77,6	63,7	27,6	42,6	102,0	52,6	81,7	161,1	78,7	64,5	30,0	36,2
United Rep. of Tanzania	0,7	5,4	9,4	14,0	14,7	9,7	17,9	21,5	27,6	17,3	48,9	58,7	52,5	49,7	56,1	53,2	45,1	51,2	34,4
Rep. of Moldova	14,6	7,7	11,8	21,6	15,2	15,9	11,7	15,3	9,4	13,5	69,6	116,5	44,4	133,0	31,4	26,9	28,8	34,5	31,4
Andorra	12,4	12,7	21,5	49,0	55,1	55,7	46,8	35,4	35,8	31,3	28,2	28,3	24,1	17,2	20,7	25,2	25,5	26,2	31,4
Ecuador	14,8	9,1	9,9	16,7	31,2	57,2	91,9	176,7	155,0	128,4	57,3	68,7	70,2	77,0	78,1	128,7	90,8	42,9	31,2
Suriname	0,2	0,3	0,9	0,6	3,9	2,0	2,3	17,9	15,9	15,7	20,9	43,1	54,7	45,8	32,9	12,0	1,2	22,4	28,7
CV¥te d'Ivoire	29,9	45,9	63,5	54,9	95,9	105,5	101,4	145,7	168,0	84,9	69,0	52,0	37,3	21,5	29,0	20,9	21,8	23,5	27,1
Zimbabwe	49,2	1,4	9,7	0,0	33,4	0,3	1,3	1,2	2,0	6,5	8,6	9,9	11,6	11,1	42,8	24,4	19,7	15,8	27,1
Senegal	17,3	19,9	21,3	36,2	55,4	61,8	77,7	68,1	100,7	72,1	112,4	148,9	118,1	20,2	16,3	10,9	7,2	34,3	25,8
Madagascar	1,2	9,7	1,0	7,3	30,8	50,2	40,3	41,7	29,4	21,9	50,5	60,9	46,2	8,1	8,9	7,8	11,5	16,6	25,1
Guyana	2,4	3,4	2,6	2,8	0,9	14,9	17,1	9,9	41,3	26,0	21,1	15,4	30,4	18,3	18,2	8,3	0,3	10,6	20,4
Belize	2,1	0,1	0,1	0,8	1,3	1,1	0,6	0,1	0,0	0,0	0,2	27,5	23,4	17,0	15,0	9,4	10,7	14,5	20,1
Mauritius	16,5	15,8	13,2	12,2	28,0	28,2	61,9	47,1	49,8	40,5	55,2	63,0	55,0	51,0	47,8	40,1	31,2	19,8	19,2
Maldives	0,7	1,7	0,6	1,8	2,3	4,7	3,8	7,5	7,3	7,0	10,1	10,6	9,4	6,5	7,4	42,3	7,9	13,4	17,2
Barbados	1,6	1,5	1,1	1,2	2,7	0,9	2,3	9,4	10,7	9,5	8,4	9,2	10,5	11,2	17,3	9,9	8,1	8,6	13,9
Uzbekistan	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	12,9	13,4
Fiji	0,0	0,0	2,8	2,3	5,0	6,5	10,1	22,5	8,7	19,1	45,1	44,8	26,7	12,4	12,3	5,4	5,6	7,4	13,2
Egypt	30,4	37,0	110,1	52,0	63,1	59,0	55,5	44,6	62,8	57,7	175,6	71,4	127,8	315,2	277,6	12,7	16,8	21,0	13,0
Burkina Faso	0,1	1,3	1,1	1,4	9,9	16,5	0,0	10,7	44,7	3,9	5,5	74,5	11,1	44,8	45,6	13,7	8,5	14,5	10,7
Aruba	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,6	1,1	8,6	11,0	12,5	9,9	5,9	8,7	11,2	8,9
Uganda	0,5	0,5	0,7	1,5	3,2	1,8	2,5	7,3	12,6	6,5	4,4	2,3	3,8	6,3	6,8	5,2	5,7	8,3	8,1
Armenia	59,3	102,2	96,8	107,8	100,8	93,7	104,2	130,0	69,0	93,1	154,0	215,4	196,0	16,5	7,2	4,7	7,1	9,2	7,5
Angola	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	3,6	5,3	2,2	4,8
Nigeria	0,1	0,1	0,0	0,0	0,0	0,0	0,2	5,7	5,5	4,7	8,1	18,6	20,7	57,6	15,0	0,0	3,5	3,1	4,7
Zambia	20,8	15,8	27,7	38,1	48,1	33,3	11,5	18,1	16,9	14,9	18,3	31,4	3,3	3,2	3,0	4,9	0,0	4,4	4,6
Greenland	0,4	0,1	0,3	0,1	0,3	0,1	0,3	0,4	0,9	0,4	1,6	3,6	2,9	1,9	3,0	3,7	5,9	3,1	4,3
Burundi	0,0	0,0	0,0	0,0	0,0	2,7	3,1	6,7	9,6	10,1	10,0	4,8	6,1	2,5	7,7	5,5	6,4	3,5	4,0
Seychelles	0,0	0,2	13,6	0,0	0,0	0,3	1,2	0,0	0,0	0,0	189,2	171,5	171,7	128,3	197,3	229,3	250,5	2,1	4,0
Albania	9,8	7,7	8,3	19,6	61,0	60,2	102,3	74,0	91,4	28,8	73,8	124,5	107,3	48,7	12,1	26,5	50,5	7,8	2,4
Azerbaijan	172,1	12,3	1,0	2,6	2,6	4,2	3,3	3,1	2,3	1,0	1,2	1,4	1,3	0,9	0,3	0,5	0,6	2,6	2,1
Palau	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,8	0,0	0,5	0,2	0,8	2,1	1,6
Gambia	0,0	0,0	0,0	0,3	1,5	0,2	0,0	0,8	35,2	6,4	4,9	1,1	0,6	2,0	3,9	0,6	1,0	0,4	1,3
Sao Tome and Principe	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,5	0,3	0,3	0,7	1,6	1,3
Saint Vincent and the Grenadines	0,4	1,0	1,2	0,4	0,2	0,8	0,7	0,5	0,2	0,3	3,0	3,3	2,2	3,1	1,5	0,6	0,4	0,8	1,3
Mongolia	16,7	12,8	6,5	23,6	41,2	17,5	13,0	10,8	0,0	0,0	0,0	0,0	0,0	9,3	8,3	9,9	7,1	6,5	1,0

