The Political Economy of Trade in Waste*

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March 8, 2022

Abstract

This paper employs a common agency framework to investigate the role played by lobby groups on international trade in waste, an externality generated by production activities in a developed-country market (Home) that can be exported to a developing country (Foreign) for disposal. The model assumes that groups have heterogeneous preferences for environmental quality and that the environmental/trade policy on the externality is endogenously determined by a political economy process characterized by balancing the competing interests of an organized environmental and industry lobby group. We show that the politically chosen tax/tariff in Home/Foreign can be below, equal to or above the socially optimal level, depending on the ranking of environmental attitudes and the degree of pollution damages from waste. Further, bringing theory to data to provide some empirical clarity on the effect of environmental movements, we find that a strong environmental lobby group in Home/Foreign will result in more/less waste to be exported from Home to Foreign. These empirical findings suggest that there may exist a waste "Green Paradox". Therefore, strengthening environmental NGOs in developed countries may not be a panacea to the waste problem. However, doing so in developing countries could prove to be more fruitful.

Keywords: Trade in waste; Political economy; Externality; Environmental tax; Import tariff; Lobby Groups; Heterogeneous preference

JEL Codes: D72, F14, F18, Q53, Q56, Q58

*I am grateful to Francesco Amodio, Hassan Benchekroun, Sophie Bernard, Laura Lasio, and Ngo Van Long, and participants at the 2022 Montreal Environmental and Natural Resource Economics workshop for their insightful comments. I also thank Wesley Longhofer from Emory University for sharing his Environmental NGO data with me.

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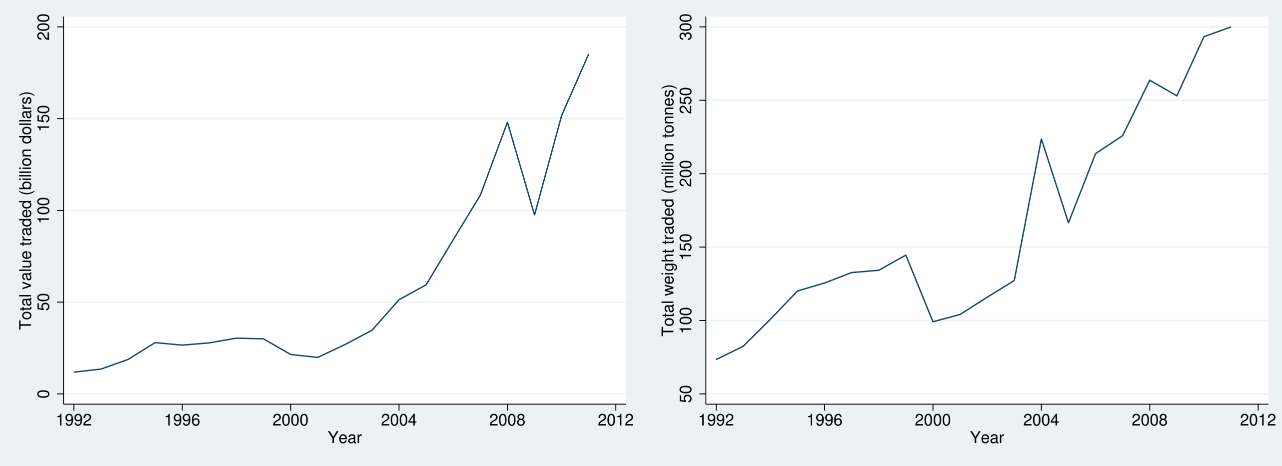
1 Introduction

With the rapid economic growth, increasing urbanization and profligate consumer culture of the past few decades, mountains of waste – both literally and metaphorically – have been generated at an unprecedented speed. Facing highly constrained domestic capacities and soaring costs while struggling to deal with the excessive waste, developed countries have long chosen to ship their garbage out of borders for disposal. With China – one of the main waste recipients – imposing a waste import ban in 2017, a waste crisis has been evolving in these countries, and many Southern and Southeastern countries have alternatively become the new "world garbage dump". In a "first-best" world of equal trade relationships, international trade in waste could be beneficial to all countries involved just like trade in any other good or service (Rauscher, 2001). However, all waste has the potential to cause environmental and public health problems. If the importing countries are incapable of dealing with waste in a sound way, the environmental consequences can be so severe as to outweigh any benefits of the waste trade. This is especially true in many of the developing countries, which are ill-equipped to handle the recycling and recovery of material that is often highly toxic, and consequently, much of the waste is dumped or discarded directly into the environment (Kellenberg, 2012). With the shocking sight of towering waste piles in the neighborhoods of developing countries and giant garbage patches floating on the ocean, global waste disputes have intensified, gaining widespread attention.[1] Unlike most of the other transboundary pollution problems that need global cooperation, the waste problem arises from the fact that the externality is intentionally and consciously packed and shipped anywhere in the world that is willing to accept it. The deliberate and voluntary nature of these actions raises hope for a possible solution. This paper thus investigates what are the appropriate policies that reduce international trade in waste.

The de facto policy approach to date includes international treaties such as the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal and its subsequent Ban Amendments,[2] the Rotterdam Convention on hazardous chemicals and the Stockholm

[1]For example, In 2006, Trafigura, a Dutch oil trading company with additional offices in Great Britain, dumped hundreds of tons of waste at Abidjan, Côte d'Ivoire (Ivory Coast), and caused nausea, headaches, vomiting, violent rashes, and even death among thousands of people living near the dump sites. After the Ivorian authorities arrested and imprisoned two executives and a representative of Trafigura, the company finally agreed to pay out 197 million US dollars to settle out the matter, but nevertheless denied legal liability, and claimed that the waste was not toxic. See https://www.business-humanrights.org/en/latest-news/trafigura-lawsuit-re-hazardous-waste-disposal-in-côte-divoire-filed-in-the-netherlands/. More recently in 2019, the dragging Canada-Philippines garbage dispute finally came to an end after Canada agreed to take back its trash sent to Philippines 6 years ago, which were falsely labelled as recyclable scrap but instead contained household waste. See https://www.nytimes.com/2019/05/23/world/asia/philippines-canada-trash.html. Inundated with shipments of ballooning illegal waste after the Chinese ban, Malaysia and Indonesia – other popular markets for the West's waste – have also implemented their own restrictions and sent back millions of tonnes of waste to their original countries.

[2]See https://www.csis.org/analysis/basel-convention-hazardous-waste-plastic-pollution for a detailed description.



(a) Total value

(b) Total weight

Figure 1: Globally exported waste

Convention on persistent organic pollutants, as well as individual countries' own restrictions and environmental regulations.[3] However, ample evidence suggests that these approaches are falling short. Like any other international environmental agreements (IEAs), the above-mentioned treaties also suffer the free-riding problem and some of them are merely seen as an attempt by countries to bolster their international image without active ratification or enforcement. The US, one of the largest waste exporters, has yet to sign any of the agreements. Even though many countries such as Australia, Canada, the UK and the European Union have ratified them, millions of tonnes of waste are still heading their way to developing countries each year. Using annual bilateral waste shipments among countries before and after one of the trading partners ratifies the Basel Convention, Kellenberg and Levinson (2014) find no evidence that the Convention has resulted in less waste being traded. As a matter of fact, the value of global trade in waste (in billions of US dollars) has grown by more than 15 times and the total weight (in million tonnes) has more than quadrupled from 1992 to 2011, see Figure 1. [4] Given these facts and to better provide policy recommendations, we first seek to understand what are the main factors that determine trade in waste.

