Scrap That: Plastic Waste Trading in the European Union: A quantitative study on the relation between EU member states' institutional setup and levels of plastic waste imports

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A quantitative study on the relation between EU member states' institutional setup and levels of plastic waste imports

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Abstract of full project

This Master thesis focuses on the effect of institutional factors on the imports of plastic waste between European Union member states. It analyses the historical development of the international waste trade up until its current state. Then, it constructs an exploratory model focusing on the effects of institutional factors on intra-EU imports of plastic waste. It tries to estimate the effects through quantitative analysis using panel data analysis on intra-EU import data. The theoretical framework analysed in this project is institutional, but the results show little evidence that institutional factors affect plastic waste imports. By researching this, the study aims to gain a deeper understanding of the dynamics of waste trading amongst Global North countries, specifically in the EU context. This can allow for contributions to the optimisation of EU circular economy policy.

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Introduction

Waste trading is a nefarious business, with large risks attached if not done properly. In the late 1980s, a ship called *Khian Sea* tried to offload its load of incinerator ash from Philadelphia in several US ports but was turned away every time (O'Neill, 2000, pp. 40–41). It spent several months unsuccessfully looking for a port that would accept the waste, and eventually dumped most of its toxic cargo on a beach in Haiti, illegally labelled as fertiliser (Baggs, 2009, p. 3). Not just the US is prone to these incidents. The EU has experienced its own waste shipping incidents as well. More recently, in 2006 the *Probo Koala* went from Amsterdam to Côte d'Ivoire to offload its freight of highly toxic hazardous waste as less toxic waste, after it was spurned by the Dutch port authorities due to its excessive toxicity (van Wingerde & Bisschop, 2019, p. 89). In Abidjan, a local contractor accepted the waste and illegally dumped it in its landfills. This led to contamination and pollution of the area with toxic chemicals.

Plastic waste creates hazards for most living things on Earth (Lavers et al., 2022). The oceans are filled with plastic waste, and it is even found in the remotest areas. Even in the depths of the Mariana Trench and the heights of Mount Everest, plastic waste has been found (Chiba et al., 2018; Napper et al., 2020). The trade of plastic creates local problems in many countries. Often, shipping waste to Global South countries harms them. These countries often do not have sufficient disposal facilities in place for their own plastic waste, (Lavers et al., 2022, p. 3). Shipping more waste on top of their waste might cause heaps of waste to accumulate in the environment (Romson et al., 2024, p. 2). Workers at Chinese recycling facilities face health risks from toxic fumes and local environments often become polluted with plastic waste (Cotta, 2020, p. 263).

Between 1952 and 2017, China accounted for 72% of all global plastic waste imports (X. Liu et al., 2022, p. 1). In 2018, China banned imports of plastic waste to face environmental and ecological concerns (X. Liu et al., 2022, p. 2). After this ban, the global trading pattern of plastic waste became much more dispersed, with many different actors taking on the waste not headed for China any more (Pacini et al., 2021). This is in line with the post-ban general trend in the EU, where extra-EU plastic waste exports to developing non-OECD countries are dropping, whilst intra-EU (among EU member states) trading is rising. Figure 1 shows this trend. Extra-EU shipments peaked in 2014 with 2,7 million tonnes. By 2022, this had dropped to 1,1 million tonnes (Eurostat, 2024b). There exists a lot of heterogeneity per country in the amount of plastic waste imported per member state as visible in Table 1 in the Dependent variable section. Plastic waste trading is a political problem, as the imports and exports of waste create winners, who dispose of their waste, and losers who have to deal with the waste in the end. Improper handling can create problems, as shown in the examples above.

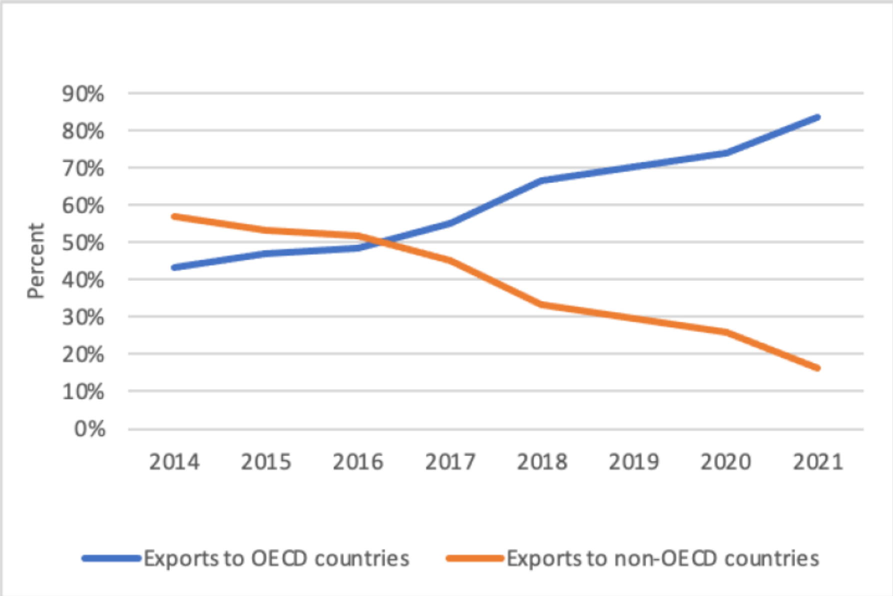

Figure 1: Export of plastic waste to OECD and non-OECD countries, as percent of total weight. Source: Romson et al. (2024, p. 7).

Why do states ship their waste to other countries? Obviously, to get rid of it. The more interesting question is: why do states accept other states' waste? Why do they want to be burdened with the plastic waste created by others? Is it voluntary? Is it coercion? Is it happenstance? And why do states differ so much in the amount they take in? Why does a country like the Netherlands accept almost 650 thousand tonnes of waste, while a country like Finland accepts slightly over a tenth of that? (Eurostat, 2024b). This study centres on the question:

What is the effect of institutional factors on intra-EU plastic waste imports?

Much research on waste trading concerns the transfer of plastic waste from Global North countries to Global South countries (Brownell, 2012; Pratt, 2011; Strohm, 1993; Xu et al., 2020). The transfer between Global North countries among themselves has not been given the same amount of attention (Bai, 2020, p. 34). This study aims to fill that gap. It is interesting to see what factors determine the level of waste imports when factors like wealth and regulatory advancement are relatively similar. Analysing the 28 EU member states will allow me to look into this, as it would mean I am analysing waste trading among rich nations, in the spirit of O'Neill (2000). The research puzzle is causal and focuses on why wealthy states accept other wealthy states' plastic waste. In contrast to O'Neill (2000), who uses qualitative analysis in a case study of the institutional makeup of 5 Global North countries, this study answers the research question through quantitative analysis. Many studies research drivers of waste imports or exports quantitatively, but there are no studies that focus exclusively on the effects of institutional setup on waste imports (Cassing & Long, 2021; Glover, 2017; Ilankoon et al., 2018; Kellenberg, 2012, 2015; X. Liu et al., 2022; Y. Liu & Lai, 2021;

Pacini et al., 2021; Xu et al., 2020). No study has yet been carried out where the impact of institutional factors on plastic waste imports is analysed quantitatively. This makes this study novel.

This study addresses the research question by constructing an explanatory model estimating the effects of institutional factors on the size of plastic waste imports of all 28 EU (including the United Kingdom) countries from 2004-2021. It tries to identify the effects of three concepts on the import of plastic waste: regulatory structure, regulatory style, and mode of implementation. These concepts will be further developed in the theory section. The study aims to research this using linear panel model estimation, also known as cross-sectional time-series (CSTS) data analysis, to see how the different factors affect the imports of countries. By constructing four linear panel models, this study aims to gain more insight into the drivers of the intra-EU plastic waste trade. The institutional approach to waste trading has been studied, but no studies are approaching the effect of states' institutional setup on waste imports with a quantitative method. This study is a first step in conducting such research.

The study has the following structure: first, it presents a literature review on the origin and current state of international waste trading. Then, it outlines the theoretical framework of the study and argues which variables are included in the models. In the results, it will discuss the explanatory power of the model. Finally, the study will conclude and argue for lessons to be drawn from the models.

Literature Review

How did the trade in waste begin?

There exists remarkable consensus on the origin of waste trading. Most authors agree that the growth of waste trading coincided with the increase of global trade and liberalisation since the 1970s (Brownell, 2012; O'Neill, 2000, 2018; Pacini et al., 2021; Strohm, 1993). Since then, Global North economies started shipping their waste to other countries because of three factors. First, waste generation increased dramatically due to the growth of Global North economies (Strohm, 1993, p. 190). As more goods were produced and consumed, more waste was produced in Global North countries. Second, it became increasingly difficult and costly to manage waste properly within Global North countries. Existing disposal facilities were at capacity, and increasing it was made difficult by the combination of more stringent environmental regulation and Not-In-My-Backyard (NIMBY) attitudes among communities surrounding envisioned disposal sites (O'Neill, 2000, p. 36; Strohm, 1993, p. 190). Third, whilst disposal costs were increasingly high in Global North countries, Global South countries did not have very stringent regulation. This made it cheap and attractive to start shipping waste there for disposal (Brownell, 2012, pp. 254–255; Strohm, 1993, p. 190).