Argentina	38,0	33,0	58,9	54,7	48,5	71,4	72,3	83,7	105,5	84,8	90,4	84,1	42,3	35,9	28,3	19,9	10,6	5,7	0,8
Samoa	0,0	0,1	0,0	0,0	0,0	0,1	0,0	0,1	0,1	0,1	0,5	0,7	1,0	3,2	1,1	0,3	0,3	0,7	0,7
Solomon Isds	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,2	0,0	0,2	0,3	0,3	0,6	0,2	0,1	0,2	0,3
Namibia	16,2	26,0	19,8	19,4	20,9	15,4	40,6	57,4	71,2	122,0	110,7	80,4	78,8	83,8	75,8	70,6	72,4	118,8	0,2
Antigua and Barbuda	0,1	0,0	0,0	0,0	0,0	0,0	0,0	1,1	0,0	0,7	0,4	0,5	0,5	3,6	5,5	2,2	1,2	1,0	0,1
Bermuda	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,4	0,0	0,0	0,0	0,0	0,0
Libya	0,0	0,0	0,0	0,0	0,0	0,0	0,0	1,4	3,0	4,3	0,1	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Congo	0,0	0,0	0,0	0,0	0,0	0,0	0,0	9,3	12,5	5,0	5,0	1,5	1,4	3,2	1,3	0,0	0,0	20,9	0,0
Togo	0,6	4,0	1,6	5,9	5,6	6,5	0,0	31,5	40,1	5,7	1,9	5,2	52,6	5,6	36,5	6,1	1,7	56,2	0,0
Honduras	25,1	65,5	50,2	46,7	74,4	104,9	183,7	137,7	0,0	116,5	175,3	128,0	194,5	0,0	203,7	65,7	61,9	166,0	0,0
Ethiopia	0,1	0,2	0,1	0,6	4,7	10,9	5,5	3,9	1,8	0,4	0,8	1,0	1,4	2,3	3,5	12,3	3,7	0,0	0,0
Bahamas	0,2	0,8	0,4	0,2	1,2	0,2	0,3	0,6	2,3	1,9	1,1	1,7	3,4	0,8	0,2	1,8	0,0	0,0	0,0
Anguilla	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Cuba	73,3	29,4	68,2	60,5	49,9	27,5	27,9	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
French Polynesia	3,1	1,8	2,8	2,9	2,9	2,9	4,3	5,0	3,6	4,8	10,7	10,4	10,9	8,0	9,6	9,8	0,0	0,0	0,0
Gabon	5,3	0,9	2,5	2,6	29,9	53,4	38,0	43,0	46,7	30,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Serbia and Montenegro	33,5	63,1	96,9	0,0	206,6	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Sierra Leone	1,0	0,0	0,3	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,1	1,3	20,0	44,6	0,0
Cook Isds	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Guinea	0,4	0,6	0,0	0,0	6,6	3,7	3,1	89,1	68,0	0,0	0,0	0,0	0,0	44,7	19,9	8,7	0,0	0,0	0,0
Panama	30,2	20,0	25,7	107,6	173,9	245,8	183,9	240,6	286,3	203,4	321,0	399,2	0,4	0,3	0,9	1,4	268,8	0,0	0,0
Bangladesh	0,9	0,7	2,8	44,8	32,6	29,0	34,6	51,5	79,6	84,6	293,4	225,3	177,4	222,4	0,0	253,5	0,0	0,0	0,0
Papua New Guinea	1,7	271,8	1444,1	1292,4	284,7	0,0	0,0	0,0	0,0	0,0	0,0	4424,3	3457,1	0,0	0,0	0,0	0,0	0,0	0,0
Guinea-Bissau	0,0	0,0	0,0	0,2	2,2	3,4	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Malawi	6,1	3,2	9,1	2,1	4,3	2,1	8,5	2,1	0,9	8,2	5,6	0,5	3,3	1,5	3,1	4,1	4,7	7,3	0,0
Bhutan	0,0	0,0	0,0	0,0	0,0	5,9	20,0	6,6	0,0	11,6	8,6	11,0	11,7	0,0	0,0	0,0	0,0	0,0	0,0
Trinidad and Tobago	7,8	125,1	12,6	71,5	125,6	82,4	186,0	137,7	191,6	68,0	203,9	231,9	150,5	187,9	229,6	135,7	0,0	0,0	0,0
Iran	7,5	8,5	21,8	65,6	110,9	197,3	479,4	0,0	0,0	0,0	151,3	141,7	0,0	392,9	102,8	0,0	503,0	458,0	0,0
Turks and Caicos Isds	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,3	0,1	0,0	0,0	0,0	0,0	0,0	0,0
Iraq	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	103,2	96,2	501,4	271,2	0,7	2,1	0,0	0,0
Comoros	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,1	0,0	0,6	0,2	0,1	0,0	0,0	0,0	0,0	0,0	0,0
Cabo Verde	0,0	0,0	0,0	0,0	0,0	1,0	2,5	0,8	0,0	3,5	5,8	9,8	14,1	0,8	0,0	0,0	0,0	0,0	0,0
Central African Rep.	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,5	1,2	0,0	0,0	0,2	0,1	0,0	0,7	0,1	0,1	2,0	0,0
Djibouti	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	4,1	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Eswatini	37,1	11,8	29,5	27,9	23,9	25,7	19,8	26,3	0,0	0,0	0,0	0,0	0,0	22,1	23,2	18,1	14,9	18,5	0,0
Dominica	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Faeroe Isds	0,0	0,0	0,0	0,0	0,0	0,0	8,5	10,2	11,2	10,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Jamaica	8,8	4,7	4,2	19,3	28,1	43,8	84,9	130,1	121,8	95,7	106,8	114,6	12,1	51,2	87,4	35,4	43,6	60,8	0,0
Lesotho	0,0	0,0	0,2	1,9	0,2	0,0	0,0	0,0	3,1	0,3	0,4	2,1	2,1	0,9	0,8	0,6	0,0	4,2	0,0
Dominican Rep.	0,0	49,1	58,2	63,0	152,9	182,3	241,3	369,6	424,1	343,1	372,6	475,8	393,7	383,3	402,9	283,6	292,2	250,7	0,0
Sri Lanka	92,3	85,4	83,4	113,3	167,2	133,1	110,1	104,6	104,2	98,3	123,9	159,8	152,8	161,3	171,6	173,6	202,8	202,8	0,0
Cambodia	3,0	0,3	1,3	2,9	4,6	4,1	7,0	10,8	21,1	11,5	64,9	54,7	21,6	31,2	23,0	22,3	26,1	0,0	0,0
Sudan	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	26,4	0,0	0,0	25,9	0,0	35,1	0,0
Cameroon	4,5	7,0	19,5	32,9	72,2	69,7	73,0	143,4	157,0	58,5	17,9	3,4	0,4	0,1	0,3	0,8	0,6	1,9	0,0
Fmr Sudan	16,9	8,3	26,1	37,8	120,1	89,3	67,0	0,0	188,9	65,4	89,5	82,1	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Rwanda	0,0	0,0	0,1	0,0	0,5	1,2	1,9	3,9	10,3	21,0	14,5	9,3	10,8	10,5	11,4	2,9	3,6	0,0	0,0
Syria	0,0	3,6	31,6	52,0	35,6	39,8	44,1	28,4	35,4	39,4	38,8	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Saint Kitts and Nevis	0,0	0,0	0,0	0,4	0,9	0,0	0,0	0,0	0,0	0,0	0,0	0,1	0,8	0,0	0,0	0,0	0,0	0,0	0,0
Timor-Leste	0,0	0,0	0,0	0,0	0,2	0,8	0,0	0,0	0,0	0,0	0,0	0,0	0,0	1,4	0,0	0,0	0,0	2,7	0,0
Saint Lucia	0,0	0,2	1,1	1,2	5,3	2,3	5,1	2,7	4,9	697,1	63,2	5,2	3,5	6,3	4,1	4,6	2,2	2,8	0,0
Tonga	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	7,2	0,4	0,4	2,9	3,4	3,1	2,0	0,0	0,0	0,0	0,0
Neth. Antilles	0,0	0,0	0,0	0,0	0,0	2,4	0,4	0,3	0,4	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Tunisia	71,3	108,0	138,6	196,6	76,0	80,5	85,6	122,9	128,4	58,7	94,6	138,7	121,5	120,5	113,2	120,1	114,4	160,9	0,0
Guatemala	40,7	37,5	47,7	47,8	55,0	68,2	67,8	95,3	136,0	106,1	135,1	168,2	173,2	184,0	205,2	195,3	207,4	223,3	0,0
Turkmenistan	15,9	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Vanuatu	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,7	0,2	4,1	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Mali	9,4	7,1	4,7	14,5	17,2	10,7	12,0	35,5	37,0	0,0	33,8	57,2	42,2	0,0	0,0	0,0	16,4	26,0	0,0
Mauritania	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	6,1	20,7	21,6	33,8	63,9	41,1	43,8	0,0	7,4	1,4	0,0
Niger	0,2	0,3	0,1	0,1	0,3	6,6	4,4	1,9	1,0	0,3	0,4	1,4	1,0	0,3	0,2	0,5	0,6	0,0	0,0
Mayotte	0,0	0,0	0,0	0,0	0,0	0,0	0,3	0,1	0,2	0,9	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
China, Macao SAR	34,1	27,0	32,3	44,3	57,5	41,5	102,7	62,5	98,6	74,2	0,0	45,1	81,5	0,0	115,2	48,9	113,8	0,0	0,0
New Caledonia	0,3	5,1	0,2	7,3	4,9	4,9	7,2	0,8	14,1	16,2	10,4	20,0	9,7	27,0	8,6	7,6	0,0	0,0	0,0
Grenada	0,0	0,0	0,0	0,1	0,0	0,0	0,0	0,1	0,4	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0

