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The Impact of Economies on Plastic Waste and Recycling Due to International Trade

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The Impact of Economies on Plastic Waste and Recycling Due to International Trade

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I. Intro

This thesis will study the impact of international trade of plastic waste from large multinational corporations and governments. The research will look at the top 20 importing countries and focus on the top two, specifically the United States and China. Due to the large amount of plastic used around the world each day, companies and countries have an overabundance of the material. Most importantly, there is a huge environmental drain from the use of plastic, because if it is not recycled, then it goes to overfilled landfills or ends up polluting neighborhoods, streets, and even rivers. Instead, many companies and governments look to recycle their used plastic in order to reuse the plastic and save money in disposal efforts. Many countries want to increase recycling efforts and decrease costs related to plastic waste, including monetary losses and environmental damage. To do so, these countries participate in the plastic waste trade.

This project will examine how countries import and export their plastic waste and the economic impact of the plastic waste trade. Specifically, this paper will look at a variety of sources and data to gather insight on the effects to the economies of large global trading partners due to the prolific use of plastic in international trade. By determining the economic impact of the plastic waste trade on countries, like the United States and China, I will offer some possible explanations for the impact in this paper. Also, it will provide a few policy recommendations to limit the environmental and economic issues posed by the plastic waste trade.

II. Literary Analysis of the Current Economics of Recycling

As companies are expanding around the world, there has been an increase in the use of plastic and cardboard packaging to transport goods (“Our planet is drowning in plastic

pollution"). Many companies use plastic to package and transport goods, as it is not expensive to manufacture and can be readily replaced. However, plastic is often not reusable for many companies unless it is recycled. It is difficult to reuse plastic and often times it must be disposed of immediately after its first use. Instead, these materials are quickly thrown away by consumers and companies, piling up in the trash. Eventually, the plastic and cardboard waste, along with other materials, must be disposed of either in a landfill or an incinerator, which leads to an increase in emissions and a detriment to the environment, unless they are recycled (Villanueva and Wenzel S29). A lot of the plastic that is used for packing is thrown away after a single use and hurting the environment, when it could be used repeatedly.

Due to the pile up of these materials, an industry of selling recyclable trash (especially in China) has formed to reused materials, which would lower the cost of packaging materials. Many companies are expending a lot of resources on packing materials that do not add to the value of their product, when they could find a more economical way to manufacture these items. In order to benefit the environment and the economy, governments around the world are focusing on incentives to encourage a reduction and reuse of plastic and cardboard use by large corporations. Plastic and cardboard waste poses a sustainability problem for countries and companies, which will not be solved, until there is economic motivation to find a different solution.

Globalization has lowered prices, making it easier to purchase more goods and dispose of more packaging than ever before. Many products and their packaging end up in landfills, the ocean, or an incinerator, leading to "2.8% of the total greenhouse gas emissions in the EU-27… in 2007" (Pericot 1932). For industrialized nations, plastic and cardboard waste have become a large economic and environmental problem (Braunegg 1755). In the United States alone, there was 262.4 billion tons of waste in 2015, which was an increase from previous years (Semuels).

With an increase in waste, there are fewer sustainable options for disposal, as landfills are filling up and incineration releases harmful gases into the air (Semuels). The current practices for disposal of waste are harming the planet.

To dispose of the large amount of plastic waste, recycling has become popular, because it is better than "either landfilling or incineration from an energy consumption perspective" (Villanueva and Wenzel S42). In order to capitalize on this industry, certain countries (like China) were buying waste to make money off of the recycling efforts. It was cheaper for companies to reuse materials instead of buying raw materials (Grabar). In 2017, the United States exported $3.27 billion worth of "recovered (waste and scrap) paper and paperboard" of which almost half went to China (Simoes and Semuels). For many first world countries, recycling has become more expensive since China, one of the largest buyers of waste materials, decided to decrease imports, so many countries are struggling to figure out what to do with their trash (Grabar). However, without China buying many recyclables, it is simply too expensive to completely recycle materials, such as paper, cardboard, glass, and plastic, as of 2020 (Grabar). Due to the change in the market, it is less expensive for many cities in the U.S. to send trash to landfills or incinerators than it is to try to recycle the materials (Semuels). Although it is better for the environment to try to recycle the waste materials, it is a couple cents cheaper to use new materials in most instances, so companies are not incentivized to recycle yet (Grabar). Although recycling benefits the environment, most companies are driven by economic considerations.