Some companies started to outright dump their waste offshore developing countries, as it cost a fraction of illegal disposal near the source and they figured the chances of getting caught were slim due to the low state capacities of such countries (Brownell, 2012, p. 255). Incidents in the 1980s like the New York Garbage Barge and Khian Sea incident raised awareness about the risks of waste dumping and trading, and inspired parts of the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal (Basel Convention).

The accumulation of hazardous wastes can lead to toxins contaminating groundwater, soil and air and can lead to damage to ecosystems (O'Neill, 2000, p. 29). Wastes like plastics, for instance, have all sorts of detrimental effects on life. More and more hazardous effects of plastics are being discovered constantly, such as reduced body size, altered blood chemistry, tissue damage, and impaired embryonic development. Plastic ingestion is ubiquitous around the globe, as it has been recorded inside organisms as small as krill and as big as sperm whales. Even human placentas have been recorded to contain plastics (Lavers et al., 2022, pp. 2–3). Children born to women living near European landfill sites have a statistically significant higher chance of birth defects (Dolk et al., 1998, p. 423; Lavers et al., 2022, p. 3). These dangers of unaccounted plastic waste show the importance of proper handling and transportation of plastic waste.

Waste treatment facilities in recipient countries are often not even up to par with the pressure of locally produced waste. As they receive additional international waste shipments, Global South countries become engulfed in waste, which often accumulates in the environment (Hoornweg & Bhada-Tata, 2012, pp. 22–24; Plastic Soup Foundation, 2022, p. 10). Trading such delicate substances is thus not to be done lightly as its improper handling can have dire consequences for both mankind and the planet.

Why do states trade waste?

An apparent pattern of waste trading is the direction North to South. Many Global North economies produce a lot of waste, while Global South countries import it (Xu et al., 2020, pp. 8–10). Some scholars connect this to neo-colonialist tendencies of Global North countries to exploit Global South countries. According to them, the predominantly Western countries that make up the Global North are inclined to look upon (often African) Global South countries with disdain. They see their culture as underdeveloped, or worth less than their own advanced Western culture. This leads to what some scholars call toxic waste colonialism, where Global North countries have little regard for the harmful effects of waste shipping on the population of the Global South. Global

South countries are used as dumps for Global North countries (Brownell, 2012, pp. 256–257; Pratt, 2011, pp. 586–588). It is important to note the involuntariness of the transaction in this school of thought. Rather than possessing the free choice to sell their pollutability, accepting waste imports is due to the poor position Global South countries have. It was not a conscience choice to have loose regulation, but the capacity for creating strict regulation was lacking (Brownell, 2012, pp. 257–258; Strohm, 1993, p. 137). For instance, Global South countries have no choice but to accept the transfer of waste in return for financial compensation, as their financial condition is desperate.

There exists a camp that views economic motivations and rational reasoning as the premier drivers of waste trading. Lawrence Summers, former Chief Economist of the World Bank, encapsulated the thought as follows: "I think the economic logic behind dumping a load of toxic waste in the lowest wage country is impeccable and we should face up to that (…). I've always thought that the under-populated countries in Africa are vastly under-polluted." (Cassing & Long, 2021, p. 2). The general logic is that underdeveloped countries have a comparative advantage in their ability to accept pollution from waste, i.e. they are more suited to handle waste. As these countries have abundant natural reserves, they have the "advantage" of being able to fill them with waste, unlike developed countries that are already filled with people and infrastructure. This is known as the pollution haven hypothesis (Cassing & Long, 2021, p. 2; Copeland & Taylor, 2004, p. 9; Kellenberg, 2012, p. 69; Strohm, 1993, p. 135). Poorer countries are more likely to accept harmful waste shipments than rich countries. For the sake of development and job creation, they allow polluting industries and enforce only loose environmental regulation (Cassing & Long, 2021, p. 2). The logic can be extended to waste. In return for financial benefits, Global South countries accept waste shipments, hoping to develop their economies further. Some proof exists for this "waste haven hypothesis," showing that waste imports decline with income (Y. Liu & Lai, 2021, pp. 6–7). This is refuted by Baggs however, who shows that relatively poor countries export their waste to relatively rich countries (2009, p. 7). Other authors in the economic camp suggest athat it is the abundance of capital that decides waste flows. Larger economies are better able to invest in waste treatment facilities, and this capacity then becomes larger than their waste production (Baggs, 2009, pp. 4, 7–11; Higashida & Managi, 2014). Surrounding countries then buy into this overcapacity, by shipping their waste to these countries. According to these authors, distance and shared borders are the most important factors in determining the direction of waste trade.

A different, but not necessarily contrasting camp in the waste trade literature sees institutional and regulatory factors as the most important reasons for states to trade waste. Authors in this camp suggest that differences in the way regulation and institutions are set up play a decisive part in deciding the size and direction of waste flows. When countries develop, they often demand stricter environmental regulation to protect their environment from harmful economic practices. This produces global heterogeneity in regulation, which plays into the hands of waste trading (Kellenberg, 2012, p. 69, 2015). The reasoning behind it can be focused on business. The logic behind it is that the fixed costs moving of an entire factory to a country with eased regulation are higher than the costs saved over time by the lower regulations. It is then cheaper to merely move the waste to a country with less restrictive environmental regulations than the entire factory (Strohm, 1993, pp. 132–133).

<u>Waste trading and the European Union</u>

The Basel Convention forms the basis for EU legislation regarding waste, which is stated in the Waste Framework Directive (WFD) and Waste Shipments Regulation (WSR) of 2006 (EC b; EC c). These rules are undergoing major changes since the Green Deal. In 2021, the WSR was amended to ban plastic waste shipments from the EU to non-OECD countries, to stop the poorer receiving countries from being overflown with plastic waste. This is only allowed under strict conditions: it must be clean and non-hazardous, not hard to recycle, and both countries need to approve the shipment (European Commission, n.d.). In 2023, an even stricter agreement was reached on new regulation regarding waste exports outside the Union. Plastic exports to non-EU countries are banned completely. Strict conditions for other waste exports apply as well. All other waste can only be exported if it can be proven that the recipient country can properly process the waste. This regulation aims to reduce the environmental impact of EU waste, increase the recycling of waste within the EU, and boost the circular economy. At the time of writing, the proposal has been adopted by the member states' representatives within the Council (Coreper) and to the Parliament's environment committee and is waiting to come into force by 2026 (Council of the European Union, 2023; European Commission, n.d., 2023).

Theory

For the theoretical framework, I build upon the institutional approach to waste trading. In this section, I outline the approach more fully and come to three hypotheses that are grounded in this theoretical framework. In this framework, I draw heavily on the work of O'Neill (2000). The reason to study institutional factors over the content or effectiveness of regulation is as follows: Given the fact that all EU member states have similar, advanced systems of regulation in place due to the overarching EU framework, the institutional approach focuses not on the content or effectiveness of regulation, but how countries come to regulation (O'Neill, 2000, p. 55). There might be differences between member states, but as they are all members of the EU, there is at least a base level they have in common.

O'Neill puts forward the notion that two concepts determine a state's propensity to import waste: *regulatory style* and *regulatory structure*. Regulatory structure is how responsibilities are distributed between different agencies or levels of government (2000, p. 55). This means that the import is decided by one strong central authority or multiple centres of authority. Regulatory style is how policy is made and implemented (2000, p. 55). This means that either many or few different interest groups have access to the policy process.

Regulatory structure

Regulatory structure can be diffuse or centralised and is composed of three parts: the ownership of the waste management industry, the allocation of regulatory responsibilities between government agencies and levels of government, and the centralisation of a state (O'Neill, 2000, p. 56). As ownership of waste management is outside the scope of this study (as explained in the Data selection section), I will focus on the allocation of regulatory responsibilities and centralisation.

A state in which regulatory responsibilities are distributed amongst many different levels of government and agencies is diffuse, whilst where there is only the central government that decides on policy is centralised (O'Neill, 2000, p. 56). The federal or unitary nature of a state affects the structure in the same way, as federal states are diffuse, and unitary ones more centralised. O'Neill's argument holds that states with diffuse structures are more likely to import waste (2000, p. 56). This is because in diffuse systems, there are fewer lower levels of government, that are more in favour of local interests, which usually oppose waste imports. In contrast, centralised systems often have a central government that puts the larger, state-wide interest over local ones, thus increasing waste imports (2000, pp. 63–64).

Regulatory style

According to O'Neill, regulatory style is composed of two parts: the number of interest groups with access to the policy process, and the mode of implementation applied in a state (2000, pp. 63–64).