Venezuela	98,8	67,2	90,4	191,3	113,3	107,8	3,8	0,0	132,1	8,8	376,7	352,8	135,0	83,4	0,0	0,0	0,0	0,0	0,0
Nepal	0,0	0,0	0,0	0,8	0,0	0,0	0,0	0,0	0,0	0,5	132,7	2,2	10,6	15,0	21,4	21,8	36,8	40,2	0,0
Yemen	0,0	0,0	0,0	0,0	51,7	30,4	34,9	60,9	48,3	56,2	72,7	84,8	73,2	89,7	26,2	33,1	0,0	0,0	0,0
Viet Nam	50,5	30,4	18,1	6,3	19,3	32,8	46,1	51,2	60,3	54,3	125,6	220,7	55,1	335,6	290,3	264,4	466,1	518,2	0,0
Algeria	82,1	56,5	320,2	289,9	523,9	647,5	775,6	415,2	739,6	710,4	361,6	37,5	45,1	66,9	167,6	64,8	74,0	82,2	0,0
Montserrat	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,1	0,0	0,0	0,0	0,0	0,0	0,0
Kiribati	0,0	0,0	0,0	0,0	0,0	0,1	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,1	0,0	0,0
Eritrea	0,0	0,0	0,0	1,5	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Lao People's Dem. Rep.	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	3,2	6,3	3,1	3,2	4,1	6,1	8,8	0,0	0,0

Appendix 5: Quantity exported by the USA to each country (million of $US)

Country	2015	2016	2017	2018	2019
China	$ 314,99	$ 283,04	$ 190,74	$ 21,42	$ 8,40
Hong Kong	$ 227,75	$ 213,03	$ 130,92	$ 54,01	$ 29,60
Canada	$ 86,94	$ 74,64	$ 67,93	$ 69,16	$ 64,49
India	$ 58,08	$ 49,64	$ 58,34	$ 50,07	$ 33,00
Indonesia	$ 22,99	$ 10,52	$ 8,31	$ 9,25	$ 10,69
Mexico	$ 18,51	$ 22,61	$ 25,57	$ 24,51	$ 19,23
Taiwan	$ 17,61	$ 8,98	$ 9,30	$ 20,87	$ 14,73
Vietnam	$ 14,99	$ 20,00	$ 49,44	$ 27,44	$ 7,34
Korea, South	$ 10,04	$ 1,78	$ 3,40	$ 14,11	$ 11,43
Malaysia	$ 8,75	$ 8,03	$ 31,50	$ 57,98	$ 15,99
El Salvador	$ 5,99	$ 4,59	$ 5,14	$ 6,59	$ 5,61
Guatemala	$ 2,82	$ 2,17	$ 1,68	$ 2,12	$ 1,44
Ireland	$ 2,79	$ 3,11	$ 0,64	$ 0,74	$ 0,74
Australia	$ 2,53	$ 5,40	$ 5,67	$ 3,44	$ 0,80
Dominican Republic	$ 2,38	$ 2,94	$ 1,93	$ 1,60	$ 2,01
Honduras	$ 2,26	$ 0,99	$ 0,66	$ 1,21	$ 0,53
Thailand	$ 1,94	$ 1,43	$ 10,77	$ 43,35	$ 8,62
Belgium	$ 1,73	$ 4,56	$ 4,27	$ 4,45	$ 3,37
Singapore	$ 1,61	$ 1,57	$ 1,73	$ 0,91	$ 0,86
Spain	$ 1,31	$ 2,27	$ 4,18	$ 2,99	$ 3,22
Nigeria	$ 0,79	$ 0,43	$ 0,71	$ 0,36	$ 0,54
Turkey	$ 0,76	$ 1,95	$ 4,20	$ 6,08	$ 7,50
Japan	$ 0,65	$ 0,99	$ 1,03	$ 0,42	$ 0,78
Germany	$ 0,62	$ 0,65	$ 0,99	$ 1,47	$ 1,10
Costa Rica	$ 0,49	$ 0,32	$ 0,19	$ 0,62	$ 0,64
Netherlands	$ 0,46	$ 0,47	$ 1,03	$ 1,48	$ 0,36
Bangladesh	$ 0,45	$ 0,56	$ 0,85	$ 1,11	$ 1,50
Sweden	$ 0,45	$ 0,32	$ 0,24	$ 0,42	$ 0,38
Italy	$ 0,44	$ 0,26	$ 0,18	$ 0,45	$ 0,77
Cayman Islands	$ 0,40	$ 0,38	$ 0,47	$ 0,24	$ 0,30
Haiti	$ 0,38	$ 0,00	$ 0,01	$ -	$ -
Philippines	$ 0,37	$ 0,37	$ 1,30	$ 2,38	$ 2,24
Pakistan	$ 0,34	$ 0,87	$ 0,91	$ 1,50	$ 1,84
France	$ 0,28	$ 0,36	$ 0,31	$ 0,35	$ 0,21
Brazil	$ 0,27	$ 0,09	$ 0,16	$ 0,85	$ 1,14
Guyana	$ 0,24	$ 0,05	$ -	$ -	$ -
Hungary	$ 0,22	$ 0,04	$ -	$ 0,02	$ 0,00
Nicaragua	$ 0,19	$ 0,20	$ 0,11	$ 0,28	$ 0,20
United Arab Emirates	$ 0,19	$ 0,05	$ 0,78	$ 0,61	$ 0,33