However, many countries have seen the negative effects of plastic and cardboard waste in landfills and incinerators, so governments are taking actions to promote recycling. They are providing incentives to businesses to reuse materials instead of manufacturing new ones. Governments are using tax exemptions, sanctions, and "community awareness campaigns" to

entice businesses and consumers to recycle more (Murakimi et al 99). Countries in Europe have seen success with their focus on environmentalism, as "27 EU member states reported the recycling of… 48 million tons of packaging waste" in 2009 (Pericot et al. 1932). The idea of a "circular economy," where countries and companies reuse their waste has become more appealing due to the growing environmental concern or plastic and paper waste in landfill and incinerators, as the current economy is comprised of "unsustainable production and consumption" (Kristensen and Mosgaard 1). Companies are more likely to focus on recyclable materials if there are economic reasons, even ones imposed by governments.

Plastic and cardboard waste disposal is a growing concern that needs to be addressed. Due to an increase in manufacturing and globalization, companies are shipping products all around the world, multiplying the amount of waste that needs to be dealt with. Although recycling companies have built up around this industry to meet the need, China's exit from the market has caused a decrease in demand and prices for recyclables. Therefore, it is currently not economical to recycle as much until the market can adjust. However, to deal with the growing and lasting question of the sustainable use of plastic and cardboard, many countries are looking to implement more government policies to push companies towards a "circular economy" (Kristensen and Mosgaard 1). The current plastic and cardboard waste disposal methods are not sustainable, but more environmentally friendly methods are not economically feasible for all companies yet.

III. Data

A. Data Sources

To better understand global recycling efforts and the plastic waste trade, I looked to online databases that gather information about recycling statistics. After shifting through several databases, the most prominent data came from the International Scrap Trade Database by the Institute of Scrap Recycling Industries, Inc. and the Postconsumer PET Container Recycling Rate Reports by the National Association of PET Container Resources. The companies that fund and conduct these research projects specifically focus on scrap and plastic waste. These resources provided information on the world trade of plastic waste and the cost to recycle it. The International Scrap Trade Database provided me with data about the trade of waste on a global level. The database summarizes the importation and exportation of scrap, such as lead, paper, and different metals, from the top twenty trading countries. Specifically, I looked at the importation and exportation of plastic in the top twenty most prolific countries around the world from 2007 to 2017. I used this data to determine how much plastic was being traded and by who. I wanted to see if the amount of plastic traded had decreased or increased over time and which countries trade the most plastic. As well, I wanted to ascertain if certain countries had increased or decreased their plastic trade to become a leader or not in trading plastic. This resource was helpful in understanding the overall global trade of plastic waste.

The Postconsumer PET Container Recycling Rate Reports provided information on the price of plastic and recycling. These consumer reports detailed how much PET products had been used from 2010 to 2017 and how much plastic recycling was done during this time frame. PET products stand for polyethylene terephthalate, which is commonly known as polyester or what most people refer to as plastic, even though there are many different types of plastics

(“About PET”). It is commonly used as “clear, strong, and lightweight plastic… for packaging foods and beverages,” such as soft drink bottles, water, and condiments, as well as personal and professional cleaning products (“About PET”). Specifically, I used the report to determine the change in price of PET products and recycled PET products over time. The report specified the average high and low price of PET bale prices per pound on the East Coast of the United States for every month from 2010 to 2017. PET bales are huge cubes, which are “approximately 30"x42"x 48" or 30"x48"x 60"” and “a minimum of 35,000 pounds” of used PET products that are crushed together to be stored before they are recycled (“Model Bale Specification: PET Bottles”). The bales are either made of used PET bottles (i.e. plastic bottles used for convenience drinks) or other PET materials bound together. The report allowed me to understand how the prices of plastic had changed in the last decade.