The gravity model has been the traditional approach in determining whether a factor plays a role in the empirical trade analysis, enjoying great popularity thanks to its unprecedented predictive power and extraordinary stability. Baggs (2009) and Kellenberg (2012) use variants of the gravity model to estimate the effects of various economic factors on international trade in waste. While Baggs (2009) observes a significant waste haven effect as rising per capita income – a proxy for the stringency of environmental policy – reduces the amount of hazardous waste countries' import, she also finds that

[3] For example, many countries, e.g., Canada and the European Union, have introduced the extended producer responsibility program, which makes producers accountable for waste disposal costs and responsible for establishing recycling and reuse objectives (Bernard, 2015).

[4] Based on data collected from UN Comtrade database, see the subsection of Data for more details.

other factors, in particular capital per worker, are more important. Using survey data from the Global Competitiveness Report to construct a direct measure of the stringency of environmental regulations, Kellenberg (2012) shows that differences in environmental regulation stringency play a substantial role in explaining the waste haven effect. However, these econometric analyses are built upon the conventional economic line that governments are benevolent in the sense that they are always maximizing social welfare, while ignoring factors such as lobby groups and political contributions, which Goldberg and Maggi (1999) and Gawande and Bandyopadhyay (2000) find important in testing the political economy hypotheses. To fill the gap, our paper takes the political economy approach and investigates the role played by organized lobby groups on international trade in waste.

It is widely acknowledged that government policies are highly influenced by lobby groups. With growing environmental awareness among the public in recent years, environmental lobby groups have increased significantly both in size and strength.[5] They have also become important political actors, extensively participating in all major international trade and environmental negotiations and pressuring national governments and world organizations such as the World Bank and the World Trade Organization to take more decisive actions to protect the environment. On the other hand, firms spend significant resources on lobbying and typically use their lobbying power to entirely block or slow down any proposed environmental regulations. In this paper, we build a political economy model of the kind introduced by Grossman and Helpman (1994) in which governments do not simply maximize social welfare, but balance competing interests in their support-maximizing calculus according to the political influence of different lobby groups. More specifically, an organized environmental lobby group and industry lobby group confront the incumbent governments with contribution schedules contingent on the governments' environmental/trade policies on waste – an externality generated by production activities in a developed-country market, called Home, that can be exported with a fee to a developing country, called Foreign. The respective Home and Foreign governments maximise a weighted sum of the social welfare and campaign contributions received from lobby groups. From this perspective, our paper contributes to the literature on the political economy approach of endogenous trade policy[6] that has been later extended to endogenous environmental policy-making, see e.g., Fredriksson (1997); Aidt (1998); Schleich (1999); Conconi (2003); Fredriksson et al. (2005); Fünfgelt

[5]For instance, up to date, the Environmental Defense Fund has an active membership of 2.5 million with operations in 28 countries and operating expenses reaching a record $216 million in 2020. See https://www.edf.org/about. The other leading environmental non-governmental organization (NGO), Greenpeace, has also expanded massively with national/regional organisations across the world. These environmental lobby groups have actively involved in the waste dispute cases mentioned earlier. In the Trafigura-Côte d'Ivoire case, Greenpeace has pursued several legal actions against Trafigura in both Netherlands and the UK over its illegal dumping of toxic waste. In the Canadian-Philippines case, Greenpeace, the EcoWaste Coalition of the Philippine and other environmental groups have organized numerous protests in pressuring Canada to take back its garbage.

[6]See Grossman and Helpman (2020) for a review of the literature.

and Schulze (2016), etc.

However, these papers generally assume that only environmentalists are concerned about the environment or that all individuals have identical environmental preferences, while neglecting the fact that people with the same income may also have heterogeneous preferences for environmental quality. This is particularly true given that we are living in a diverse world where some individuals are serious about environmental protection while others do not care at all. The strength of such feelings for the environment are not correlated with income levels and the diversity of such attitudes is largely considered as a source of social conflict (Cassing and Long, 2021). To better reflect the reality, we follow much of Cassing and Long (2021)'s framework and assume that groups have heterogeneous preferences for environmental quality [7] – a major departure from the standard trade-and-the-environment models discussed in Copeland, Shapiro and Taylor (2021). Our paper extends the work by Cassing and Long (2021) in a number of dimensions: (i) we include a waste-receiving country, whose optimal choice of the tariff rate on imported waste is also governed by a politically determined process; (ii) we relax some of the restrictive assumptions about the ranking of environmental attitudes among lobby groups and show that the politically chosen policy can be even tighter than the socially optimal one if environmental damages caused by waste are large enough; (iii) we demonstrate and discuss explicitly how lobby groups might affect the waste exports/imports through the mechanism of a politically determined tax/tariff; and (iv) we bring the theory to data for empirical clarity of the effect of environmental movement on trade in waste.

Our main findings show that when environmentalists and capitalists are organized as lobby groups while ordinary workers are not, the politically chosen tax/tariff in Home/Foreign can be below, equal to or above the socially optimal level, depending on the ranking of environmental attitudes and the degree of pollution damages from waste. This political distortion arises from the fact that lobby groups offer campaign contributions to an electorally motivated government in exchange for particular political favours (Aidt, 1998) and that lobby groups with heterogeneous environmental attitudes respond differently to various degrees of waste-induced environmental damages. While environmentalists always push for a higher tax/tariff, capitalists typically lobby in the opposite direction for a less stringent environmental tax or a lower tariff. Because of the additional incentive to reduce the negative effect of a higher tax/tariff on profits that do not accrue to environmentalists and the relative lower valuation of environmental damages, capitalists will lobby more aggressively for a less stringent environmental tax or a lower tariff, which eventually dominates any countervailing efforts from environmentalists.

[7] While Cassing and Long (2021) assume that individuals have heterogeneous environmental preference within and across different groups, we consider the situation where environmental preference only differs across groups but remains the same within the group, so our case can be considered as a special one of theirs. One reason for doing so is that it allows us to analytically investigate the effect of environmental movement.

The resulting equilibrium policy level will typically be lower than the socially optimal one. However, if environmental damage caused by waste is significant enough, it will play an increasing role in both lobby groups' welfare calculations. From the capitalists' perspective, the loss from environmental damages caused by waste can be so severe as to outweigh any profit gains due to a lower tax/tariff. As a result, capitalists will diminish their lobby efforts for a lower tax/tariff or even lobby in the same direction as environmentalists for a higher one. Meanwhile, in response to the significant environmental damages, environmentalists will lobby more aggressively for a higher tax/tariff. Consequently, the political equilibrium policy may equal or even overshoot the social optimum.