United Kingdom	$ 0,18	$ 0,38	$ 0,25	$ 0,36	$ 0,48
Chile	$ 0,16	$ 0,32	$ 0,28	$ 0,59	$ 0,06
Switzerland	$ 0,14	$ 0,21	$ 0,14	$ 0,21	$ 0,23
Panama	$ 0,14	$ 0,10	$ 0,04	$ 0,04	$ -
Ecuador	$ 0,14	$ 0,11	$ 1,27	$ 3,76	$ 3,01
New Zealand	$ 0,13	$ 0,07	$ 0,03	$ 0,04	$ 0,02
Jamaica	$ 0,13	$ 0,08	$ 0,09	$ 0,12	$ 0,23
Israel	$ 0,11	$ 0,20	$ 0,53	$ 1,07	$ 0,13
Morocco	$ 0,11	$ 0,01	$ 0,06	$ 0,06	$ 0,53
Venezuela	$ 0,11	$ 0,04	$ -	$ 0,03	$ 0,35
Bermuda	$ 0,11	$ 0,03	$ 0,08	$ 0,07	$ 0,08
Czech Republic	$ 0,10	$ 0,17	$ 0,73	$ 0,59	$ 0,97
Saudi Arabia	$ 0,08	$ 0,04	$ 0,02	$ 0,43	$ 0,14
Samoa	$ 0,08	$ 0,10	$ 0,06	$ -	$ -
South Africa	$ 0,08	$ 0,00	$ 0,03	$ 0,11	$ 0,08
Uruguay	$ 0,07	$ 0,03	$ 0,06	$ 0,10	$ -
Colombia	$ 0,07	$ 1,42	$ 6,33	$ 1,20	$ 0,79
Barbados	$ 0,07	$ 0,01	$ -	$ -	$ -
Bahrain	$ 0,06	$ 0,05	$ 0,04	$ 0,01	$ 0,02
Lebanon	$ 0,05	$ 0,01	$ -	$ 0,05	$ 0,01
Denmark	$ 0,05	$ 0,02	$ 0,01	$ 0,03	$ 0,05
Turks and Caicos Islands	$ 0,05	$ 0,04	$ 0,05	$ 0,02	$ 0,09
Austria	$ 0,04	$ 0,02	$ 0,06	$ 0,08	$ 0,11
Algeria	$ 0,04	$ -	$ -	$ 0,10	$ -
Yemen	$ 0,04	$ 0,01	$ 0,03	$ 0,02	$ 0,01
Argentina	$ 0,03	$ 0,03	$ 0,02	$ 0,03	$ 0,09
Greece	$ 0,03	$ 0,11	$ 0,17	$ 0,08	$ 0,32
Trinidad and Tobago	$ 0,03	$ 0,02	$ 0,03	$ 0,02	$ 0,03
Jordan	$ 0,03	$ 0,05	$ -	$ 0,01	$ -
Macau	$ 0,03	$ 0,01	$ -	$ -	$ -
Sint Maarten	$ 0,02	$ -	$ 0,02	$ 0,02	$ 0,00
Slovenia	$ 0,02	$ 0,00	$ 0,01	$ 0,12	$ 0,07
Kuwait	$ 0,02	$ 0,04	$ 0,01	$ 0,03	$ -
Slovakia	$ 0,02	$ 0,02	$ -	$ -	$ -
Ghana	$ 0,02	$ -	$ 0,09	$ 0,26	$ 0,43
Peru	$ 0,02	$ 0,16	$ 0,11	$ 0,17	$ 0,11
Cameroon	$ 0,02	$ -	$ -	$ -	$ -
British Virgin Islands	$ 0,02	$ -	$ 0,01	$ 0,01	$ -
Namibia	$ 0,02	$ -	$ -	$ -	$ -
Mauritius	$ 0,01	$ -	$ -	$ -	$ -
Egypt	$ 0,01	$ -	$ 0,07	$ -	$ 0,13
Aruba	$ 0,01	$ 0,01	$ -	$ -	$ -