Policy access can be open or closed in terms of groups that have access (2000, pp. 63–64). This determines how closed or open the style of regulation is. In closed styles, states act on their own in formulating and implementing policy, while in open styles, many different actors have a seat at the policy table. The argument is that states with closed styles, where very few actors have a say on policy, import more waste. This is because less attention will be given to the arguments of interests such as environmental advocacy groups, and more to business interests.

Mode of implementation is about how strict regulation is implemented and can be either rigid or flexible (2000, pp. 63–64). When a country has a flexible mode of implementation, rules are applied more on a case-by-case basis. In environmental terms, this means that companies are obliged to implement environmental regulation, but that they can decide for themselves what is feasible. There is a gap between effort and result. In contrast, a rigid mode of implementation entails hard quotas and targets for all companies to adhere to. O'Neill mentions the UK as an example of a more flexible mode, and Germany as a more rigid one (2000, pp. 63–64). According to her, states with flexible modes of implementation are more likely to import waste, as companies are under a lot less scrutiny from the government.

Hypotheses

Based on the theoretical framework outlined above, I formulate three theoretical expectations. The first holds that states with a decentralised institutional setup are more likely to import waste from abroad than states with a centralised, unitary structure. The second expectation holds that states in which few interest groups are able to participate in the policy-making process are more likely to import plastic waste from abroad. The third expectation holds that states where rules are implemented more flexibly are more likely to import plastic waste from abroad. The hypotheses that will be tested are as follows:

H1: States with a highly decentralised structure import more plastic waste.

H2: States where few different interest groups have access to the policy process import more plastic waste.

H3: States with a flexible implementation mode import more plastic waste.

Methodology

The research design is a most similar systems design linear panel model analysis. In essence, the aim is to create a model that predicts the amount of intra-EU import of plastic waste for all EU member states. To test the hypotheses, I constructed a new dataset, combining data from multiple datasets. The process of data selection, collection and analysis is discussed in this chapter, as well as this methodology's drawbacks and how I overcome them.

Scope

The research is a most similar systems design, as many institutional aspects of EU member states are similar, but their plastic waste imports vary heavily. Compared to the rest of the world, they are wealthy, fairly free party democracies, with a lot of (environmental) regulation. Additionally, this regulation largely coincides due to the overarching superstructure of the EU. These similarities allow me to isolate the effects of institutional differences between countries on their propensity to import plastic waste. The United Kingdom (UK) is included in the research until 2019 because they left the union in 2020. The UN Comtrade database data is used to fill in their values for plastic waste imports, as they are not included in the Eurostat data.

The time frame of the study is 2004-2021. This time frame was chosen as most studies in the field have not yet included more recent years in their analysis. This makes my study very topical and relevant. The start date of 2004 is chosen to give some effects from the years prior to the coming into force of the EU WSR, which came into force in mid-2006 (European Commission, n.d.). The sample size is N = 27 x 18 + 16 = 502, as 27 EU member states are analysed for 19 years, and the UK is tested for 16 years. Missing cases in the data reduced this number to N = 491, which is a decrease of 2.2%

For the testing of H3, data was only available from 2007 to 2021. This forces me to select this shorter time frame to test the hypothesis. This means that for the testing of H3, the sample size is N = 28 x 15 = 420. Missing cases in the data decreased this number to N = 372, which is a reduction of 11.4%

Data selection

This section outlines the selection and operationalisation of indicators for the different variables used in this study. Descriptive statistics of all variables can be found in the results section. The research depends heavily on the availability of data on both the dependent as well as the independent variables. As this study is too small to allow me to construct my own variables on the regulatory structure, style, and mode of implementation of 28 EU countries, the study relies on existing databases. Many datasets lacked a part of the member states or only had data available for too small a timeframe. An example is the variable regulatory style, where I could not easily access quantitative data on the private versus public ownership of the waste management industry easily accessible. Therefore, I chose to omit this ownership of the waste management industry. Sometimes, this means that the variables I use are slightly incongruent with the theoretical concepts. This forces me to be creative in the selection of indicators. This raises problems for the validity of my research. I overcome this by choosing variables that can be argued for that they overlap with the theoretical concepts as closely as possible. This section will outline my arguments for using each indicator.

Dependent variable

The dependent variable of this study is the amount of plastic waste imported by EU member states from other EU countries. For data, I turned to Eurostat, where imports are aggregated by tonne and displayed yearly from 2004-2023 (Eurostat, 2024b). The metadata on this dataset states that plastic waste is conceptualised based on the EU Combined Nomenclature codes, which in turn is based on the UN Harmonised System (UN HS) (Eurostat, 2022). For plastics, UN HS code 3915 is used. This consists of ethylene polymers, styrene polymers, vinyl polymers, and other non-specified plastic wastes (Kellenberg, 2012, p. 84). For the UK, I use Comtrade database data, which also uses UN HS code 3915 for plastic (UN Comtrade Database, 2024). The UK's Yearly imports from the 27 other EU member states into the UK are aggregated from 2004 until 2019.

Table 1: 2017-2021 annual intra-EU imports of plastic waste per EU Member state

Country	2021	2020	2019	2018	2017
Total	**2,872,862**	**2,406,597**	**2,558,849**	**2,527,316**	**2,614,536**
Netherlands	642,813	530,804	458,952	454,211	520,038
Germany	424,724	377,990	367,048	374,787	406,474
Austria	227,540	185,535	204,038	180,413	205,497
Belgium	222,374	197,756	197,569	196,363	221,312
Czechia	216,815	208,532	199,659	177,282	127,081
Poland	157,792	133,807	120,671	147,909	135,137
France	137,324	120,666	129,180	128,905	120,377
Italy	125,939	113,629	110,322	142,505	170,955
Spain	122,520	100,267	97,194	101,293	81,618
Slovenia	112,515	93,841	82,636	79,381	82,293
United Kingdom	-	-	96,861	105,974	110,239
Denmark	79,804	21,299	73,880	71,588	41,895
Lithuania	73,155	49,758	46,584	42,928	36,102
Portugal	65,499	39,796	66,353	51,559	48,825
Romania	58,354	53,619	83,460	72,659	62,388
Bulgaria	46,390	35,044	41,130	37,876	33,561
Hungary	24,916	9,838	14,006	13,621	27,475
Ireland	23,681	26,575	50,430	62,626	65,716
Greece	22,857	19,310	29,000	16,976	13,421
Croatia	18,649	30,728	32,260	17,149	18,317
Slovakia	17,885	15,478	21,641	20,282	41,569
Latvia	17,710	12,065	8,220	4,242	16,268
Luxembourg	12,581	12,093	12,322	12,639	14,078
Sweden	9,445	3,642	8,596	7,775	7,553
Finland	7,048	8,265	4,325	3,853	2,998
Estonia	4,533	3,710	2,508	2,516	3,348
Cyprus	0	2,549	0	4	0
Malta	0	2	4	-	3

Note: Imports are given in tonnes, sorted by largest importer in the most recent year reported. "-" denotes no data was available for that year. Source: Eurostat (2024b) *and UN Comtrade database* (UN Comtrade Database, 2024).

Table 1 shows the plastic waste imports per country per year in tonnes for the most recent years of the dataset. It is interesting to see that a country like the Netherlands surpasses every other country by some distance, including European giants like France, Italy, and Germany. Other relatively small countries like Slovenia and Czechia rank high in their imports. The data is very heterogeneous. It appears that imports are increasing for some countries, but decreasing for others. Some countries exhibit a dip in imports in 2020, which might be the result of the COVID-19 pandemic, as production of products generally decreased in that period. Other countries are not that much affected by this phenomenon.

Independent variables

Table 2 shows an overview of what signs each variable is expected to have, as dictated by the hypotheses.

Regulatory structure

For regulatory structure, I use the indicator POLCONV from the Political Constraints Index dataset (POLCON). The indicator measures the amount of political constraints, i.e. the difficulty of changing policy for 1 actor in the political field in a country. This is constructed with 8 different aspects: the number of branches of government with veto powers, the extent of party alignment within branches of government, and the preference heterogeneity in each branch (Henisz, 2002). The variable is a continuous variable ranging from 0 to 1, with high scores indicating a high amount of constraints for any one actor to instigate policy change. This is an appropriate variable to observe the institutional structure of a country. High scores indicate more political constraint and less feasibility for policy change. This corresponds to a decentralised structure of regulation, as there are many different levels of government with the power to instigate or prevent change. Low scores indicate a more centralised structure. According to H1, I expect that countries with high values for Constraints import less plastic waste. High values indicate an open regulatory structure, where many different bodies have a say on policy. Low values indicate a closed regulatory structure, where central governments have fewer levels of lower government to contend with.