By combining the data from the International Scrap Trade Database and the Postconsumer PET Container Recycling Rate Reports, I could see how much plastic was being traded globally, how the global trade of plastic waste had increased or decreased with time, and the price of plastic waste each year. As seen in Figure 2, I used Excel to merge the data from the International Scrap Trade Database of the top 20 countries that import plastic waste and the global total of plastic waste traded in metric tons from 2010 to 2017 with the per pound price of PET bales from the Postconsumer PET Container Recycling Rate Reports. I used an end of year average between the December high and low per pound price of the PET bales to set a consistent timeframe for the price of the plastic for each year. By creating a table in Excel where I could calculate the changes in plastic waste traded in each country over time along with the changes in price of the plastic waste, I could see if there was a correlation between the amount of plastic being traded worldwide with its price. As seen in Figure 3, I did not have price data from 2007 to

2009, even though I had data for the top 20 country plastic waste importers for those years. Although I was not able to use this data in the same manner as the data from 2010 to 2017, I can still use it to calculate how the volume of plastic waste imported has changed over time globally and in each country. These resources provided me with the data to create a resource to see if there was a correlation between the volume of plastic being traded globally, the price of plastic, and how it affects different countries.

Figure 1

Definitions for Important Variables

Variable	Definition	Source
PET	Polyethylene Terephthalate (Polyester) – It is a clear, lightweight plastic used in mass production for food, beverage, and hygiene containers.	Article: About PET Publisher: PETRA – PET Resin Association
End of Year Average Price	They are averages of the average high / low non-deposit PET bottle bale prices on the East Coast of the United States during December of each year.	Article: Postconsumer PET Container Recycling Rate Reports Publisher: NAPCOR – National Association for PET Container Resources

Imported Plastic Waste	It is imports of plastic scrap, calculated in metric tons, by the top 20 largest importing countries.	Article: International Scrap Trade Database Publisher: Institute of Scrap Recycling Industries, Inc.

Figure 2

Top 20 Country Importers

	China	Hong Kong	Netherlands	Germany	USA	Belgium	Malaysia	Austria	Italy	Taiwan	Canada	India
2010	8,009,674	4,795,350	295,928	296,940	379,490	285,426	81,885	146,137	138,291	148,887	148,031	116,252
2011	8,384,190	3,962,054	374,308	302,344	342,014	322,250	142,860	210,909	145,795	153,084	153,294	131,419
2012	8,877,767	3,200,487	467,433	420,106	361,294	292,285	176,779	218,640	138,957	149,491	155,107	195,988
2013	7,881,304	2,506,171	531,881	423,052	372,705	259,805	301,435	194,626	134,360	201,522	146,523	259,614
2014	8,254,247	3,080,676	622,941	501,628	417,046	226,729	225,986	250,263	160,232	204,365	186,390	251,546
2015	7,354,229	2,864,769	598,127	545,607	393,392	259,728	249,941	245,451	153,379	221,499	249,179	185,746
2016	7,347,176	2,877,956	611,300	548,029	447,945	312,587	287,673	240,589	178,631	177,934	171,657	166,859
2017	5,828,750	1,889,224	633,601	516,740	442,544	246,820	549,786	220,192	195,905	202,099	140,662	145,580

	Turkey	Sweden	U.K.	Czechia	France	Indonesia	Poland	Portugal	Rest of the World	Grand Total	End of Year Average
2010	23,260	300,324	53,110	58,555	98,940	39,906	113,677	21,625	889,657	**16,441,343**	**$ 0.2500**
2011	55,780	255,449	64,237	93,122	109,177	90,535	113,133	55,617	1,070,135	**16,531,706**	**$ 0.1950**
2012	56,497	134,230	73,907	111,373	109,822	106,994	67,305	45,308	1,045,232	**16,405,000**	**$ 0.1900**
2013	67,396	213,483	93,487	122,698	111,921	135,993	57,771	51,078	1,202,175	**15,268,998**	**$ 0.1450**
2014	105,287	153,842	111,097	128,088	110,017	107,423	62,416	82,725	1,138,664	**16,381,608**	**$ 0.1600**
2015	104,031	179,539	87,280	131,523	117,055	97,146	85,814	134,784	1,118,591	**15,376,810**	**$ 0.0775**
2016	159,569	139,748	130,021	129,925	122,987	120,979	118,800	107,251	1,087,326	**15,484,941**	**$ 0.0975**
2017	261,863	NR	117,314	124,109	144,688	128,951	119,191	112,446	1,339,123	**13,359,589**	**$ 0.1425**

End of Year Average reprents the average price on the East Coast of the United States.