Portugal	$ 0,01	$ 0,01	$ 0,01	$ 0,31	$ 0,06
Qatar	$ 0,01	$ -	$ -	$ 0,00	$ 0,02
Finland	$ 0,01	$ -	$ 0,01	$ 0,01	$ -
Norway	$ 0,01	$ -	$ -	$ -	$ -
St Vincent and the Grenadines	$ 0,01	$ -	$ -	$ 0,02	$ 0,03
Iceland	$ 0,00	$ -	$ -	$ -	$ -
Uzbekistan	$ 0,00	$ -	$ -	$ -	$ -
Curacao	$ 0,00	$ -	$ -	$ -	$ -
Mali	$ 0,00	$ -	$ -	$ -	$ -
Bolivia	$ 0,00	$ 0,02	$ 0,01	$ 0,01	$ 0,03
Senegal	$ -	$ -	$ -	$ -	$ 3,15
Russia	$ -	$ -	$ -	$ 0,11	$ 1,34
Latvia	$ -	$ -	$ 0,01	$ 0,01	$ 0,79
Afghanistan	$ -	$ -	$ -	$ 0,01	$ 0,80
Laos	$ -	$ -	$ -	$ 0,08	$ 0,66
Tanzania	$ -	$ -	$ 0,11	$ 0,30	$ 0,08
Oman	$ -	$ -	$ -	$ 0,08	$ 0,28
Burma	$ -	$ 0,02	$ 0,22	$ 0,07	$ 0,04
Cambodia	$ -	$ -	$ -	$ 0,35	$ -
St Lucia	$ -	$ 0,08	$ 0,01	$ 0,04	$ 0,02
Georgia	$ -	$ 0,03	$ -	$ 0,12	$ -
Djibouti	$ -	$ -	$ -	$ -	$ 0,15
Mozambique	$ -	$ -	$ -	$ -	$ 0,15
Ethiopia	$ -	$ -	$ -	$ 0,06	$ 0,05
Ukraine	$ -	$ -	$ -	$ 0,04	$ 0,06
Bahamas	$ -	$ -	$ 0,03	$ 0,01	$ 0,06
Paraguay	$ -	$ -	$ -	$ 0,02	$ 0,08
Bulgaria	$ -	$ 0,02	$ 0,03	$ -	$ 0,04
Romania	$ -	$ 0,03	$ 0,04	$ 0,02	$ -
Kenya	$ -	$ -	$ -	$ 0,01	$ 0,06
Poland	$ -	$ 0,00	$ 0,05	$ 0,01	$ -
Mauritania	$ -	$ 0,04	$ 0,01	$ 0,01	$ -
Sri Lanka	$ -	$ 0,00	$ 0,00	$ 0,02	$ 0,03
Iraq	$ -	$ -	$ 0,00	$ 0,01	$ 0,03
Tunisia	$ -	$ -	$ -	$ 0,04	$ -
Cyprus	$ -	$ -	$ -	$ -	$ 0,03
Croatia	$ -	$ -	$ -	$ 0,03	$ -
Angola	$ -	$ -	$ -	$ -	$ 0,02
Heard and McDonald Islands	$ -	$ 0,02	$ -	$ -	$ -
Christmas Island	$ -	$ -	$ 0,01	$ -	$ -
Vatican City	$ -	$ 0,01	$ -	$ -	$ -
St Kitts and Nevis	$ -	$ 0,01	$ -	$ -	$ -

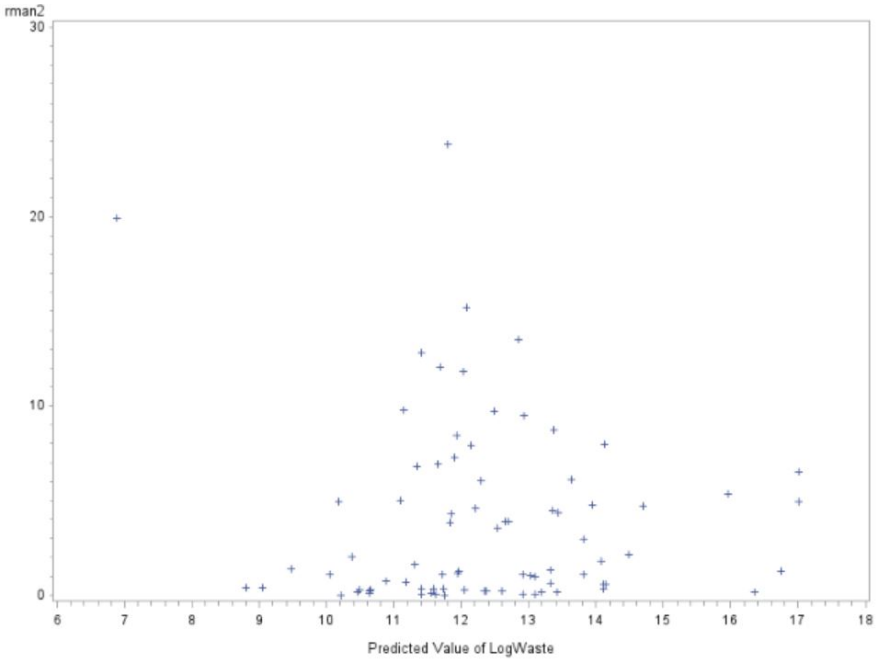
British Indian Ocean Territories	$ -	$ -	$ 0,01	$ -	$ -
Uganda	$ -	$ -	$ -	$ -	$ 0,01
Nepal	$ -	$ 0,01	$ -	$ -	$ -
Togo	$ -	$ -	$ -	$ -	$ 0,01
Suriname	$ -	$ 0,01	$ -	$ -	$ -
Lithuania	$ -	$ -	$ -	$ -	$ 0,00
Montenegro	$ -	$ -	$ 0,00	$ -	$ -
Dominica	$ -	$ -	$ -	$ -	$ 0,00
Serbia	$ -	$ -	$ -	$ -	$ 0,00
Antigua and Barbuda	$ -	$ -	$ -	$ 0,00	$ -
Belize	$ -	$ 0,00	$ -	$ -	$ -

Appendix 6: Quantity exported by each US port (million $US)