Regulatory style

As proxies for regulatory style, I use deliberative and participatory component indices from the Varieties of Democracy 14 (V-dem) dataset. This dataset includes data on the status and development of democracy in most countries in the world from 1789-2023 (Coppedge et al., 2024, p. 44). According to the V-dem codebook, the deliberative principle holds that decisions in a country are made based on reasoning about the common good for the polity, rather than coercion or the whims of any particular group that finds itself in a position of power (2024, p. 58). The indicator assesses whether elites in a country respect counter-arguments and take into account divergent positions when making a decision. The participatory principle holds that citizens need to participate in political processes other than electoral ones (2024, pp. 48, 55). For example, citizens might engage in civil society organisations, protests or sub-national elected bodies.

The participatory component is a good proxy for regulatory style as it indicates the extent to which groups in society are able to voice their opinions. This is a prerequisite for being able to influence policy, as per O'Neill, but it is not sufficient (2000, p. 62). This is where the deliberative component comes in. Only in a polity where enough attention is given to what is best for everyone, and where multiple parties are given a voice in the decision-making process, do these two factors work together to what O'Neill would call an open style of regulation.

Both indicators are continuous on a 0-1 scale, with higher values indicating a country has incorporated the aspect more fully. For deliberative, this means that the country has a more open discussion about decision-making in the polity, and more parties are consulted. For participatory, this in turn means that a country has a polity in which people engage in politics through civil society organisations, referenda, and subnational elected bodies (Coppedge et al., 2024, pp. 55, 58). For this study, higher values indicate a more open style of regulation, whilst lower values indicate a more closed style. According to H2, I expect that countries with high values for both variables import less waste. Countries with higher values have more interest groups and voices at the decision-making table, which would decrease the amount of plastic waste that is imported. In countries with low values, mostly government and business interests have a voice in the process, which increases waste imports.

In this study, the separate components are preferred over their index combined with democracy. I specifically look at countries' regulatory style, which I do not want to be muddied with the functioning of their democracies. As many Eastern European countries were new, developing democracies for a large part of the time frame, and others experienced democratic backsliding for a period, there can be much variance in their respective democratic aspect. Using only the deliberative and participatory components thus is more appropriate in this regard.

Mode of implementation

To analyse the effect of the mode of implementation, I use the size of the bureaucracy in a country. I use this as a proxy for the flexibility of systems. According to O'Neill, smaller bureaucracies tend to be more flexible, while larger ones tend to be more rigid (2000, pp. 63–64). Specifically, I use OECD data from the yearly updates from Government at a Glance. To display the size of a bureaucracy, the metric "employment in the general government as a percentage of total employment" is used (OECD, 2023). The data is available from 2007-2021, and data from Bulgaria, Cyprus, and Malta are missing. In accordance with H3, the expectation is that countries with higher values have lower imports, as low values denote a smaller bureaucracy and thus more flexible mode of implementation.

Control variables

Population

To control for the size of countries, this study uses population as a control variable (Y. Liu & Lai, 2021). The logic is that larger countries attract more waste, as there is more demand for the goods that can be made from the waste (Higashida & Managi, 2014, p. 261). Also, as countries with larger populations have a larger economy, we can expect imports to rise with Population. The logic behind this is that larger economies have larger processing capacities, as they have more financial space to invest in these facilities (Baggs, 2009, p. 7; Glover, 2017, p. 61). As these countries have more capacity, it is more likely that they import from their smaller neighbours, who lack these facilities. Research has shown that countries like the Netherlands and Malaysia require large imports to fuel their highly developed plastic recycling industries (Romson et al., 2024, p. 16). As data was not available from a single source for the selected time frame, I constructed this variable by combining data from CPDS and Eurostat. For 2004-2021, population is taken from the variable "pop" in CPDS (Armingeon et al., 2023). For 2022-2023, population is taken from Eurostat (2024a). Population is given in thousands of inhabitants. Some researchers also use GDP as a control variable to control for the size of countries (Cassing & Long, 2021, p. 2; O'Neill, 2000, p. 36). However, as this variable produced high correlation with Population, GDP was omitted from the variables.

GDP per capita

To control for the effect of differences in wealth between countries, I use GDP per capita, similar to Kellenberg (2012) and Liu & Lai (2021). GDP per capita is calculated by dividing World Bank GDP data by the Population figure mentioned above and multiplying by 1000, to get GDP per capita in 2024 US dollars per person. GDP is taken from World Bank data and is given in 2024 US dollars (World Bank, 2024). Data is available from 2004-2022, as GDP is available until 2022. In concurrence with the Pollution Haven hypothesis, I assume that countries with lower GDP per capita within the EU also accept more waste shipments, to gain monetary impulses (Cassing & Long, 2021; Copeland & Taylor, 2004; Y. Liu & Lai, 2021). The expectation is that a country's GDP per capita will have a negative effect on imports. As GDP per capita rises, countries are less willing to accept waste shipments.

Table 2: Overview of variables with their expected signs

Variable	Hypothesis	Expected sign
Constraints	H1	-
Deliberative	H2	-
Participatory		-
Bureaucracy	H3	-
Population	Control	+
Income		-

Descriptive statistics

The sample of this study consists of the 27 current EU member states from 2004-2021, and the UK from 2004-2019. Table 3 displays the relevant descriptive statistics of the dependent variables and the independent variables for all countries across the time period. The mean of all countries and years for Imports is 72,695, which would put it in 13th place in 2021. It is interesting to see that Constraints, Deliberative, and Participatory have means near or above 0.7. This indicates that all countries in the EU have fairly many political constraints and a well-developed deliberative and participatory democracy. This translates to fairly decentralised structures and open styles of regulation, respectively. The standard deviation for Participatory is 0.05, which is quite small on a 0-1 scale. This means that most observations are grouped between 0.57 and 0.77 for Participatory. It is noticeable that the N for Bureaucracy is lower than the other variables, this is due to the unavailability of data for this variable before 2007, and for Bulgaria, Cyprus and Malta.

Table 3: Descriptive statistics of used variables

Variable	N	mean	sd	min	max
Imports	491	72695	98932	0	642813
Constraints	491	0.76	0.12	0.33	0.89
Deliberative	491	0.86	0.11	0.35	0.98
Participatory	491	0.67	0.05	0.56	0.86
Bureaucracy	372	18.66	4.63	10.57	30.75
Population	491	18259	22851	401.2	83196
Income	491	33111	22494	3362	133517

Data analysis

To test the hypotheses and answer the research question, I analyse the data using R software version 4.3.3. The dependent variable is continuous, as it represents the amount of plastic waste imported by an EU member state. Often, when researching the effects of multiple variables on one dependent variable across few entities, linear panel data model estimation is used, as pooling data over time allows more accurate models due to the number of increased data points, as well as more control for outside shocks experienced by all entities (Plümper et al., 2005, p. 328). An example of the latter would be an economic crisis affecting all EU member states, or China's ban on plastic waste imports. With the number of countries in this study at 28, cross-sectional data analysis is impossible due to the small N. Pooling the data over time gives me more data points and reliability, so that is why linear panel model estimation is the method of this study. I run four different models: three to test the hypotheses individually, and a separate one to test the effect of all variables put together. I run both fixed, random, and time-fixed effects regressions using linear panel model estimation, based on the work of Croissant & Millo on doing panel data analysis in R (Croissant & Millo, 2008; Torres-Reyna, 2010). After running a Hausman test, it will become clear that the fixed effects model is more suitable than the random effects model. A Breusch-Pagan Lagrange multiplier test shows that fixed effects are more suitable than time-fixed effects. Thus, the focus of the results will be on interpreting the fixed effects model.

The four models were analysed using fixed effects linear panel model estimation. To analyse the impact of institutional factors in these models, along with control variables, the following basic equations are specified and written symbolically as:

Model 1: $M_{it} = a_i + \beta_1 PC_{it} + \beta_2 Pop._{it} + \beta_3 I_{it} + u_i + e_{it}$ (1)

Model 2: $M_{it} = a_i + \beta_1 Del._{it} + \beta_2 PY_{it} + \beta_3 Pop._{it} + \beta_4 I_{it} + u_i + e_{it}$ (2)

Model 3: $M_{it} = a_i + \beta_1 BC_{it} + \beta_2 Pop._{it} + \beta_3 I_{it} + u_i + e_{it}$ (3)

Model 4: $M_{it} = a_i + \beta_1 PC_{it} + \beta_2 Del._{it} + \beta_3 PY_{it} + \beta_4 BC_{it} + \beta_5 Pop._{it} + \beta_6 I_{it} + u_i + e_{it}$ (4)

Where M_{it} is the amount of plastic waste imported in country *i* in year *t* in tonnes. The letters *i* and *t* represent the *i*th country and *t*th year, a_i represents the unknown intercept for each country, and β_1, β_2, β_3, β_4, and β_5 are the coefficients. these country-specific intercepts allow the models to control for all characteristics of the countries that do not change over time and produce unobserved heterogeneity (Bartels, 2009, p. 2). The variable *PC* represents the amount of political constraint, measured on a scale from 0 to 1. Variable *Pop.* is the population in thousands of inhabitants. *I* is the level of income measured as GDP per capita. *Del.* and *PY* are the deliberative and participatory components of a country, and *BC* is the size of the bureaucracy as a percentage of total employment in a country. All variables are given in country *i* and year *t*. u_i represents the country-specific fixed effects. It captures differences between countries that are not captured by the other variables. Finally, e_{it} denotes the error term.