Further, we investigate how strengthening the environmental lobby group – measured by an increase in the number of environmentalists and the joining members' associated environmental valuation – might affect the stringency of the environmental/trade policies and by extension firms' decision on waste exports/imports. This can be interpreted as a situation where increased environmental awareness has enabled environmentalists to mobilize more ordinary people to join forces and exert pressure on governments to take more actions. We show that when capitalists have a dominating lobbying power that leads to a downward distorted tax/tariff that is inefficiently weak, a strengthening of environmental lobby group will lead to a higher tax/tariff and thereby result in more/less waste to be exported from Home to Foreign. Indeed, as more people become environmentally concerned and join the green lobbying while the number of capitalists is fixed, this translates into more power exercised by the environmental lobby group. As a result, the government will respond to this boosted political pressure by increasing regulation on the externality. This in turn leads to a higher tax in Home and a higher tariff in Foreign, where the former increases the cost of disposing waste domestically and thereby induces firms to export more waste out of border for disposal, and the latter effectively deters more waste from being imported. McAusland (2008) draws a similar conclusion, demonstrating that when facing an increased political pressure exercised by the organized interest groups, regulators have an incentive to increase regulation on pollution that is a by-product of consumption activities and thereby induce firms to export waste to locations with lower environmental regulation.

However, in the case where environmentalists lobby more aggressively while capitalists diminish their lobbying efforts that leads to an upward distorted tax/tariff that is inefficiently strict, a strengthening of environmental lobby groups may unexpectedly lead to a lower tax/tariff and result in less/more waste to be exported from Home to Foreign. While this result may seem counterintuitive, the main intuition behind it is that we are starting with a situation where the equilibrium tax/tariff is already set very high, meaning that the marginal benefit for any extra efforts to increase the policy stringency would be very small, but the marginal loss of doing so could be significant. While environmentalists enjoy saving the country from suffering too much environmental damage caused by waste, they also derive utility from consumption. When the extra savings from environmental damages cannot exceed their loss from happiness of consumption, they would like to exchange some environmental protection for more consumption, which relaxes the policy stringency. As the number of the members increases, the desire for the tradeoff also increases, which further reduces the tax/tariff. As the pollution tax in Home decreases, the cost of disposing waste domestically goes down and thereby less waste will be exported to other countries; while a lower tariff rate in Foreign will induce firms to import more waste. Eventually when all workers become environmentalists, the equilibrium tax/tariff will equal the social optimum level, leading to a political internalization of the environmental externality (Aidt, 1998).

The model provides us some insights into the relationship between the strength of environmental lobby group, the policy stringency, and firms' decision on waste exports/imports. However, the theory does not yield unambiguous predictions without making any further assumptions. To better understand the role played by environmental lobby group on trade in waste, we take the theory seriously and bring it to data for empirical clarity. Using novel data on the number of environmental NGOs as a proxy for the strength of the environmental lobby group while controlling for other factors that might also affect trade in waste, we find evidence that a strong environmental lobby group in Home/Foreign will result in more/less waste to be shipped from Home to Foreign, thereby confirming a positive relationship between the environmental lobbying strength and policy stringency. This finding suggests that strengthening environmental NGOs may not be a panacea to the waste problem, but rather result in more waste to be exported, potentially causing further environmental degradation in the developing world. This result resembles the so-called "Green Paradox" (Sinn, 2008; Jensen et al., 2015; Van der Ploeg and Withagen, 2015), in which increased environmental stringency leads to accelerated fossil fuel extraction and therefore greater pollution. Similarly, within the waste trade context, a well-intended movement to strengthen environmental protection leads to increased domestic environmental stringency and more waste – often highly toxic– to be shipped to countries that are less equipped to deal with it, possibly exacerbating the environmental damages. However, the good news is that doing so in developing countries may prove fruitful, as it effectively deters more waste from being imported. Therefore, one policy implication from these results is that it may be worthwhile for international donor organizations to provide support for the development of environmental NGOs in developing countries (Binder and Neumayer, 2005; Fredriksson et al., 2005). As for developed countries, increasing the already stringent environmental standards may not solve the waste problem, but instead more resources should be spent on promoting new clean technologies, increasing the recycling use of waste and improving the enforcement of environmental laws, etc.

The remainder of the paper is structured as follows. Section 2 presents the theoretical framework.

Section 3 illustrates our empirical work. Finally, Section 4 concludes with a summary of our findings.

2 The theoretical framework

In this section, we present a political economy model with the simplest possible structure that captures much of the essential elements of international trade in waste. We analyze two representative small open economies on the highly-integrated world markets, which thus do not affect the market prices of waste, e.g. consider Canada and the Philippines. [8] This is a sensible assumption which we consider true for most economies in terms of waste trade. Indeed, on the waste supply side, suppliers are fairly competitive in taking the price of waste treatment as given; on the waste demand side, there is considerably more competition as many firms in the developing countries vie for those waste-disposal contracts. We construct a model where there is an environmentally harmful byproduct – called waste – generated during the production process in a developed-country market. This byproduct is tolerated at some level and subjected to a pollution tax, and can be exported to a developing country for disposal with a fee. The developing country may want to restrict the imports of waste materials and imposes a tariff rate to avoid the country from becoming a waste dump. In both countries, there is an organized environmental lobby group and industry lobby group, who seek to influence the governments' policies, where the governments try to balance the competing interests of various lobby groups and maximized a weighted sum of social welfare and political contributions received from lobby groups.

2.1 The Home country: waste supply

A small open competitive economy, called Home, has 2 sectors. The first one is a clean sector, which produces a numeraire good using labor only with constant returns to scale and a one-to-one input-output ratio. The other one is a polluting sector that uses capital and labor to produce a manufacturing output according to the neoclassical production function $Y = F(K, L)$ that exhibits constant returns to scale with positive and diminishing marginal products and convex isoquants. During the manufacturing process, a negative externality or by-product called "waste" is generated. For simplicity, we assume that each unit of output is accompanied by a unit of waste, denoted by $E = Y$. Suppose the Home country can ship $Q \leq Y$ units of its waste to the Foreign country at a constant unit price $\mu > 0$. For Q units of waste exported, Home incurs a cost $\eta(Q)$ in collecting, sorting as well as packaging and transportation of waste, where η is strictly convex with $\eta(0) = 0, \eta'(Q) > 0$ and $\eta''(Q) > 0$.[9] We

[8] See Cassing and Kuhn (2003) for the case of market power when both waste-importing and waste-exporting countries act strategically to utilize national environmental policies to attach rents arising from trade in waste.

[9] One can also interpret $\eta(Q)$ as the amount of labor that is required for these activities.

assume that Home is endowed with a fixed supply of capital and labor, denoted by $\bar{K}$ and $\bar{L}$, respectively, and that labour is perfectly mobile across sectors and full employment prevails. Suppose the domestic and world prices of the numeraire good are set equal to one, then the economy wide wage rate is fixed at $w = 1$.