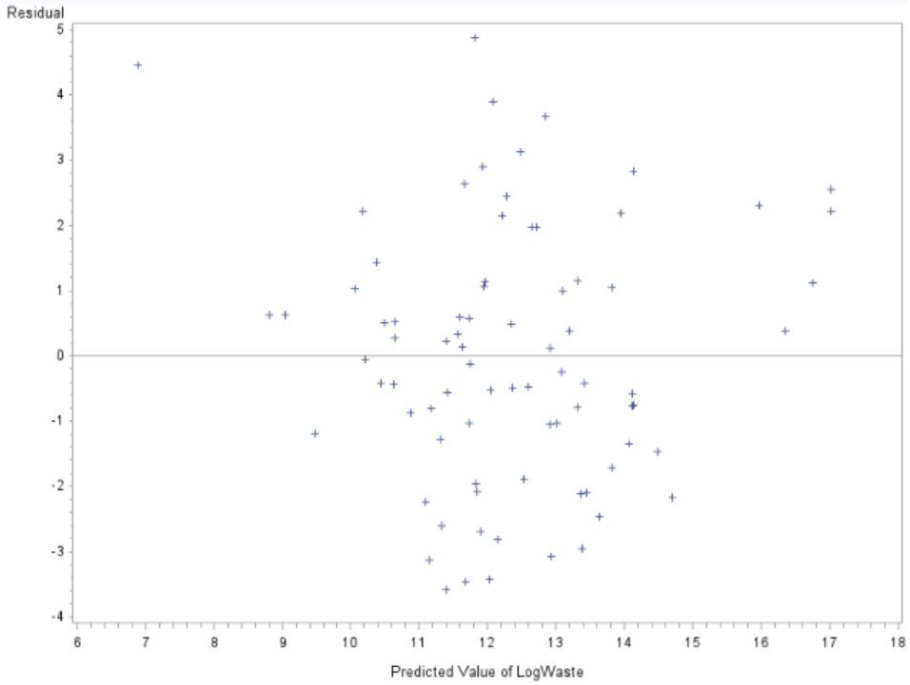
US ports	2015	2016	2017	2018	2019
Los Angeles, CA	$ 309,33	$ 248,52	$ 196,75	$ 103,93	$ 47,11
New York City, NY	$ 75,45	$ 80,05	$ 69,30	$ 58,93	$ 37,63
San Francisco, CA	$ 58,75	$ 40,71	$ 34,29	$ 23,69	$ 11,85
Charleston, SC	$ 48,14	$ 49,11	$ 50,14	$ 31,01	$ 18,32
Houston-Galveston, TX	$ 47,85	$ 46,60	$ 42,89	$ 35,45	$ 20,64
Seattle, WA	$ 42,06	$ 43,06	$ 38,92	$ 20,99	$ 7,25
Savannah, GA	$ 40,17	$ 39,72	$ 35,99	$ 28,17	$ 14,52
Norfolk, VA	$ 34,12	$ 45,34	$ 36,78	$ 24,03	$ 15,41
Detroit, MI	$ 31,61	$ 28,53	$ 22,89	$ 23,08	$ 22,43
Buffalo, NY	$ 23,50	$ 15,25	$ 15,09	$ 17,34	$ 15,03
Ogdensburg, NY	$ 16,36	$ 16,52	$ 18,26	$ 17,86	$ 20,56
Laredo, TX	$ 11,88	$ 12,93	$ 14,06	$ 9,80	$ 6,86
Miami, FL	$ 11,56	$ 8,09	$ 5,45	$ 4,22	$ 3,15
Baltimore, MD	$ 9,48	$ 4,01	$ 3,64	$ 2,98	$ 1,99
Tampa, FL	$ 7,65	$ 6,80	$ 6,28	$ 3,21	$ 1,98
Boston, MA	$ 7,00	$ 6,57	$ 4,46	$ 3,56	$ 1,00
Wilmington, NC	$ 5,63	$ 3,10	$ 0,27	$ 0,24	$ 0,00
San Juan, PR	$ 4,28	$ 4,16	$ 8,27	$ 3,96	$ 3,24
St. Albans, VT	$ 3,96	$ 3,57	$ 3,81	$ 3,36	$ 3,78
Low Value	$ 3,81	$ 3,49	$ 2,08	$ 1,83	$ 2,33
El Paso, TX	$ 3,26	$ 3,62	$ 1,50	$ 2,44	$ 1,89
Mobile, AL	$ 3,10	$ 2,34	$ 2,49	$ 1,52	$ 0,94
San Diego, CA	$ 2,80	$ 5,80	$ 9,55	$ 11,63	$ 10,05
Pembina, ND	$ 2,77	$ 2,51	$ 2,24	$ 2,09	$ 1,19
Duluth, MN	$ 2,33	$ 5,02	$ 4,66	$ 4,69	$ 1,00
Cleveland, OH	$ 2,13	$ 0,86	$ 0,64	$ 0,64	$ 1,44
Chicago, IL	$ 1,51	$ 1,68	$ 1,08	$ 0,68	$ 2,21
New Orleans, LA	$ 1,46	$ 2,37	$ 1,80	$ 1,64	$ 1,86
Great Falls, MT	$ 1,27	$ 1,17	$ 0,90	$ 0,96	$ 0,56
Honolulu, HI	$ 0,98	$ 0,63	$ 1,00	$ 1,11	$ 0,58
Anchorage, AK	$ 0,89	$ 0,58	$ 0,40	$ 0,26	$ 0,12
Philadelphia, PA	$ 0,49	$ 0,45	$ 0,23	$ 0,52	$ 0,64
Columbia-Snake, OR	$ 0,37	$ 0,24	$ 0,16	$ 0,23	$ 0,44
Nogales, AZ	$ 0,33	$ 0,05	$ 0,18	$ 0,12	$ 0,04
Portland, ME	$ 0,26	$ 0,24	$ 0,17	$ 0,14	$ 0,25
Washington, DC	$ 0,11	$ 0,03	$ 0,15	$ 0,09	$ 0,19
Dallas-Fort Worth, TX	$ 0,08	$ 0,13	$ 0,09	$ 0,08	$ 0,07
Minneapolis, MN	$ 0,03	$ -	$ -	$ 0,01	$ -
U.S. Virgin Islands	$ -	$ 0,02	$ -	$ -	$ -