Results

This section reports the empirical results of the estimation of the effects of institutional factors on plastic waste imports. It offers the results of the fixed effects linear panel model estimation of the four models testing the hypotheses:

H1: States with a highly decentralised structure import more plastic waste.

H2: States where few different interest groups have access to the policy process import more plastic waste.

H3: States with a flexible implementation mode import more plastic waste.

The results show contradictory signs to the hypotheses, except for the variable Deliberative, whose effect is in line with the expectations. Other than that variable, most results are insignificant.

Estimation results

Table 4 displays the results of the fixed effects linear panel model estimation.

Table 4: Fixed Effects Regression Results with Robust Standard Errors for Plastic Waste Imports

	Model 1	Model 2	Model 3	Model 4
Constraints	-13,284.417			41,770.483
	(43,298.99)			(57,310.05)
Deliberative		-125,301.566 **		-134,301.125 **
		(67,553.34)		(78,297.36)
Participatory		61,655.664		-77762.893
		(136,060.88)		(176,584.14)
Bureaucracy			-80.038	312.709
			(3,520.70)	(3,540.77)
Population	17.354 ***	17.666 ***	22.602 ***	22.556 ***
	(6.35)	(6.58)	(9.29)	(9.17)
Income	1.552 ***	1.530 ***	0.041	-0.086
	(0.99)	(0.92)	(0.58)	(0.43)
R^2	0.110	0.125	0.088	0.111
Adj. R^2	0.052	0.066	0.016	0.032
Num. obs.	491	491	372	372

*Note: Table displays Fixed Effects estimate results (response variable is plastic waste imports). Robust standard errors are displayed in parentheses, with *** $p < .001$; ** $p < .01$; * $p < .05$.*

In Model 1, one observes that political constraints have a large negative effect on the amount of plastic imports. A value of 1 This means that when the Constraints value increases to 1 in a given year in a country, that country will import 13,284.417 tonnes less plastic waste. However, this effect is not significant. Therefore, one cannot conclude that the observed effect is real. The effects of Population and Income are both positive and significant for p < .001. When Population increases by 1,000 inhabitants compared to a year earlier, a country imports 17.354 tonnes more plastic waste.

When GDP per capita increases by $1, 1.552 tonnes of plastic waste more are imported. This means that for Imports to increase by 1,000 tonnes, GDP per capita needs to increase by $650, on average.

In the second model, the deliberative and participatory components have opposing signs, and Deliberative has a much stronger effect on Imports than Participatory and it is significant for $p < .01$. Deliberative's coefficient means that if a country goes from having no deliberative aspect at all to a fully deliberative democracy, it imports 123,301.56 tonnes of plastic waste less. This also means that if a country increases its Deliberative value by the standard deviation of 0.11, it will import 13,893 tonnes less than it did previously. Participatory, on the other hand, has a negative coefficient, and it means that if a country would go from having no participatory democracy to a fully-fledged one, the imports would actually increase by 61,655.664 tonnes. This is however not significant, so one cannot draw any conclusions based on this coefficient. Population and Income have similar coefficients as in Model 1 and are both significant for $p < .001$.

The main explanatory variable in Model 3, Bureaucracy has no significance, so there is no evidence to assert that the effect of Bureaucracy plays a large role in Imports. Its coefficient is negative, and it indicates that for every additional percent point of the labour force employed in government, Imports decrease by 80.038 tonnes. Population has a larger coefficient in this model than in the previous two, indicating that every additional 1,000 inhabitants correlate with 22.602 extra tonnes of Imports. Income loses its significance, and its effect becomes much smaller than in the previous models.

In Models 1-3, the explanatory variables were analysed separately to observe their isolated effects. In Model 4, all variables are put together in one model to see their effects when aggregated. It is noticeable that Constraints, Participatory and Bureaucracy all change signs from the previous models. Only Deliberative retains the same sign as previously, and its effect becomes stronger than in Model 2. When put together, the Constraints variable does exhibit a positive effect on Imports, and both Participatory and Bureaucracy affect it negatively. For the control variable Population, not much changes, but for Income, it now is negative and insignificant. This shows how the 3 insignificant explanatory variables do not have a clear effect on Imports.

The adjusted R^2 of all models ranges from .016 to .066, with Model 3 explaining the least, and Model 2 explaining the most variance. This means that between 1.6 and 6.6 percent of the variance in imports can be attributed to the models.

Furthermore, to assess the quality of the model and data, several tests were conducted.

A Hausman's test prefers the use of fixed effects over random effects. Fixed effects were preferred over time-fixed effects after conducting a Breusch-Pagan Lagrange multiplier test. The null hypothesis of this test holds that no time-fixed effects are required (Torres-Reyna, 2010, p. 18). This null was rejected for Models 1 and 2, which suggests that for those models time-fixed effects were better suited than fixed effects. However, given the fact that the Deliberative variable loses significance in time-fixed effects and that the panel is not of a length – according to Hsiao this is near infinity – that would make time-effects a large problem, I prefer fixed effects over time-fixed effects (2003, p. 33). Using fixed effects for all models also eases the comparison between models, as well as the interpretation of the estimated coefficients. The results from random effects and time-fixed effects estimation are reported in Appendix A.

Due to the small T of the panel data, it is not necessary to test for cross-sectional dependence, as this only becomes a problem in datasets where the amount of time is much larger than the number of units studied (Baltagi et al., 2012, p. 165). Autocorrelation should therefore not be a large issue in this study. According to the Dickey-Fuller test, the data does not contain a unit root and is therefore stationary. This means that the models' coefficients are stable and consistent over time, and this adds to the robustness of my model. The Breusch-Pagan test shows that my panel is heteroskedastic, meaning that there is variance in the errors across observations (Chamberlain, 1982, p. 6). This is corrected by using robust standard errors using Arellano, and the robust standard errors are displayed in Table 4. The conventional standard errors are reported in Appendix A.

Discussion

In this section, I interpret the meaning of the estimation results and proceed to give answers to the hypotheses and research question. Recalling the previous section, the results section showed that all explanatory variables except Deliberative were insignificant. Also, to revert to the hypotheses and expected signs, Deliberative was the only variable where the coefficient consistently was in the expected direction. Table 5 shows how the signs from the estimation results hold up against the expected sign as expressed in the Methodology section above. Wherever the control variables were significant, they conformed to the expectation.

Table 5: Expected sign and sign from Estimation results

Variable	Hypothesis	Expected sign	Estimated sign
Constraints	H1	-	Insig.
Deliberative	H2	-	-
Participatory		-	Insig.
Bureaucracy	H3	-	Insig.
Population	Control	+	+
Income	Control	-	+

Note: Insig. indicates the coefficients were inconclusive in their sign, and not significant.

For Model 1, the effect of the regression is in line with the expectation of H1, as it is negative. H1 states that states with a highly decentralised structure import more plastic waste. However, given the insignificance of the effect, we cannot reasonably accept H1, and must therefore reject it. This seems to refute the research spelt out in the literature review on the institutional approach. The effect of the variable in this study has a direction that is in line with the existing literature, but its significance is insufficient to speak about causation with confidence. Thus, while the effect suggests that countries with closed regulatory structures import more waste, its insignificance disallows claiming with confidence that countries with more constraints, and thus a more decentralised regulatory structure, import more plastic waste.

In Model 2, the effect of Deliberative is both significant and negative, which is in line with the expectations of H2. H2 states that states where few different interest groups have access to the policy process, import more plastic waste. The effect may seem very large, but given the distribution of the variables around the mean as given in the descriptive statistics, it will be smaller in reality. According to the data, no country goes from 0 to 1 in its Deliberative score. There is always a basis where countries start from, and no country has a perfect Deliberative democracy score. Participatory is insignificant, and contrary to the expectations of H2. This requires that H2 is not accepted, and it is thus rejected. H2 hinges on the presence of both Deliberative and Participatory, as explained in the methodology. A country with both Deliberative and Participatory components will have an open regulatory style, according to the theory. This refuting the importance of the effect of Participatory thus debunks the theory.

Model 3, like Model 1 has effects that conform to the hypothesis but is not significant. H3 states that states with a flexible implementation mode import more plastic waste. And while we see that Bureaucracy has a negative effect on Imports, it is not significant. Therefore, we cannot confirm that countries with large bureaucracies, and thus more rigid implementation modes, import less plastic waste. This means that H3 is also rejected.

In Model 4 the effects of all variables are visible when they are aggregated in one model. This should be closer to the situation in the real world, where things do not operate in isolation, but are interdependent. Together, the signs of all variables previously insignificant change. Only Deliberative retains its negative effect and similar size. The fact that these variables switch signs, indicates that their explanatory value is limited. Also, seeing that the variables together make Income insignificant shows that they are not adding to the explanatory power of the model. This switch adds to the evidence that the hypotheses cannot be accepted. The fairly low model fit also goes to show that many of the variables were of no influence on the level of imports. The low R2 in Model 3 can be attributed to the smaller N used in the model.