The economy is populated by a large number of individuals n, each endowed with $\bar{l}$ units of labor, where $\bar{L} = n\bar{l}$. Each individual i derives utility from consumption of both goods, denoted by a quasi-linear and additively separable utility function:

$$U_i = x_i + u(y_i),$$

where x_i, y_i denotes the consumption of numeraire and manufactured good, respectively, and $u' > 0, u'' < 0$. However, discomfort arises from seeing the pollution caused by waste in the country, so the welfare of individual i is given by

$$W_i(x_i, y_i, Z) = x_i + u(y_i) - \beta_i D(Z),$$

where $D(Z)$ is a positive and convex damage function with $D(0) = 0, D'(Z) > 0, D''(Z) > 0$, $Z = Y - Q$ is the amount of waste or pollution that remains in the country, and β_i denotes individual i's preference for environmental quality. Let $\bar{\beta} = \frac{1}{n}\sum_{i=1}^{n} \beta_i$ represent the society's average environmental preference, then it follows that the social marginal cost of a unit of waste is

$$\frac{\partial \sum_{i=1}^{n} W_i}{\partial Z} = n\bar{\beta}D'(Z).$$

Suppose the n individuals in this economy can be categorized into 3 groups. Among them, group 1 consists of $m_1 < n$ individuals who own capital, which we refer to as capitalists. For simplicity, we assume that all the capitalists have the same environmental preference, denoted by $\beta_C \in (0, \bar{\beta}]$, and each of them has an equal endowment of capital, $\bar{K}/m_1$. Group 2 consists of m_2 non-capitalists who share the same strong preference for environmental quality, which we refer to as environmentalists, with $\beta_E \geq \bar{\beta}$. In this paper, we assume that environmentalists are those who care only about local pollution and do not have global concerns – referred to as NIMBYs (not in my backyard). Finally, the remaining m_3 non-capitalists, which we refer to as workers, constitute Group 3, with the same moderate preference for environmental quality at $\beta_W \in [\beta_C, \beta_E]$, but whether β_W is greater than $\bar{\beta}$ or not remains unknown.

Suppose individuals with similar interests can overcome the free-riding problem (Olson, 1965), and are formed as organized lobby groups to further their interest by taking collective action to influence government policies. We adopt the structure of the two-stage common agency game developed by Bernheim and Whinston (1986) and later employed by Grossman and Helpman (1994) on endogenous trade policies. In the first stage of the game, each of the organized groups simultaneously and non-cooperatively offers to the incumbent government a campaign contribution contingent on the pollution tax selected by the government to correct for the externality. While a group who prefers low taxes will always make more political donations the lower is the announced tax, a group that stands to gain in terms of its own welfare with respect to a higher tax will always increase its contributions. Within the context, the not-in-my-back-yard environmentalists will typically push for a higher environmental tax to avoid too much pollution in the country, while capitalists will only lobby for a lower tax if doing so increases their welfare. By definition, individuals in an unorganized group do not have enough stake in the policy outcome and thus make no campaign contributions. In the second stage of the game, the government takes the "announced contribution schedules" as given and choose an environmental tax t on the manufacturing output to maximize a weighted sum of social welfare and its receipt of campaign contributions:

$$\max_t G(t) = \delta J(t) + \sum_{h\in\Lambda} \psi_h(t),$$

where $J(t) = \sum_{i=1}^{n} J_i(t)$ is the aggregate social welfare, $\psi_h(t)$ is the campaign contribution made by organized lobby group $h \in \Lambda$ and $\delta > 0$ is an exogenously given weight that the government attributes to social welfare relative to political contributions.

Finally, the domestic firms will receive a tax refund t for every unit of waste that is being exported, i.e., the government will only tax the pollution that remains within the country. This can be seen as a form of border tax adjustment (Keen and Kotsogiannis, 2014; Cosbey et al., 2020). Another way to interpret this tax refund is that firms will save an equivalent per unit cost of t in administrating these exported waste. As for the remaining tax revenue, the government will distribute it as a lump-sum tax transfer to all the individuals in the economy. Refunding environmental charges back to the polluting industry and consumers are quite often and typically reduces resistance from the polluters, making the policy more politically acceptable than a standard tax. See, for example, the refunded emission payment scheme in Sweden (Sterner and Isaksson, 2006), the carbon tax rebate programs in Canada, and other examples in Aidt (2010).

In the following, we solve the problems of firms, consumers, lobby groups and the government, respectively. First, taking as given the consumer price of the manufactured good p_c, the unit waste absorption fee μ, and the environmental tax t on manufacturing output, which is also the refund per unit of waste exported, each competitive manufacturing firm chooses the input levels (K_j, L_j) and waste export level (Q_j) to maximize its profit:

$$\max_{K_j, L_j, Q_j} \pi_j = (p_c - t)F(K_j, L_j) - wL_j - rK_j + (t - \mu)Q_j - \eta(Q_j),$$

where $w = 1$ is the wage rate and r is the rental rate. With the constant returns to scale assumption and $\sum_j K_j = \bar{K}$, we know that for the manufacturing industry as a whole, the industry's employment of labor L and waste exports Q must be determined by maximizing the aggregate return to the capital stock. Thus, the firms' problem can be reformulated as

$$\max_{L,Q} \Pi = (p_c(t) - t)F(\bar{K}, L) - L + (t - \mu)Q - \eta(Q).$$

Assuming an interior solution, the first order conditions with respect to Q and L are respectively

$$t - \mu = \eta'(Q), \tag{1}$$

and

$$(p_c(t) - t)F_L(\bar{K}, L) = 1, \tag{2}$$

where F_L denotes the marginal product of labor in manufacturing. Equation (1) says that at the optimal waste export level $\hat{Q}$, the marginal benefit must be equal to the marginal cost of exporting waste. As long as $t > \mu$, manufacturing firms would want to export waste abroad. Equation (2) says that at the optimal labor allocation $\hat{L}$, the value of marginal product of labor is equated to the wage rate. Given $\hat{Q}$ and $\hat{L}$, the maximized aggregate return to capital is

$$\hat{\Pi} = (p_c(t) - t)\hat{Y} - \hat{L} + (t - \mu)\hat{Q} - \eta(\hat{Q}), \quad \text{where } \hat{Y} = F(\bar{K}, \hat{L}).$$

After solving for firms' problem, we now turn to the consumer's problem. Each consumer i is maximizing the utility subject to her budget constraint:

$$\max_{x_i, y_i} [x_i + u(y_i)], \quad s.t. \quad x_i + p_c y_i = M_i,$$

where M_i is the income of consumer i. Every consumer in the economy receives income from two sources: first, she supplies her endowment of labour inelastically to the competitive labour market and thus earns the wage income $w\bar{l}$; second, she receives $1/n$ of the government's net tax revenue $t(\hat{Y} - \hat{Q})$ as a lump sum transfer. However, a capitalist has one additional income source from her endowment of capital, which claims $\frac{\hat{\Pi}}{m_1}$. Therefore, the income of a representative non-capitalist, i.e., environmentalist or worker, is given by

$$M_j = \bar{l} + t(\hat{Y} - \hat{Q})/n, \tag{3}$$

while that of a representative capitalist is

$$M_k = \hat{\Pi}/m_1 + \bar{l} + t(\hat{Y} - \hat{Q})/n. \tag{4}$$

Utility maximization yields the first order condition:

$$u'(y_i) = p_c. \tag{5}$$

Thus, the demand for the manufactured good and numeraire good are respectively:

$$\hat{y}_i = (u')^{-1}(p_c) \equiv \hat{y}(p_c), \quad \hat{x}_i = M_i - p_c\hat{y}_i,$$

and the indirect utility function of consumer i is

$$V_i = M_i - p_c\hat{y}(p_c) + u(\hat{y}(p_c)) = M_i + CS(\hat{y}(p_c)),$$

where $CS(\hat{y}(p_c)) = u(\hat{y}(p_c)) - p_c\hat{y}(p_c)$ is the consumer surplus with

$$\frac{dCS(\hat{y}(p_c))}{dp_c} = -\hat{y}(p_c).$$

The resulting welfare level of consumer i is

$$W_i = M_i + CS(\hat{y}(p_c)) - \beta_i D(\hat{Z}),$$

where $\hat{Z} = \hat{Y} - \hat{Q}$ and M_i is given by equation (3) for a non-capitalist and equation (4) for a capitalist. Therefore, the gross welfare of each group can be expressed as

$$J_1(t) = m_1\left[\hat{\Pi}(t)/m_1 + \bar{l} + t(\hat{Y}(t) - \hat{Q}(t))/n + CS(p_c(t))\right] - m_1\beta_C D(\hat{Y}(t) - \hat{Q}(t)),$$

$$J_2(t) = m_2\left[\bar{l} + t(\hat{Y}(t) - \hat{Q}(t))/n + CS(p_c(t))\right] - m_2\beta_E D(\hat{Y}(t) - \hat{Q}(t)),$$

$$J_3(t) = m_3\left[\bar{l} + t(\hat{Y}(t) - \hat{Q}(t))/n + CS(p_c(t))\right] - m_3\beta_W D(\hat{Y}(t) - \hat{Q}(t)).$$

and the aggregate social welfare is

$$J(t) = n\left[\bar{l} + t(\hat{Y}(t) - \hat{Q}(t))/n + CS(\hat{y}(t))\right] + \hat{\Pi}(t) - n\bar{\beta}D(\hat{Y}(t) - \hat{Q}(t)), \tag{6}$$

where by definition,

$$n\bar{\beta} = m_1\beta_C + m_2\beta_E + m_3\beta_W.$$

Before we proceed to characterize the two-stage subgame perfect equilibrium, it will be useful to derive the first-best environmental tax so that we have a benchmark to compare to. Also, it will be helpful to compute the comparative statics of $\hat{L}, \hat{Y}, \hat{Q}, \hat{Z}, \hat{\Pi}$ with respect to t, which constitute a building block to analyze the effect of environmental lobby group on pollution tax and by extension trade in waste. But first note that in equilibrium, the total consumption of the manufactured good must be equal to that sector's total output, i.e.,

$$n\hat{y} = \hat{Y} = F(\bar{K}, \hat{L}) \Longleftrightarrow \hat{y} = \frac{\hat{Y}}{n}, \tag{7}$$

and we have

$$\begin{aligned}
\frac{dJ_1}{dt} &= \frac{d\hat{\Pi}}{dt} + \frac{m_1}{n}\left[\hat{Y} - \hat{Q} + t\left(\frac{d\hat{Y}}{dt} - \frac{d\hat{Q}}{dt}\right)\right] + m_1\frac{dCS(p_c)}{dp_c}\frac{dp_c}{dt} - m_1\beta_C D'(\hat{Z})\left(\frac{d\hat{Y}}{dt} - \frac{d\hat{Q}}{dt}\right) \\
&= \left[\frac{dp_c}{dt} - 1\right]\hat{Y} + \hat{Q} + \frac{m_1}{n}\left[\hat{Y} - \hat{Q} + t\left(\frac{d\hat{Y}}{dt} - \frac{d\hat{Q}}{dt}\right)\right] - m_1\frac{\hat{Y}}{n}\frac{dp_c}{dt} - m_1\beta_C D'(\hat{Z})\left(\frac{d\hat{Y}}{dt} - \frac{d\hat{Q}}{dt}\right),
\end{aligned}$$

$$\begin{aligned}
\frac{dJ_2}{dt} &= \frac{m_2}{n}\left[\hat{Y} - \hat{Q} + t\left(\frac{d\hat{Y}}{dt} - \frac{d\hat{Q}}{dt}\right)\right] - m_2\frac{\hat{Y}}{n}\frac{dp_c}{dt} - m_2\beta_E D'(\hat{Z})\left(\frac{d\hat{Y}}{dt} - \frac{d\hat{Q}}{dt}\right), \\
\frac{dJ_3}{dt} &= \frac{m_3}{n}\left[\hat{Y} - \hat{Q} + t\left(\frac{d\hat{Y}}{dt} - \frac{d\hat{Q}}{dt}\right)\right] - m_3\frac{\hat{Y}}{n}\frac{dp_c}{dt} - m_3\beta_W D'(\hat{Z})\left(\frac{d\hat{Y}}{dt} - \frac{d\hat{Q}}{dt}\right),
\end{aligned}$$

and

$$\begin{aligned}
\frac{dJ}{dt} &= \left[\frac{dp_c}{dt} - 1\right]\hat{Y} + \hat{Q} + \left[\hat{Y} - \hat{Q} + t\left(\frac{d\hat{Y}}{dt} - \frac{d\hat{Q}}{dt}\right)\right] - \hat{Y}\frac{dp_c}{dt} - n\bar{\beta}D'(\hat{Z})\left(\frac{d\hat{Y}}{dt} - \frac{d\hat{Q}}{dt}\right) \\
&= \left(t - n\bar{\beta}D'(\hat{Z})\right)\left(\frac{d\hat{Y}}{dt} - \frac{d\hat{Q}}{dt}\right).
\end{aligned}$$

2.1.1 Pigovian tax

Without any political considerations, a benevolent government only cares about the aggregate welfare level of its country and thus welfare maximization is the main force that drives the environmental policy decisions. Maximizing (6) with respect to t yields the optimal environmental tax, i.e.,

$$\frac{dJ}{dt} = \left(t - n\bar{\beta}D'(\hat{Z})\right)\left(\frac{d\hat{Y}}{dt} - \frac{d\hat{Q}}{dt}\right) = 0,$$

or

$$t^* = n\bar{\beta}D'(\hat{Z}).$$

That is, the social optimal or Pigovian tax is equal to the social marginal cost of waste.