Figure 3

No price data for these years.

	China	Hong Kong	Netherlands	Germany	USA	Belgium	Malaysia	Austria	Italy	Taiwan	Canada	India
2007	6,912,222	4,145,835	221,914	239,700	416,683	281,228	81,900	131,224	199,010	122,913	187,747	169,909
2008	7,074,626	4,503,012	238,843	227,723	412,156	294,000	38,194	148,423	162,786	150,203	161,881	97,936
2009	7,325,810	4,752,654	144,459	214,448	356,098	350,481	92,323	106,394	116,475	119,829	129,748	478,491

	Turkey	Sweden	U.K.	Czechia	France	Indonesia	Poland	Portugal	Rest of the World	Grand Total	End of Year Average
2007	19,114	79,494	97,992	41,874	70,526	313	67,390	12,050	649,764	**14,148,804**	-
2008	10,848	87,251	75,784	54,849	81,392	8,588	42,222	14,876	768,681	**14,654,275**	-
2009	7,169	138,100	46,256	48,074	58,708	3,175	47,907	13,514	784,800	**15,334,914**	-

B. Data Analysis

In order to perform an analysis of the data that I had gathered, I created an Excel document with the top 20 importer countries of plastic waste and the price of PET on the east coast for 2010 to 2017. Based off this data, I chose to concentrate on the United States and China, because they have the two largest economies of any of the top 20 importing countries. The United States and China had the most data on plastic waste than any of the other top 20 importing countries. Specifically, China imports the most plastic waste of any other country in the world. As well, the United States is the leading world economy and exports most of their plastic waste to China, based off what I learned in my literature review. From this table in Excel, I conducted a regression analysis, using the regression tool under data analysis. I separated my regressions by country to focus to see if there was a correlation between price and volume of plastic waste imported in the major world economies. Lastly, I created line graphs of each regression to visualize the relationship between price and volume in each country. By conducting regression analysis of the price and volume data for plastic waste trade in the United States and China, I was able to determine the proximity of the relationship for the two variables.

My first step in performing an analysis of the information and data was to create an Excel document with the top 20 importing countries of plastic waste from 2007 to 2017 and the price per pound of PET bales on the East Coast from 2010 to 217 (Figures 2 and 3), which I outlined in the previous section. Based off the data and information that I found in this data, I chose to concentrate my analysis on the United States and China. Not only are the United States and China the largest two economies of any of the top 20 plastic waste importing countries and in the world, but they also had the most data on plastic waste within their country and on their global plastic waste trade. The United States and China had the most data on plastic waste than any of

the other top 20 importing countries. Specifically, the United States is the leading world economy and exports most of their plastic waste to China, based off what I learned in my literature review. As well, China imports the most plastic waste of any other country in the world. By narrowing down my focus to these two countries, I could focus on how the plastic waste trading relationship between them changes as the amount and price of plastic waste alters.

After choosing to concentrate on the plastic waste trading relationship between the United States and China, I moved on to the second step of my data analysis: conducting a regression analysis. From this the table in Excel (Figure 2), I conducted a regression analysis, using the regression tool under data analysis. I separated my regressions by country to focus to see first if there was a correlation between price and volume of plastic waste imported in the major world economies before looking at the relationship between the two countries. Lastly, I created line graphs of each regression to visualize the relationship between price and volume in each country. By conducting regression analysis of the price and volume data for plastic waste trade in the United States and China, I was able to determine the proximity of the relationship for the two variables.

Based on the regression analysis and linear graph below in Figures 4 and 5, there is a statistical correlation between the volume of plastic waste imported and the price of plastic in the United States. The P-value of 0.06 suggests that there is a statistically significant relationship in the United States between the two variables. This relationship is statistically significant at the 10% level, but not the 5% level, as seen in Figure 4. For every one dollar ($1) increase in the price of plastic waste, the United States imports .46 fewer metric tons, which is the coefficient for the trade relationship in the United States, less of plastic waste. As well, since the p-value for the United States regression is positive at .05, then the price of plastic will increase decrease as

the volume traded increases. As seen in Figures 4 and 5, the number of metric tons of plastic waste imported to the United States and the price per pound of PET bales are dependent on each other in the United States.