Appendix 7: Output of the 2015 MLR

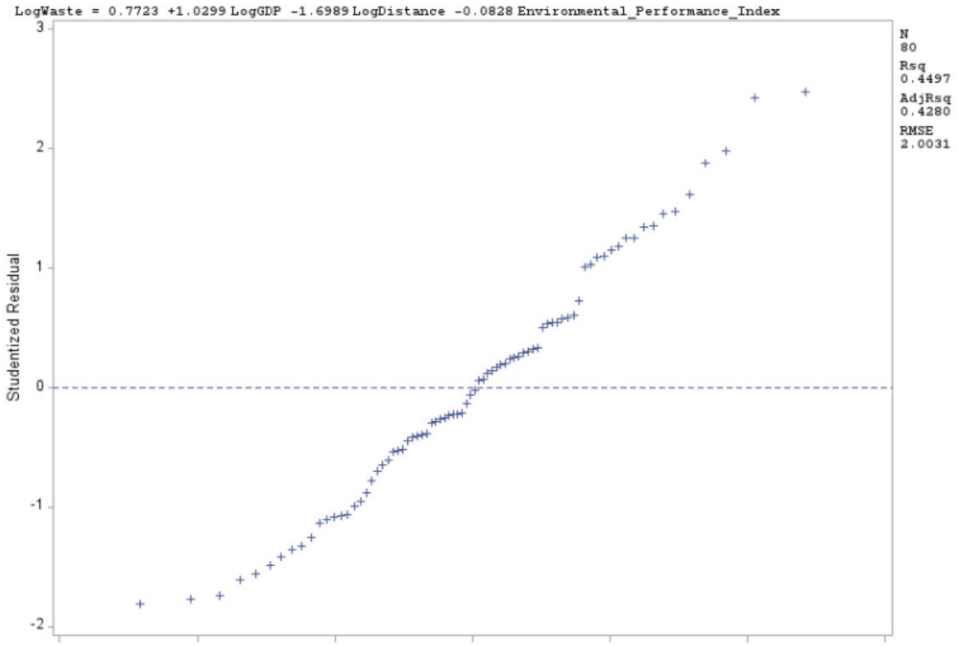
- Homoscedasticity of the residuals



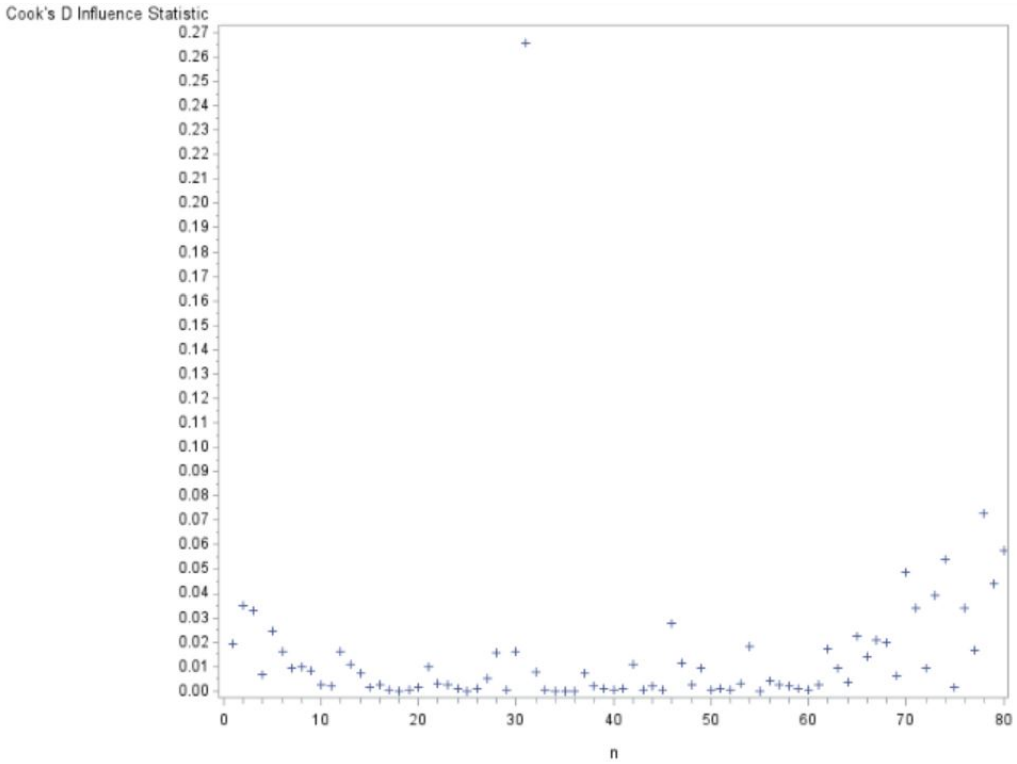
- Linearity of the residuals



- Normality of the residuals :



- Cook's Distance

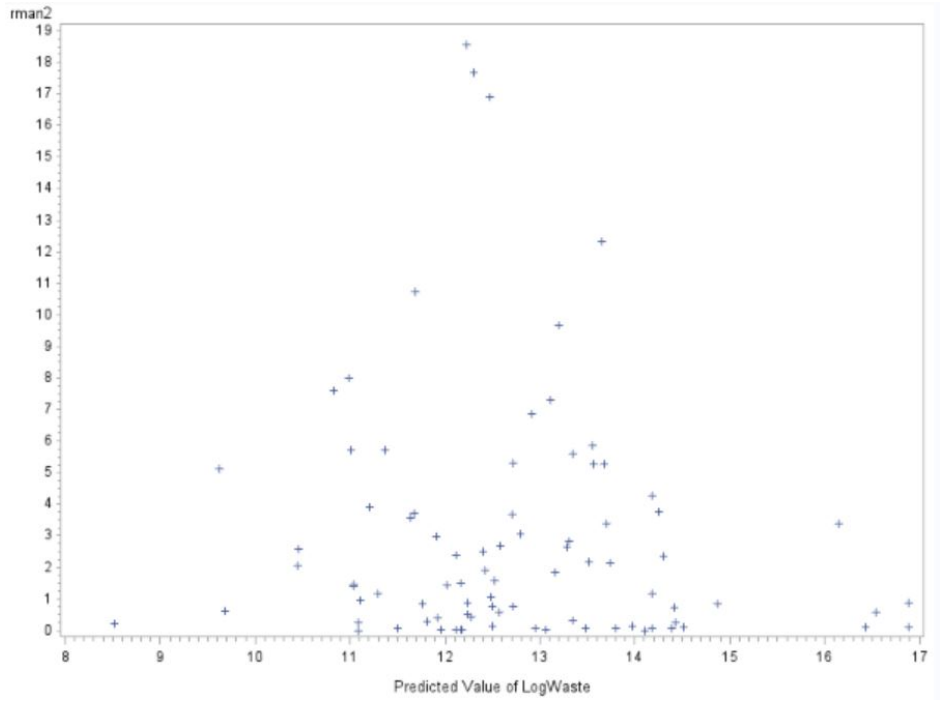


Analysis of Variance					
Source	**DF**	**Sum of Squares**	**Mean Square**	**F Value**	**Pr > F**
Model	3	203.65160	67.88387	22.33	<.0001
Error	81	246.28564	3.04056		
Corrected Total	84	449.93724			