2.1.2 Comparative statics with respect to tax

The equilibrium demand for labour in the manufacturing sector, $\hat{L}$, is implicitly given by equation (2): $(p_c(t) - t)F_L(\bar{K}, L) = 1$. This, combined with equation (5): $u'(y_i) = p_c$ and equation (7): $\hat{y} = \frac{\hat{Y}}{n} = \frac{F(\bar{K},\hat{L})}{n}$, yields a unique equation that determines $\hat{L}$ as a function of t:

$$\left[u'\left(\frac{F(\bar{K},\hat{L})}{n}\right) - t\right]F_L(\bar{K},\hat{L}) - 1 = 0. \tag{8}$$

Totally differentiate (8) with respect to $\hat{L}$ and t yields

$$dL\left[u''(\hat{y})\frac{F_L}{n} \cdot F_L + (u'(\hat{y}) - t)F_{LL}\right] + dt\left[-F_L\right] = 0.$$

Since $F_L > 0, F_{LL} < 0, u' > 0, u'' < 0$, we must have

$$\frac{d\hat{L}}{dt} = \frac{F_L}{u''F_L^2/n + F_{LL}/F_L} < 0.$$

Then,

$$\frac{d\hat{Y}}{dt} = F_L\frac{d\hat{L}}{dt} = \frac{F_L^2}{u''F_L^2/n + F_{LL}/F_L} = \frac{1}{u''/n + F_{LL}/F_L^3} < 0.$$

and

$$\frac{dp_c}{dt} = \frac{u''}{n}\frac{d\hat{Y}}{dt} = \frac{u''F_L^2/n}{u''F_L^2/n + F_{LL}/F_L} < 0,$$

with

$$\frac{dp_c}{dt} - 1 = \frac{-F_{LL}/F_L}{u''F_L^2/n + F_{LL}/F_L} = -\frac{1}{\frac{u''}{n}\frac{F_L^3}{F_{LL}} + 1} = -\frac{F_{LL}}{F_L^3}\frac{d\hat{Y}}{dt} < 0.$$

The equilibrium waste exports, $\hat{Q}$, can be implicitly obtained from equation (1): $t - \mu = \eta'(Q)$ as a function of t. Totally differentiate (1) with respect to $\hat{Q}$ and t yields

$$\frac{d\hat{Q}}{dt} = \frac{1}{\eta''(Q)} > 0.$$

Therefore, the equilibrium pollution level is $\hat{Z}(t) = \hat{Y}(t) - \hat{Q}(t)$ with

$$\frac{d\hat{Z}}{dt} = \frac{d\hat{Y}}{dt} - \frac{d\hat{Q}}{dt} < 0.$$

Finally, using the envelope theorem, we can get

$$\frac{d\hat{\Pi}}{dt} = \left[\frac{dp_c}{dt} - 1\right]\hat{Y} + \hat{Q} = \hat{Q} - \hat{Y}\frac{F_{LL}}{F_L^3}\frac{d\hat{Y}}{dt},$$

which can be rearranged as

$$\frac{dp_c}{dt} - 1 = \frac{\frac{d\hat{\Pi}}{dt} - \hat{Q}}{\hat{Y}} < 0. \tag{9}$$

Intuitively, a higher pollution tax increases firms' burden and would typically lead to a lower aggregate industry profits or producer surplus. Thus, by construction,

$$\frac{d\hat{\Pi}}{dt} < 0 \Longleftrightarrow \hat{Q} < \hat{Y}\frac{F_{LL}}{F_L^3}\frac{d\hat{Y}}{dt}.$$

2.1.3 Political economy tax

In this paper, we only consider two organized interest groups – capitalists and environmentalists, while workers are not organized.[10] We now investigate how the pressure exercised by an environmental and industry lobby group could result in a political economy equilibrium and characterize the government's optimal choice of environmental tax.

The incumbent government's action is the unit pollution tax and the lobby groups' actions are contribution schedules that map each tax policy into a contribution level. The political equilibrium thus consists of a set of feasible contribution functions $(\{\psi_h(t^{**})\}_{h\in\Lambda})$ and the environmental tax policy (t^{**}). Following Bernheim and Whinston (1986), we focus on the interior equilibrium contribution schedules that truthfully reflect the gains expected by the pressure groups such that

[10]When all groups are organized, the political economy equilibrium tax is efficient and identical to the Pigovian tax, see e.g., Aidt (1998) or Cassing and Long (2021).

$\psi_h(t) = J_h(t) - B_h$, where $B_h > 0$ is a constant.[11] Then, t^{**} must be the solution of the problem

$$\max_t \hat{G}(t) = (1+\delta)\Big[J_1(t) - B_1 + J_2(t) - B_2\Big] + \delta J_3(t).$$

The first-order condition yields

$$\frac{d\hat{G}(t)}{dt} = (1+\delta)\left(\frac{dJ_1}{dt} + \frac{dJ_2}{dt}\right) + \delta\frac{dJ_3}{dt} = 0,$$

or

$$\frac{dJ_1}{dt} + \frac{dJ_2}{dt} + \delta\frac{dJ}{dt} = 0.$$

That is,

$$\left[\frac{dp_c}{dt}-1\right]\hat{Y}+\hat{Q}+\frac{m_1+m_2}{n}\left[\hat{Y}-\hat{Q}+t\left(\frac{d\hat{Y}}{dt}-\frac{d\hat{Q}}{dt}\right)\right]-\frac{m_1+m_2}{n}\hat{Y}\frac{dp_c}{dt}-(m_1\beta_C+m_2\beta_E)D'(\hat{Z})\left(\frac{d\hat{Y}}{dt}-\frac{d\hat{Q}}{dt}\right)$$

$$+\delta\Big(t - n\bar{\beta}D'(\hat{Z})\Big)\left(\frac{d\hat{Y}}{dt} - \frac{d\hat{Q}}{dt}\right) = 0.$$

This equation reduces to

$$\frac{m_3}{n}\hat{Y}\left[\frac{dp_c}{dt} - 1\right] + \frac{m_3}{n}\hat{Q} + \left(\frac{m_1+m_2}{n}t - (m_1\beta_C + m_2\beta_E)D'(\hat{Z})\right)\left(\frac{d\hat{Y}}{dt} - \frac{d\hat{Q}}{dt}\right)$$

$$+\delta\Big(t - n\bar{\beta}D'(\hat{Z})\Big)\left(\frac{d\hat{Y}}{dt} - \frac{d\hat{Q}}{dt}\right) = 0.$$

Substitute with equation (9):

$$\frac{dp_c}{dt} - 1 = \frac{\frac{d\hat{\Pi}}{dt} - \hat{Q}}{\hat{Y}},$$

and use the result

$$m_1\beta_C + m_2\beta_E = n\bar{\beta} - m_3\beta_W = \frac{m_1+m_2+m_3}{n}n\bar{\beta} - m_3\beta_W = \frac{m_1+m_2}{n}n\bar{\beta} - \frac{m_3}{n}(n\beta_W - n\bar{\beta}),$$

the equation becomes

$$\frac{m_3}{n}\frac{d\hat{\Pi}}{dt} + \left[\frac{m_1+m_2}{n}t - \left(\frac{m_1+m_2}{n}n\bar{\beta} - \frac{m_3}{n}(n\beta_W - n\bar{\beta})\right)D'(\hat{Z})\right]\left(\frac{d\hat{Y}}{dt} - \frac{d\hat{Q}}{dt}\right)$$

[11] We do not derive the equilibrium condition here. For a detailed description of the common-agency game, please refer to Bernheim and Whinston (1986) and see Proposition 1 in Grossman and Helpman (1994) for the necessary and sufficient conditions of the subgame-perfect Nash equilibrium.