The effect of both control variables is quite large in models 1 and 2. For Population, the direction is in line with the expectation in the methodology. The size of the effect of Population is very large. This is quite logical as well, as countries with more inhabitants have more capacity to import and process plastic waste, which conforms to the expectation set out in the methodology section. For Income, the effect in the results is positive. This is contrary to the expected sign set out in the methodology. The size of the effect seems small at first glance, but given that every additional $1 has that effect, it adds up to large amounts of extra plastic waste imported when GDP per capita starts to increase by a few percent of GDP. An increase of 1,9% of the mean GDP per capita in this study would already translate into the 1,000 tonnes of extra plastic waste imported, as mentioned in the example in the results section. This quite large negative effect of Income suggests that the pollution haven hypothesis is incorrect, as a higher GDP per capita is associated with lower Imports in the results. This thus adds to the evidence against the pollution haven hypothesis, at least in the European sphere. What this means for the pollution haven hypothesis in Global South countries, remains to be seen. In models 3 and 4, Population's effect becomes larger than before and Income loses its significance and much of its effect. In Model 4, its effect even becomes negative. This confirms the irrelevance of the other variables of the model, as they steal away Income's effect.

Conclusion

To answer the research question, the results show that the effect of institutional factors on intra-EU waste imports is limited. In the isolated fixed effects linear panel models, it became clear that there was some sense to the theory, as some of the effects of the explanatory variables were in the same direction as hypothesised. However, in both models 1 and 3, no significance was found for the hypotheses. In Model 2, half of the hypothesis was proven, but as H2 hinged on the presence of both Deliberative and Participatory being proven as having an effect, H2 could not be accepted.

In the aggregated Model 4, the reversal of the effect direction of the explanatory variables, with the exception of Deliberative, confirmed that these variables had no significant effect on plastic waste imports. This means that all hypotheses were rejected. This could mean that these variables were not constructed properly, or that the theory does not apply to plastic waste, but only to waste in general.

For the broader literature, the rejection of all hypotheses means that this study has failed to establish quantitative backing for the institutional approach to waste imports as outlined by O'Neill (2000). It could mean that her institutional approach is not applicable to plastic waste and that other more important factors exist in plastic waste imports than for general waste. This study did confirm that the size of countries matters, in line with a few studies mentioned above (Baggs, 2009; Glover, 2017; Higashida & Managi, 2014). The study also showed that the pollution haven hypothesis does not hold in the context of Global North countries trading waste amongst each other. This is in contrast to Liu & Lai (2021) but in line with Baggs (2009). For cases outside of the EU context, this might not be the case. Especially in Global South countries, the pollution haven hypothesis might still apply.

This study adds to existing knowledge that there is some relationship between plastic imports and the deliberative component of a country. The societal impact of this study is slight. It did not produce overwhelming evidence that centralised regulatory structures, open regulatory styles, or rigid modes of implementation cause low or high levels of plastic waste imports. Therefore, it remains difficult to see how losers and winners are created by the effects of the plastic waste trade.

Limitations

As mentioned above, one limitation of this research has to do with the availability of data for the independent variables. To overcome validity issues created by this study's reliance on theoretically incongruent variables from existing datasets, special care has been given to their overlap with the theoretical concepts as closely as possible. This might have been a cause of the majority of the models not being significant. A more extensive study might use variables that were constructed by the researcher themselves. That way ensures that the variables are capturing the right concepts. The insignificance of the majority of the models might be explained by the limited sources used for the theoretical framework. Applying more sources from multiple schools of thought could have allowed for the selection and construction of more insightful variables.

Further research

Further research should be focused on developing the institutional approach to waste importing further. Given the insignificance of much of the models, the institutional approach to plastic waste trading should be advanced. Both qualitative and quantitative methodologies should be applied to both develop new indicators and hypotheses and test these empirically. Out of the scope of this study is the effect of the number and sophistication of treatment facilities. Some research mentioned above suggests that this plays a large role in the amount of waste that is imported (Higashida & Managi, 2014). A country with a well-developed plastic recycling industry is likely to import more plastic waste. To see what the statistical effect of industrial factors would be, would be very interesting. Additionally, further research could focus on the effects of changing EU regulations on plastic imports, as there are very current developments. The new Regulation (EU) 2020/2174 has come into force in 2021, and the most recent change to the law is only set to come into force in a few years (European Commission, n.d., 2023). Seeing the effects of these new policies can only be done when they have been in place for some time.

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Appendix A: Additional Results

Table A1: Fixed Effects Regression Results for plastic waste imports with conventional standard errors

	Model 1	Model 2	Model 3	Model 4
Constraints	-13284.417			41770.483
	(28170.603)			(37036.015)
Deliberative		-125301.566 **		-134301.125 **
		(43861.562)		(49948.197)
Participatory		61655.664		-77762.893
		(69026.629)		(89179.423)
Bureaucracy			-80.038	312.709
			(2424.734)	(2409.432)
Population	17.354 ***	17.666 ***	22.602 ***	22.556 ***
	(3.003)	(3.000)	(4.019)	(4.011)
Income	1.552 ***	1.530 ***	0.041	-0.086
	(0.367)	(0.365)	(0.490)	(0.492)
R^2	0.110	0.125	0.088	0.111
Adj. R^2	0.052	0.066	0.016	0.032
Num. obs.	491	491	372	372

*Note: Table displays Fixed Effects estimate results (response variable is plastic waste imports). Conventional standard errors are displayed in parentheses, with *** p < .001; ** p < .01; * p < .05.*

Table A2: Random Effects Regression Results for plastic waste imports

	Model 1	Model 2	Model 3	Model 4
Intercept	-20689.151	58119.625	106027.850 *	231600.202 **
	(29868.142)	(56188.259)	(49023.467)	(76976.526)
Constraints	-2896.385			56023.570
	(28444.327)			(37707.310)
Deliberative		-111127.267 *		-109576.876 *
		(43348.299)		(49971.071)
Participatory		13211.975		-131824.741
		(69196.783)		(89864.786)
Bureaucracy			-4042.430	-3452.947
			(2112.642)	(2094.944)
Population	1.916 **	2.653 ***	2.194 **	1.803 *
	(0.659)	(0.681)	(0.749)	(0.776)
Income	1.460 ***	1.566 ***	0.339	0.262
	(0.327)	(0.333)	(0.420)	(0.419)
s_idios	42708.620	42388.912	39870.188	39538.979
s_id	72070.363	81589.80	84248.796	81421.087
R^2	0.078	0.082	0.041	0.071
Adj. R^2	0.070	0.074	0.033	0.053
Num. obs.	491	491	372	372

*Note: Table displays Random Effects estimate results (response variable is plastic waste imports). Conventional standard errors are displayed in parentheses, with *** p < .001; ** p < .01; * p < .05.*

Table A3: Time-Fixed Effects Regression results for plastic waste imports

	Model 1	Model 2	Model 3	Model 4
Constraints	3559.260			18029.279
	(26382.380)			(36316.823)
Deliberative		-29875.267		-58595.341
		(43949.057)		(51623.629)
Participatory		27286.915		26558.037
		(65293.128)		(88541.147)
Bureaucracy			-530.883	-466.197
			(2508.290)	(2515.259)
Population	7.262 *	7.658 *	12.076 **	12.735 **
	(2.997)	(3.041)	(4.141)	(4.201)
Income	-0.454	-0.405	-0.873	-0.793
	(0.469)	(0.474)	(0.576)	(0.581)
factor(2005)	4552.892	4349.537		
	(10609.085)	(10619.285)		
factor(2006)	15226.215	14882.792		
	(10722.834)	(10739.436)		
factor(2007)	24884.986 *	24278.004 *		
	(11311.123)	(11349.576)		
factor(2008)	26581.060 *	25780.935 *	2669.789	2450.814
	(11957.772)	(12016.694)	(10901.616)	(10932.797)
factor(2009)	25278.975 *	24603.992 *	163.657	276.820
	(11306.825)	(11355.784)	(10868.127)	(10899.818)
factor(2010)	35013.762 **	34577.474 **	10302.174	10601.707
	(11283.340)	(11311.202)	(11061.076)	(11096.699)
factor(2011)	45732.623 ***	45091.588 ***	22740.900 *	22916.026 *
	(11653.016)	(11705.704)	(10904.056)	(10937.364)
factor(2012)	47741.418 ***	47043.687 ***	23926.226 *	24238.687 *
	(11299.706)	(11351.284)	(10936.453)	(10977.828)
factor(2013)	45317.265 ***	44315.571 ***	20849.577	20466.006
	(11649.182)	(11741.189)	(10931.911)	(10964.163)
factor(2014)	49389.655 ***	48519.620 ***	26014.261 *	25886.800 *
	(11749.256)	(11820.469)	(10945.177)	(10974.006)
factor(2015)	49443.565 ***	48833.050 ***	22771.415 *	22918.519 *
	(11199.327)	(11242.190)	(11076.686)	(11108.749)
factor(2016)	61346.265 ***	60564.388 ***	35093.877 **	35175.354 **
	(11291.745)	(11353.341)	(11012.830)	(11045.732)
factor(2017)	64393.480 ***	62740.992 ***	37715.263 ***	36602.385 **
	(11732.648)	(11926.686)	(10943.149)	(11071.412)
factor(2018)	61278.564 ***	59357.483 ***	35948.279 **	34236.840 **
	(12175.006)	(12437.167)	(11110.533)	(11333.480)
Factor(2019)	61759.159 ***	60027.445 ***	35998.667 **	34218.137 **
	(12081.491)	(12326.984)	(11128.091)	(11352.792)
factor(2020)	60576.961 ***	58753.968 ***	35312.764 **	33259.879 **
	(12140.229)	(12418.385)	(11290.252)	(11612.471)
factor(2021)	80892.389 ***	79243.600 ***	58879.711 ***	56878.081 ***
	(13298.297)	(13528.043)	(12069.820)	(12493.986)
R^2	0.262	0.263	0.211	0.214
Adj. R^2	0.184	0.183	0.113	0.108
Num. obs.	491	491	372	372