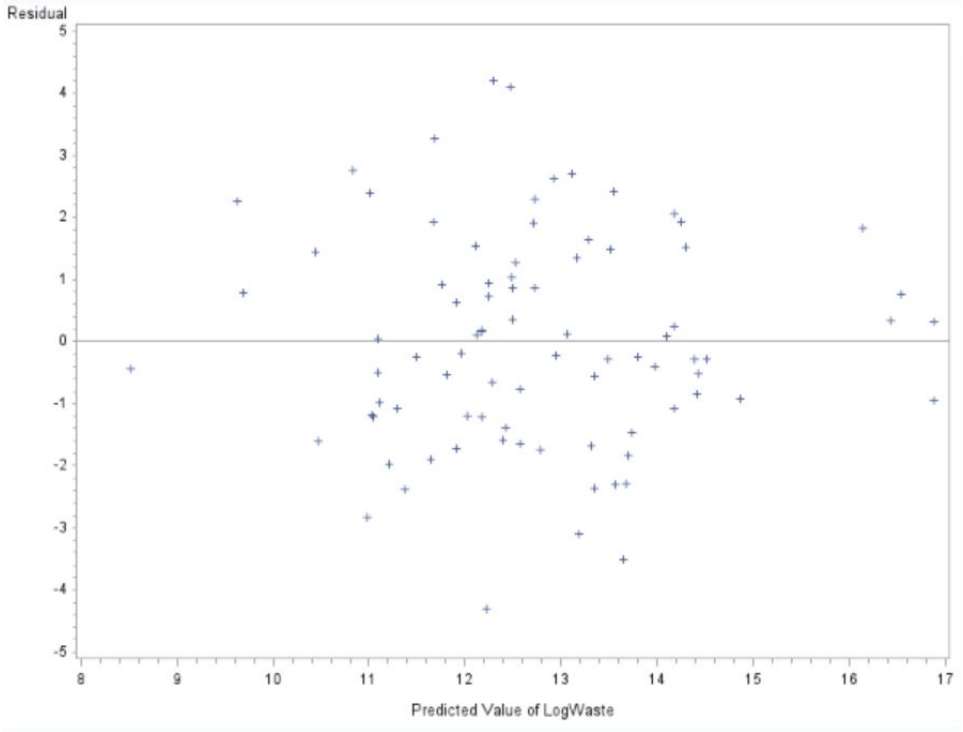
Root MSE	1.74372	**R-Square**	0.4526
Dependent Mean	12.74189	**Adj R-Sq**	0.4323
Coeff Var	13.68495		

Appendix 8: Output of the 2019 MLR

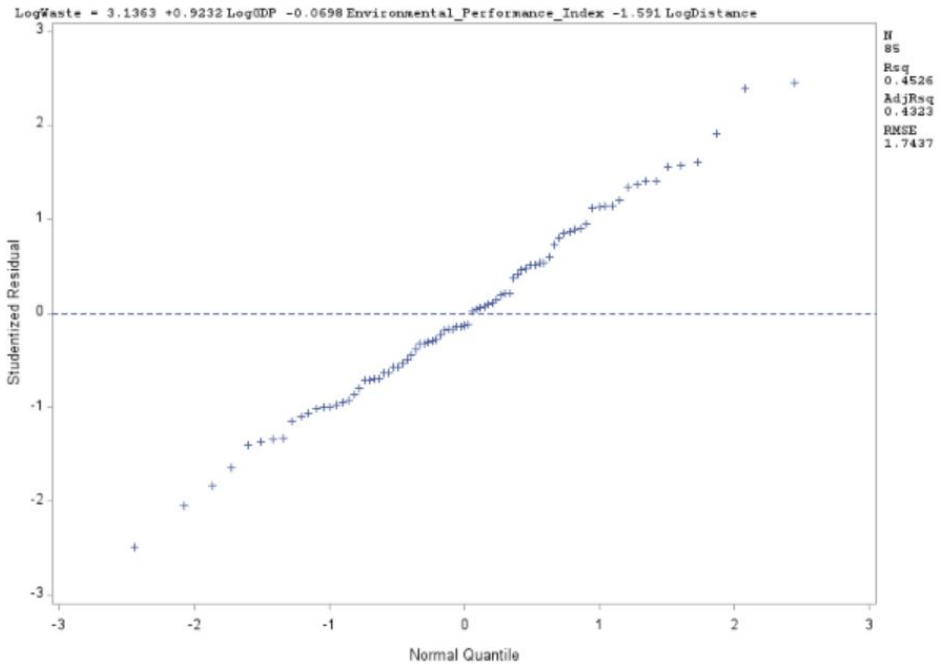
- Homoscedasticity of the residuals



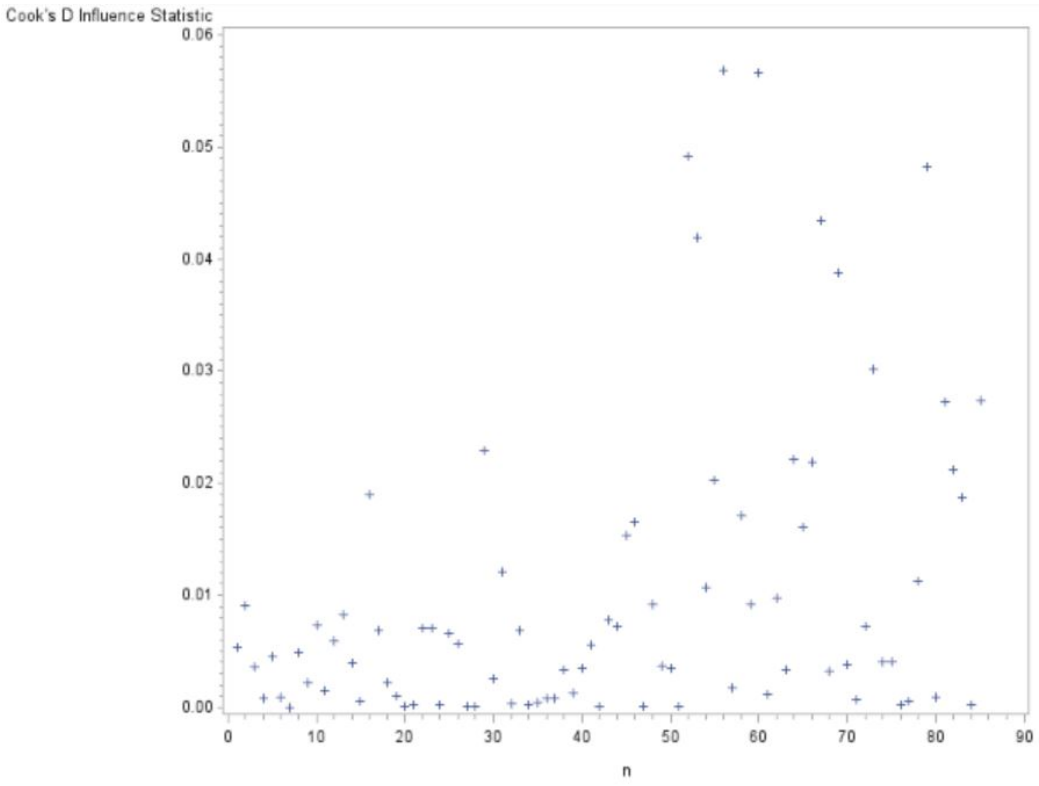
- Linearity of the residuals



- Normality of the residuals



Cook's Distance



Analysis of Variance					
Source	**DF**	**Sum of Squares**	**Mean Square**	**F Value**	**Pr > F**
Model	3	203.65160	67.88387	22.33	<.0001
Error	81	246.28564	3.04056		
Corrected Total	84	449.93724			

Root MSE	1.74372	**R-Square**	0.4526
Dependent Mean	12.74189	**Adj R-Sq**	0.4323
Coeff Var	13.68495		