$$+\delta\Big(t - n\bar{\beta}D'(\hat{Z})\Big)\left(\frac{d\hat{Y}}{dt} - \frac{d\hat{Q}}{dt}\right) = 0.$$

Define $\lambda_0 = \frac{m_1+m_2}{n}$ as the fraction of the population that belong to the organized group, then

$$(1-\lambda_0)\frac{d\hat{\Pi}}{dt} + \left[\lambda_0\Big(t - n\bar{\beta}D'(\hat{Z})\Big) + (1-\lambda_0)(n\beta_W - n\bar{\beta})D'(\hat{Z})\right]\left(\frac{d\hat{Y}}{dt} - \frac{d\hat{Q}}{dt}\right)$$

$$+\delta\Big(t - n\bar{\beta}D'(\hat{Z})\Big)\left(\frac{d\hat{Y}}{dt} - \frac{d\hat{Q}}{dt}\right) = 0.$$

Combine terms, we have

$$\frac{d\hat{G}(t)}{dt} = (\lambda_0+\delta)\Big(t-n\bar{\beta}D'(\hat{Z})\Big)\left(\frac{d\hat{Y}}{dt}-\frac{d\hat{Q}}{dt}\right)+(1-\lambda_0)\left[\frac{d\hat{\Pi}}{dt}+(n\beta_W-n\bar{\beta})D'(\hat{Z})\left(\frac{d\hat{Y}}{dt}-\frac{d\hat{Q}}{dt}\right)\right] = 0.$$

Thus, when both environmentalists and capitalists are organized, the political economy equilibrium tax t^{**} is characterized by the following equation:

$$\frac{\frac{d\hat{G}(t)}{dt}}{(\lambda_0+\delta)\frac{d\hat{Z}}{dt}} = \Omega \equiv \Big[t - n\bar{\beta}D'(\hat{Z})\Big] + \frac{1-\lambda_0}{\delta+\lambda_0}\left\{(n\beta_W - n\bar{\beta})D'(\hat{Z}) + \frac{d\hat{\Pi}}{d\hat{Z}}\right\} = 0, \tag{10}$$

where

$$\frac{d\hat{Z}}{dt} = \frac{d\hat{Y}}{dt} - \frac{d\hat{Q}}{dt} < 0, \quad \frac{d\hat{\Pi}}{d\hat{Z}} = \frac{d\hat{\Pi}/dt}{d\hat{Z}/dt} > 0.$$

Note that for t^{**} to be a maximum, we need to ensure that the second order condition of the government's maximization with respect to t is negative, i.e.,

$$\frac{d^2\hat{G}(t)}{dt^2} = (\lambda_0+\delta)\frac{d^2\hat{Z}}{dt^2}\Omega + (\lambda_0+\delta)\frac{d\hat{Z}}{dt}\frac{d\Omega}{dt} < 0.$$

Since $\Omega = 0$ and $\frac{d\hat{Z}}{dt} < 0$, we must have

$$\frac{d\Omega}{dt} = 1 - n\bar{\beta}D''(\hat{Z})\frac{d\hat{Z}}{dt} + \frac{1-\lambda_0}{\delta+\lambda_0}\left((n\beta_W - n\bar{\beta})D''(\hat{Z})\frac{d\hat{Z}}{dt} + \frac{\frac{d^2\hat{\Pi}}{dt}\frac{d\hat{Z}}{dt} - \frac{d\hat{\Pi}}{dt}\frac{d^2\hat{Z}}{dt^2}}{(\frac{d\hat{Z}}{dt})^2}\right) > 0.$$

Now, we are ready to compare the outcome of this political equilibrium with the benchmark outcome under a benevolent social planner. Clearly, from equation (10), the political equilibrium tax is indeterminate in size relative to the Pigovian one. If $\beta_W \geq \bar{\beta}$, i.e., the society has a disproportionally large number of capitalists or capitalists have an extremely low environmental valuation, with $D'(\hat{Z}) > 0$ and $\frac{d\hat{\Pi}}{d\hat{Z}} > 0$, then we have $t^{**} < t^* = n\bar{\beta}D'(\hat{Z})$. So the pressure exercised by the lobby groups creates a politically downward distortion of environmental policy that is inefficiently weak.

While environmentalists always push for a higher tax, capitalists typically lobby in the opposite direction for a less stringent environmental tax. Because of the additional incentive to reduce the negative effect of a higher tax on its profits that do not accrue to environmentalists and the relative lower valuation of environmental damages, the capitalists will lobby more aggressively for the tax that moves in favor of its direction. As a result, the politically determined tax when balancing the opposing effects of an organized environmental lobby group and industry lobby group will be lower than the Pigovian one.

However, if instead, we assume $\beta_C \leq \beta_W < \bar{\beta} \leq \beta_E$ (i.e., the society has a disproportionally large number of environmentalists or environmentalists have an extremely high preference for a clean environment), then $(n\beta_W - n\bar{\beta})D'(\hat{Z}) < 0$ and we may have different cases where the political equilibrium tax is above, equal or less than the Pigovian level. Denote $A \equiv (n\beta_W - n\bar{\beta})D'(\hat{Z}) + \frac{d\hat{\Pi}}{d\hat{Z}}$, then we can rewrite A as

$$\underbrace{(n\beta_W - n\bar{\beta})D'(\hat{Z})\frac{d\hat{Z}}{dt}}_{>0} + \underbrace{\frac{d\hat{\Pi}}{dt}}_{<0},$$

where the first term is the positive effect of tax on social environmental valuations (i.e., savings from environmental damages), and the second term is the negative effect of tax on industry profits. If $D'(\hat{Z})$ is small enough, then $A < 0$ and thus $t^{**} < t^* = n\bar{\beta}D'(\hat{Z})$. The same intuition as earlier applies here. However, if $D'(\hat{Z})$ is large enough, then we may have a situation where the two effects cancelled out or even the former effect dominates, i.e., $A \leq 0$. In this case, we would have $t^{**} \geq t^* = n\bar{\beta}D'(\hat{Z})$. This is because the significant environmental damage caused by waste plays an increasing role in both lobby groups' welfare calculation. From the capitalists' perspective, the loss from environmental damages caused by waste can be so severe as to dominate any profit gains due to a lower tax. As a result, capitalists will diminish their lobby efforts for a lower tax or even lobby in the same direction with environmentalists for a higher one. Meanwhile, in response to the significant environmental damages, environmentalists will lobby more aggressively for a higher tax. Consequently, the political tax may overshoot the Pigovian level. We can thus summarize these findings in Proposition 1:

Proposition 1. *If group 3 is not organized, when $\beta_W \geq \bar{\beta}$, or $\beta_W < \bar{\beta}$ but $D'(\hat{Z})$ is small enough, the political economy equilibrium tax on the externality is below the Pigovian one. However, when $\beta_W < \bar{\beta}$ and $D'(\hat{Z})$ is large enough, the political tax can be equal or above the Pigovian level.*