Figure 4

US Recycables Imports Regression Analysis

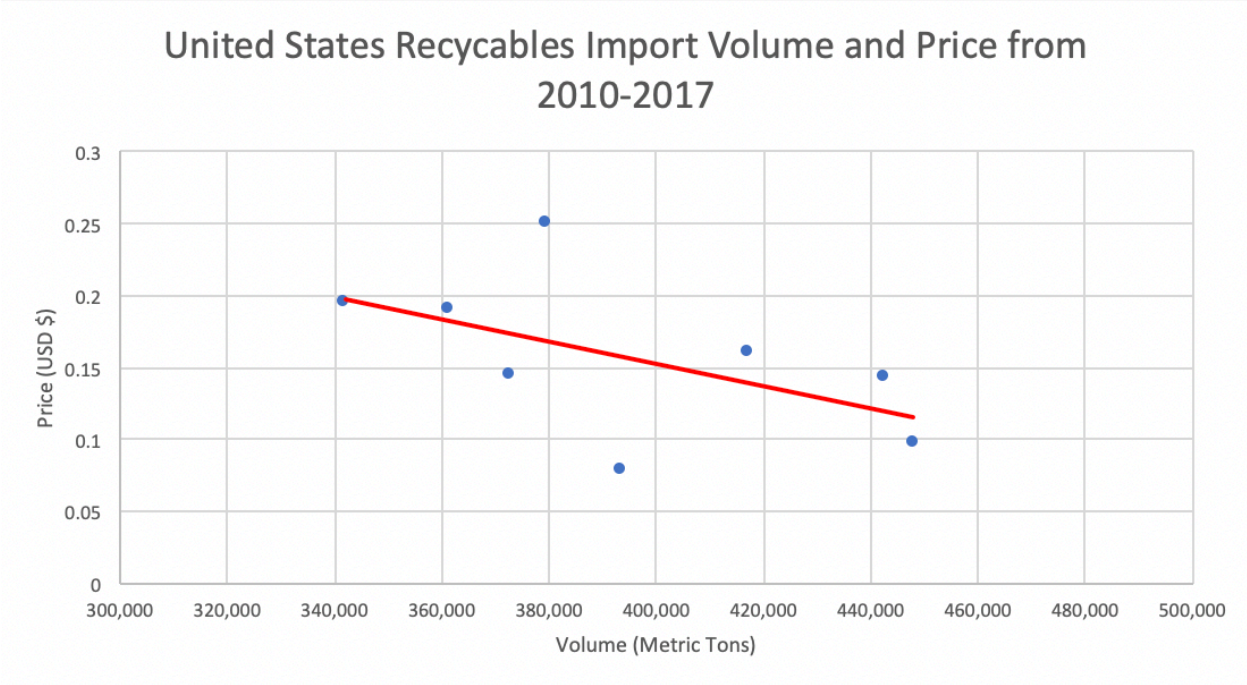
Regression Statistics	
Multiple R	0.536893987
R Square	0.288255153
Adjusted R Square	0.169631012
Standard Error	0.050390528
Observations	8

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	0.006170237	0.006170237	2.429987269	0.170047694
Residual	6	0.015235232	0.002539205		
Total	7	0.021405469			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	0.463581152	0.197357903	2.348936341	0.057141461	-0.019336241	0.946498545	-0.019336241	0.946498545
USA	-7.76557E-07	4.98163E-07	-1.558841643	0.170047694	-1.99552E-06	4.42404E-07	-1.99552E-06	4.42404E-07

Figure 5



The data shows a different relationship for the importation of plastic waste into China. Based on the regression analysis and subsequent linear graph in Figures 6 and 7, there is not a statistical correlation between the volume of plastic waste imported the price of plastic in China. The P-value for the Chinese data, which was 0.73, was greater than the Significance F, which was 0.24, shows that meaning that there was is not a statistically significant relationship in the data. However, based on this data for China, for every one dollar ($1) increase in the price of plastic waste will result in the country importing will import .06 more metric tons, which is the coefficient for the trade relationship in the China, more of plastic waste. Also, the price per pound of PET bales will increase as the volume of imported plastic waste increases. As seen in Figures 6 and 7, the amount of plastic waste in metric tons imported to China and the price per pound of PET bales are not dependent on each other in China.