*Note: Table displays Time-Fixed Effects estimate results (response variable is plastic waste imports). Conventional standard errors are displayed in parentheses, with *** p < .001; ** p < .01; * p < .05.*

Appendix B: R script

```
getwd()
setwd("C:/Users/moerl/OneDrive - Universiteit Leiden/IO/Thesis/Data")

#####Libraries####
library(tidyverse)
library(haven)
library(psych)
library(broom)
library(marginaleffects)
library(car)
library(texreg)
library(readxl)
library(plm)
library(foreign)
library(gplots)
library(stargazer)
library(lmtest)
library(tseries)

####Importing xlsx data file####
EU_Database <- read_xlsx("Dataset.xlsx")
view(EU_Database)
summary(EU_Database)
describe(EU_Database)

####Recoding missing values####
EU_Database$Imports <- ifelse(EU_Database$Imports == ":", NA, EU_Database$Imports)
EU_Database$Imports <- as.numeric(EU_Database$Imports)
EU_Database <- EU_Database %>%
  mutate(POLCON3 = ifelse(POLCON3 == 0, NA, POLCON3),
       POLCON5 = ifelse(POLCON5 == 0, NA, POLCON5))
view(EU_Database)

#Creating Data Frame for Hypotheses
EU_H1H2 <- select(EU_Database, -Bureaucracy)
EU_H3 <-data.frame(EU_Database)
view(EU_H1H2)
view(EU_H3)

N0 <- length(EU_H1H2$Country); N0
EU_H1H2 <- na.omit(EU_H1H2)
N1 <- length(EU_H1H2$Country); N1

N3 <- length(EU_H3$Country); N3
EU_H3 <- na.omit(EU_H3)
N4 <- length(EU_H3$Country); N4

# should go from 502, 491, 372

# Calculate/format/show statement with loss of cases
```

```
cat("Cases with missing values for H1H2:", N0-N1, "(", round(((N0-N1)/N0)*100, 1), "% )\n")
cat("Cases with missing values for H3:", 420-N4, "(", round(((420-N4)/420)*100, 1), "% )\n")


summary(EU_H1H2)
summary(EU_H3)

####Descriptive statistics####

#saving options to prevent it from messing with other outputs
default_options <- options()
options(digits=4)

#For H1-2
describe(EU_H1H2$Imports, fast = TRUE)
describe(EU_H1H2$Population, fast = TRUE)
describe(EU_H1H2$Income, fast = TRUE)
describe(EU_H1H2$POLCON5, fast = TRUE)
describe(EU_H1H2$Deliberative, fast = TRUE)
describe(EU_H1H2$Participatory, fast = TRUE)

#For H3
describe(EU_H3$Imports, fast = TRUE)
describe(EU_H3$Population, fast = TRUE)
describe(EU_H3$Income, fast = TRUE)
describe(EU_H3$POLCON5, fast = TRUE)
describe(EU_H3$Deliberative, fast = TRUE)
describe(EU_H3$Participatory, fast = TRUE)
describe(EU_H3$Bureaucracy, fast = TRUE)

options(default_options)
#Check whether no missing values remain
colSums(is.na(EU_H1H2))
colSums(is.na(EU_H3))

####Exploring the data####

#Checking correlation
cor_H1H2 <- cor(EU_H1H2[c('POLCON5', 'Deliberative', 'Participatory', 'Population',
'Income')])
cor_H3 <- cor(EU_H3[c('POLCON5', 'Deliberative', 'Participatory', 'Bureaucracy', 'Population',
'Income')])
view(cor_H1H2)
view(cor_H3)
#Correlation was high for GDP, now that that's removed its good

plotmeans(EU_H1H2$Imports ~ Country, main="Heterogeineity across countries",
data=EU_H1H2)
#We see a few peaks for Belgium, Czechia, Germany, Italy and NL. Other than that quite low for
the rest
```

```
plotmeans(Imports ~ Year, main="Heterogeineity across years", data=EU_H1H2)
#This line is much more consistent. Steady rise since 2004, with a large bump after 2020.

# Remove package 'gplots' from the workspace
detach("package:gplots")

##### OLS regressions####
olsH1<-lm(Imports ~ POLCON5 + Population + Income, data=EU_H1H2)
olsH2<-lm(Imports ~ Deliberative + Participatory + Population + Income, data=EU_H1H2)
olsH3<-lm(Imports ~ Bureaucracy + Population + Income, data=EU_H3)
olsH123<-lm(Imports ~ POLCON5 + Federal + Deliberative + Participatory + Bureaucracy +
Population + Income, data=EU_H3)
#sexy table
screenreg(list(olsH1, olsH2, olsH3, olsH123), digits=3)

#POLCON5
plot(EU_H1H2$POLCON5, EU_H1H2$Imports, pch=19, xlab="POLCON5",
ylab="Imports")
abline(lm(EU_H1H2$Imports~EU_H1H2$POLCON5),lwd=3, col="red")
#Deliberative
plot(EU_H1H2$Deliberative, EU_H1H2$Imports, pch=19, xlab="Deliberative",
ylab="Imports")
abline(lm(EU_H1H2$Imports~EU_H1H2$Deliberative),lwd=3, col="red")
#Participatory
plot(EU_H1H2$Participatory, EU_H1H2$Imports, pch=19, xlab="Participatory",
ylab="Imports")
abline(lm(EU_H1H2$Imports~EU_H1H2$Participatory),lwd=3, col="red")
#Bureaucracy
plot(EU_H3$Bureaucracy, EU_H3$Imports, pch=19, xlab="Bureaucracy", ylab="Imports")
abline(lm(EU_H3$Imports~EU_H3$Bureaucracy),lwd=3, col="red")

#Income
plot(EU_H1H2$Income, EU_H1H2$Imports, pch=19, xlab="Income", ylab="Imports")
abline(lm(EU_H1H2$Imports~EU_H1H2$Income),lwd=3, col="red")
#Population
plot(EU_H1H2$Population, EU_H1H2$Imports, pch=19, xlab="Population", ylab="Imports")
abline(lm(EU_H1H2$Imports~EU_H1H2$Population),lwd=3, col="red")

####Least squares dummy variable model with vars####
fixed.dum <- lm(Imports ~ POLCON5 + Federal + Deliberative + Participatory + Population
+ Income + factor(Country) - 1, data = EU_H1H2)
summary(fixed.dum)
Ihat<-fixed.dum$fitted

sum(is.na(Ihat))
sum(is.na(EU_H1H2$POLCON5))
# Scatterplots against OLS regression
#POLCON5
scatterplot(Ihat~EU_H1H2$POLCON5|EU_H1H2$Country, boxplots=FALSE,
xlab="POLCON5", ylab="Ihat",smooth=FALSE)
abline(lm(EU_H1H2$Imports~EU_H1H2$POLCON5),lwd=3, col="red")
```

```
#Deliberative
scatterplot(Ihat~EU_H1H2$Deliberative|EU_H1H2$Country, boxplots=FALSE,
xlab="Deliberative", ylab="Ihat",smooth=FALSE)
abline(lm(EU_H1H2$Imports~EU_H1H2$Deliberative),lwd=3, col="red")
#Participatory
scatterplot(Ihat~EU_H1H2$Participatory|EU_H1H2$Country, boxplots=FALSE,
xlab="Participatory", ylab="Ihat",smooth=FALSE)
abline(lm(EU_H1H2$Imports~EU_H1H2$Participatory),lwd=3, col="red")
#Bureaucracy

####Fixed effects####

#H1
fixedH1 <-plm(Imports ~ POLCON5 + Population + Income, data=EU_H1H2,
index=c("Country", "Year"), model="within")
summary(fixedH1)
fixef(fixedH1)
pFtest(fixedH1, olsH1)
#H2
fixedH2 <-plm(Imports ~ Deliberative + Participatory + Population + Income,
data=EU_H1H2, index=c("Country", "Year"), model="within")
summary(fixedH2)
fixef(fixedH2)
pFtest(fixedH2, olsH2)
#H3
fixedH3 <-plm(Imports ~ Bureaucracy + Population + Income, data=EU_H3,
index=c("Country", "Year"), model="within")
summary(fixedH3)
fixef(fixedH3)
pFtest(fixedH3, olsH3)
#H123
fixedH123 <-plm(Imports ~ POLCON5 + Deliberative + Participatory + Bureaucracy +
Population + Income, data=EU_H3, index=c("Country", "Year"), model="within")
summary(fixedH123)
fixef(fixedH123)
pFtest(fixedH123, olsH123)

#sexy table