Figure 6

China Recycables Imports Regression Analysis

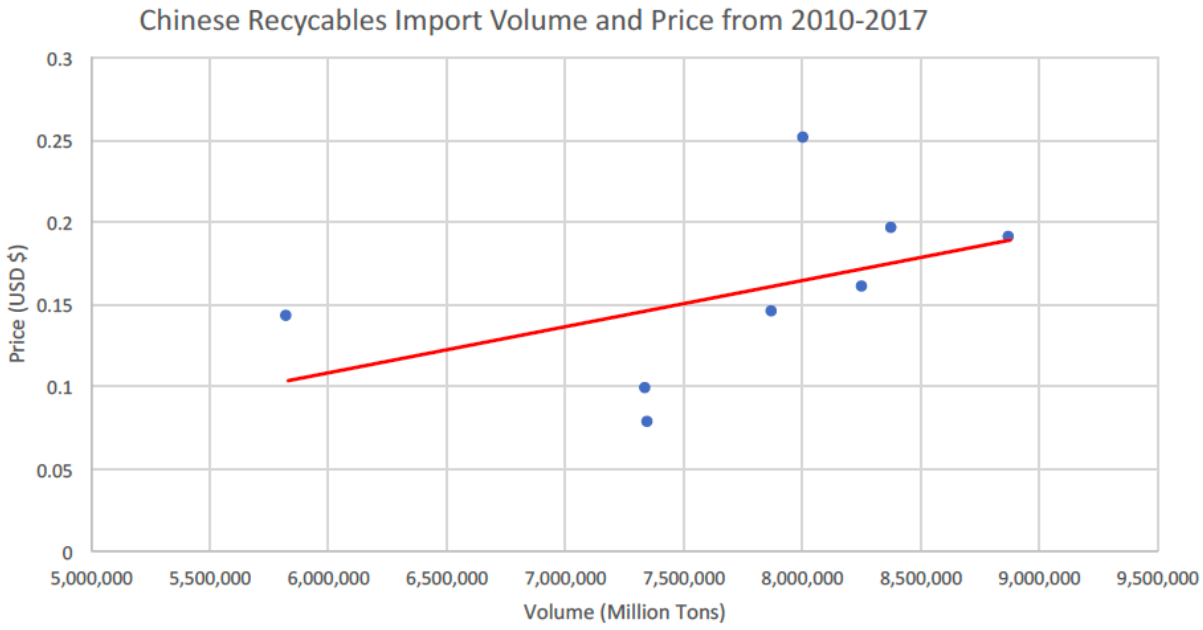
Regression Statistics	
Multiple R	0.46986257
R Square	0.220770835
Adjusted R Square	0.090899308
Standard Error	0.052725335
Observations	8

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	0.004725703	0.004725703	1.699917137	0.240084749
Residual	6	0.016679766	0.002779961		
Total	7	0.021405469			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	-0.059684557	0.167378619	-0.356584115	0.733607793	-0.469245282	0.349876169	-0.469245282	0.349876169
China	2.80118E-08	2.14846E-08	1.303808704	0.240084749	-2.45591E-08	8.05827E-08	-2.45591E-08	8.05827E-08

Figure 7



Overall, I found that there is a significant and negative relationship between price and volume of plastic imported in the United States but not in China. In the United States, the price of plastic waste decreases as the volume imported increases. Oppositely, the price of plastic waste increases as the volume imported increase in China. As the per-pound price of PET bales increases, the volume of imported plastic waste decreases in the United States and increases in China. Therefore, the increase in plastic waste prices causes less plastic waste to go to the United States and more to go to China.

D. Caveats

Although I have been able to conclude from my data that there is a relationship between the volume of plastic waste imported and price in the United States but not in China, I am aware that my conclusions are limited. I was only able to use data from 2010 to 2017, which is a narrow timespan. Using a larger timespan would increase the precision of the estimates. As well, I am only using two countries to determine whether or not there is a relationship between the volume and price. The relationship, or lack thereof, could be defined more concretely if there were more country variables. Using countries with smaller economies and less trade would add a different perspective the data and conclusions, too. These two considerations could expand the data and augment the results.