screenreg(list(fixedH1, fixedH2, fixedH3, fixedH123), digits=3)

####Random effects ####
#H1
randomH1 <-plm(Imports ~ POLCON5 + Population + Income, data=EU_H1H2,
index=c("Country", "Year"), model="random")
randomH2 <-plm(Imports ~ Deliberative + Participatory + Population + Income,
data=EU_H1H2, index=c("Country", "Year"), model="random")
randomH3 <-plm(Imports ~ Bureaucracy + Population + Income, data=EU_H3,
index=c("Country", "Year"), model="random")
randomH123 <-plm(Imports ~ POLCON5 + Deliberative + Participatory + Bureaucracy +
Population + Income, data=EU_H3, index=c("Country", "Year"), model="random")
```

```
#sexy table
screenreg(list(randomH1, randomH2, randomH3, randomH123), digits=3)


####tests and controls for violations####

#Hausman Test, Null is random effects is preferred over fixed effects
phtest(fixedH1, randomH1)
phtest(fixedH2, randomH2)
phtest(fixedH3, randomH3)
phtest(fixedH123, randomH123)
#All p-values are <0,05 --> Reject null, fixed effects are all preferred over random

#Time-fixed effects
fixed.timeH1<-plm(Imports ~ POLCON5 + Population + Income + factor(Year),
data=EU_H1H2, index=c("Country", "Year"), model="within")
fixed.timeH2<-plm(Imports ~ Deliberative + Participatory + Population + Income +
factor(Year), data=EU_H1H2, index=c("Country", "Year"), model="within")
fixed.timeH3<-plm(Imports ~ Bureaucracy + Population + Income + factor(Year),
data=EU_H3, index=c("Country", "Year"), model="within")
fixed.timeH123<-plm(Imports ~ POLCON5 + Deliberative + Participatory + Bureaucracy +
Population + Income + factor(Year), data=EU_H3, index=c("Country", "Year"),
model="within")
#table
screenreg(list(fixed.timeH1, fixed.timeH2, fixed.timeH3, fixed.timeH123), digits=3)

pFtest(fixed.timeH1, fixedH1)
pFtest(fixed.timeH2, fixedH2)
pFtest(fixed.timeH3, fixedH2)
pFtest(fixed.timeH123, fixedH2)
#all p-values in this test are <0,05 --> use time-fixed effects over OLS regression

#Breusch-Pagan Lagrange Multiplier test for time-fixed effects (Breusch-Pagan)
plmtest(fixedH1, c("time"), type=("bp"))
plmtest(fixedH2, c("time"), type=("bp"))
plmtest(fixedH3, c("time"), type=("bp"))
plmtest(fixedH123, c("time"), type=("bp"))
#H1 and H2 are <0,05, H3 and H123 are >0,05. So use time-fixed for H1 and H2, no need to
use time-fixed for H3 and H123

#Niet nodig ivm fixed/time-fixed die beter zijn?
#Breusch-Pagan Lagrange Multiplier test for random effects vs OLS
poolH1 <-plm(Imports ~ POLCON5 + Population + Income, data=EU_H1H2,
index=c("Country", "Year"), model="pooling")
poolH2 <-plm(Imports ~ Deliberative + Participatory + Population + Income,
data=EU_H1H2, index=c("Country", "Year"), model="pooling")
poolH3 <-plm(Imports ~ Bureaucracy + Population + Income, data=EU_H3,
index=c("Country", "Year"), model="pooling")
poolH123 <-plm(Imports ~ POLCON5 + Deliberative + Participatory + Bureaucracy +
Population + Income, data=EU_H3, index=c("Country", "Year"), model="pooling")
summary(poolH1, poolH2, poolH3, poolH123)
```

```
summary(poolH2)
summary(poolH3)
summary(poolH123)
#All values <0,05 --> reject null hypothesis of no panel effect, therefore we can use random effects panel data over OLS

#####Testing for serial correlation (Necessary?)#####

#BPLM and Pasaran CD tests
#The null hypothesis in the B-P/LM and Pasaran CD tests of independence is that residuals across entities are not correlated.

#Breusch-Pagan LM test for cross-sectional dependence
pcdtest(fixedH1, test = c("lm"))
pcdtest(fixedH2, test = c("lm"))
pcdtest(fixedH3, test = c("lm"))
pcdtest(fixedH123, test = c("lm"))
#all are <0,05, so reject null --> there is serial correlation

#PasaranCD test for cross-sectional dependence
pcdtest(fixedH1, test = c("cd"))
pcdtest(fixedH2, test = c("cd"))
pcdtest(fixedH3, test = c("cd"))
pcdtest(fixedH123, test = c("cd"))
#all are <0,05, so reject null --> there is serial correlation

#Breusch-Godfrey/Wooldridge test for serial correlation
#Null is that there is no serial correlation
pbgtest(fixedH1)
pbgtest(fixedH2)
pbgtest(fixedH3)
pbgtest(fixedH123)
#all are <0,05, so reject null --> there is serial correlation

#####Testing for Unit roots/stationarity#####

#The null hypothesis is that the series has a unit root
Panel.set<-plm.data(EU_H1H2, index = c("Country", "Year"))
adf.test(Panel.set$Imports, k=2)
#p-value <0,05 --> reject null, ergo there is no unit root present which is AOK

#####Heteroskedasticity#####

#Null for Breusch -Pagan test is that there is no heteroskedasticity
bptest(Imports ~ POLCON5 + Population + Income + factor(Country), data = EU_H1H2, studentize=F)
bptest(Imports ~ Deliberative + Participatory + Population + Income + factor(Country), data = EU_H1H2, studentize=F)
bptest(Imports ~ Bureaucracy + Population + Income + factor(Country), data = EU_H3, studentize=F)
```

```
bptest(Imports ~ POLCON5 + Deliberative + Participatory + Bureaucracy + Population +
Income + factor(Country), data = EU_H3, studentize=F)
#All p-values are <0,05 --> There is heteroskedasticity

#controlling for heteroskedasticity
#for fixed effects
#Original coefficients
coeftest(fixedH1)
coeftest(fixedH2)
coeftest(fixedH3)
coeftest(fixedH123)

# Heteroskedasticityconsistent coefficients`
coeftest(fixedH1, vcovHC)
coeftest(fixedH2, vcovHC)
coeftest(fixedH3, vcovHC)
coeftest(fixedH123, vcovHC)
# Heteroskedasticityconsistent coefficients (Arellano)
rob1 <- coeftest(fixedH1, vcovHC(fixedH1, method = "arellano"))
rob2 <- coeftest(fixedH2, vcovHC(fixedH2, method = "arellano"))
rob3 <- coeftest(fixedH3, vcovHC(fixedH3, method = "arellano"))
rob123 <- coeftest(fixedH123, vcovHC(fixedH123, method = "arellano"))
screenreg(list(rob1, rob2, rob3, rob123))

# Heteroskedasticityconsistent coefficients, type 3
coeftest(fixedH1, vcovHC(fixed, type = "HC3"))
coeftest(fixedH2, vcovHC(fixed, type = "HC3"))
coeftest(fixedH3, vcovHC(fixed, type = "HC3"))
coeftest(fixedH123, vcovHC(fixed, type = "HC3"))


# The following shows the HC standard errors of the coefficients
t(sapply(c("HC0", "HC1", "HC2", "HC3", "HC4"), function(x) sqrt(diag(vcovHC(fixedH1, type
= x)))))
t(sapply(c("HC0", "HC1", "HC2", "HC3", "HC4"), function(x) sqrt(diag(vcovHC(fixedH2, type
= x)))))
t(sapply(c("HC0", "HC1", "HC2", "HC3", "HC4"), function(x) sqrt(diag(vcovHC(fixedH3, type
= x)))))
t(sapply(c("HC0", "HC1", "HC2", "HC3", "HC4"), function(x) sqrt(diag(vcovHC(fixedH123,
type = x)))))
```