Another important consideration of my findings that I am aware of is the origin of the price data. The Postconsumer PET Container Recycling Rate Reports calculate the price per pound of PET bales from 2010 to 2017 on the East Coast of the United States. I was unable to find data that synthesizes the global price of PET bales, as well as the national price of PET bales in each country. I believe that this additional data would give a more complete look at the

relationship between the volume of plastic waste imported and its price, especially in China. I do not want to conclude too strongly about the relationship between the volume of plastic scrape imported into a country and the price; however, I believe that my findings are the initial steps to determining more about the relationship.

IV. Policy Recommendation and Conclusion

From my analysis of the data I collected, I have found that there is a difference in where plastic waste is imported globally depending on the per pound price of PET bales on the East Coast of the United States. When prices are lower, corporations in the United States are willing to buy more plastic waste. However, when the price is higher, less plastic waste is bought in the United States and more plastic waste is imported to China. Based off the combination of the literary research and data analysis, corporations in the United States are unwilling to buy as much plastic waste nationally or import it from other countries, when the price is high, so they turn to other options. Therefore, when the price of PET bales is higher, US corporations sell their plastic waste to China and other countries or dispose of it. When these corporations dispose of the plastic waste, sometimes it is recycled in the United States, but more times than not (due to the increase in PET bale prices), the plastic waste is dumped in a landfill or burn in an incinerator. Neither of these options is beneficial to the environment, but it is less expensive for the company and cuts down expenses. The per pound price of PET bales in the United States affects where companies deposit their plastic waste and how the environment is affected by plastic waste.

Based off my literary findings and the research I conducted, I believe there are two explanations for the increase in China's importation of plastic waste considering with an increase

in PET prices. As I mentioned previously about the caveats of my findings, I think there could be a difference in the price per pound of PET bales in China versus on the East Coast of the United States. Therefore, even when prices are higher in the United States, the prices could be lower (either due to differences in supply and demand or exchange rates), making the importation of plastic waste more attractive to Chinese companies than companies in the United States. My other explanation is that Chinese companies were taking advantage of the United States' and other global companies desire to sell and get rid of plastic waste when the price is higher, so they could recycle it and sell it back to these companies as shipping and packaging materials at a higher rate or use it for another purpose. China became the dumping grounds for the rest of the world's plastic waste, along with other types of debris.

However, in 2017, China banned almost all of its imports of plastic waste due to environmental concerns "to halt a deluge of soiled and contaminated materials that was overwhelming Chinese processing facilities" (Katz). Obviously, for China, the economic benefits of importing 43.6% of the world's plastic waste in 2017 (based off data I collected) were not as high as the environmental costs due to this ban. Now that China is not accepting imports of plastic waste, other countries must find ways to dispose of it. Many countries, including the United States, have turned to dumping the waste in landfills, incinerating it, and allowing it to pile up (Katz). As well, the recycling markets are scrambling, because they lost a huge buyer (Katz). The market is shifting to Southeast Asia, but it will take years for these countries to replace the buying power of China (Parker). Unfortunately, I do not have the volume or price data to see how the market has been affected since China banned the importation of plastic waste in 2017.

Countries cannot keep importing plastic waste at the 2017 global rate of 13,359,589 metric tons per year, so there must be a solution to the economic and environmental problems ("International Scrap Trade Database"). After researching the issues, I believe the best way to combat the problem would be financial incentives from governments to stop the overabundant use of plastic. Although countries, such as the United States, already provide some financial incentives to companies, they could be increased. Large global companies, such as PepsiCo. and Coca-Cola, are already trying to find ways to limit the use of plastic in their packaging materials to win over environmentally conscientious consumers. However, tax cuts for companies that find new ways to decrease their plastic consumption and waste would inspire them to increase their efforts and other companies initiate research, as well. If the decrease in taxes was higher than the extra cost of using different or recyclable materials, then companies would want to change their practices. As well, tax cut incentives to recycle plastic and other waste locally that could not be switched out for other materials would not only help the large corporations, but it would also help the recycling industry and the environment. Lastly, if companies were forced to find new materials or ways to ship and package products, then they might find that the new method is better than using plastic and less expensive. Overall, finding a new way to ship and package products would be better for everyone involved.

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