It will prove helpful to illustrate the model and the findings of the above proposition with some specific functional forms and numerical examples. These examples will serve as benchmarks when analyzing the effects of environmental lobby group on environmental tax and by extension waste exports. Suppose the production function, utility function, cost function and damage function take the following forms respectively:

$$Y = F(K, L) = 2K^{\frac{1}{2}}L^{\frac{1}{2}}, \quad u(y) = Ay - \frac{1}{2}y^2, \quad \eta(Q) = \frac{1}{2}Q^2, \quad D(Z) = \frac{\gamma}{2}Z^2,$$

which will allow us to obtain an analytical solution. For simplicity, let $\bar{K} = 1$, then

$$Y = F(\bar{K}, L) = 2L^{\frac{1}{2}}, \quad F_L(\bar{K}, L) = L^{-\frac{1}{2}}, \quad F_{LL}(\bar{K}, L) = -\frac{1}{2}L^{-\frac{3}{2}}, \quad \frac{F_{LL}}{F_L^3} = -\frac{1}{2},$$

and we have

$$u'(y) = A - y, \quad \eta'(Q) = Q, \quad D'(Z) = \gamma Z.$$

From equation (8):

$$\left[u'\left(\frac{F(\bar{K}, \hat{L})}{n}\right) - t\right] F_L(\bar{K}, \hat{L}) - 1 = 0,$$

we can obtain the optimal labour and thereby output in the manufacturing sector as

$$\hat{L}(t) = \left(\frac{n(A-t)}{n+2}\right)^2, \quad \hat{Y}(t) = 2\hat{L}^{\frac{1}{2}} = \frac{2n(A-t)}{n+2}.$$

From equation (1), the optimal exported waste can be expressed as

$$\hat{Q}(t) = t - \mu.$$

Therefore, the optimal pollution is given by

$$\hat{Z}(t) = \hat{Y}(t) - \hat{Q}(t) = \frac{2n(A-t)}{n+2} - t + \mu.$$

To ensure $\hat{Y}, \hat{Q}, \hat{Z} > 0$, we would need

$$\mu < t < \frac{2nA + \mu(n+2)}{3n+2} < A.$$

Clearly,

$$\frac{d\hat{Y}(t)}{dt} = -\frac{2n}{n+2} < 0, \quad \frac{d\hat{Q}(t)}{dt} = 1 > 0, \quad \frac{d\hat{Z}(t)}{dt} = -\frac{2n}{n+2} - 1 < 0,$$

Then, we have

$$\frac{d\hat{\Pi}}{dt} = \hat{Q} - \hat{Y}\frac{F_{LL}}{F_L^3}\frac{d\hat{Y}}{dt} = t - \mu - \frac{2n(A-t)}{n+2}(-\frac{1}{2})(-\frac{2n}{n+2}) = t - \mu - \frac{2n^2(A-t)}{(n+2)^2},$$

and

$$\frac{d\hat{\Pi}}{d\hat{Z}} = \frac{\frac{d\hat{\Pi}}{dt}}{\frac{d\hat{Z}}{dt}} = \frac{t - \mu - \frac{2n^2(A-t)}{(n+2)^2}}{-\frac{2n}{n+2} - 1} = \frac{2n^2(A-t) - (t-\mu)(n+2)^2}{(3n+2)(n+2)}$$

To ensure $\frac{d\hat{\Pi}}{dt} < 0$ or $\frac{d\hat{\Pi}}{d\hat{Z}} > 0$, we need

$$t < \frac{2n^2 A + \mu(n+2)^2}{3n^2 + 4n + 4}.$$

It can be easily verified that

$$\frac{2n^2 A + \mu(n+2)^2}{3n^2 + 4n + 4} < \frac{2nA + \mu(n+2)}{3n+2}.$$

Therefore, the resulting political equilibrium tax must satisfy the condition:

$$\mu < t < \frac{2n^2 A + \mu(n+2)^2}{3n^2 + 4n + 4}.$$

Finally, from equation (10), we have

$$t - n\bar{\beta}\gamma\hat{Z} + \frac{1-\lambda_0}{\delta+\lambda_0}\left[(n\beta_W - n\bar{\beta})\gamma\hat{Z} + \frac{d\hat{\Pi}}{d\hat{Z}}\right] = 0.$$

That is,

$$t + \gamma\frac{m_3\bar{\beta}_M - (\delta+1)n\bar{\beta}}{\delta + \frac{m_1+m_2}{n}}\left[\frac{2n(A-t)}{n+2} - t + \mu\right] + \frac{\frac{m_3}{n}}{\delta + \frac{m_1+m_2}{n}}\left[\frac{2n^2(A-t) - (t-\mu)(n+2)^2}{(3n+2)(n+2)}\right] = 0$$

For numerical illustrations, we use the following parameter values:

$$n = 10, \quad \mu = 2.5, \quad A = 5, \quad \bar{L} = 10, \quad m_1 = 3, \quad m_2 = 2, \quad m_3 = 5, \quad \delta = 0.5.$$

Thus,

$$\lambda_0 = \frac{m_1 + m_2}{n} = 0.5, \quad \frac{1-\lambda_0}{\delta+\lambda_0} = \frac{0.5}{0.5+0.5} = 0.5$$

Example 1. Suppose the average environmental preference for each group is such that

$$\beta_C = 0.01 < \bar{\beta} = 0.2 < \beta_W = 0.25 < \beta_E = 0.36,$$

with

$$m_1\beta_C + m_2\beta_E + m_3\beta_W = 3 \times 0.01 + 2 \times 0.36 + 5 \times 0.25 = 2 = 10 \times 0.2 = n\bar{\beta}$$

and $\gamma = 3$, then the political economy equilibrium tax can be solved as

$$t^{**} = 3.7867 \in \left(\mu = 2.5, \frac{2n^2 A + \mu(n+2)^2}{3n^2 + 4n + 4} = 3.9535 \right).$$

Thus, we have

$$\hat{L}(t^{**}) = 1.0223, \quad \hat{Y}(t^{**}) = 2.0222, \quad \hat{Q}(t^{**}) = 1.2867, \quad \hat{Z}(t^{**}) = 0.7355,$$

and the Pigovian tax is

$$t^* = n\bar{\beta}\gamma\hat{Z} = 4.4130 > t^{**} = 3.7867.$$

Example 1 shows that when $\beta_W \geq \beta$, the political economy equilibrium tax on the externality is below the Pigovian level.

Example 2. Suppose the average environmental preference for each group is such that

$$\beta_C = 0.02 < \beta_W = 0.18 < \bar{\beta} = 0.2 < \beta_E = 0.52,$$

with

$$m_1\beta_C + m_2\beta_E + m_3\beta_W = 3 \times 0.02 + 2 \times 0.52 + 5 \times 0.18 = 2 = 10 \times 0.2 = n\bar{\beta}$$

and $\gamma = 1$, then the political economy equilibrium tax can be solved as

$$t^{**} = 3.4101 \in \left(\mu = 2.5, \frac{2n^2 A + \mu(n+2)^2}{3n^2 + 4n + 4} = 3.9535 \right).$$

Thus, we have

$$\hat{L}(t^{**}) = 1.7554, \quad \hat{Y}(t^{**}) = 2.6498, \quad \hat{Q}(t^{**}) = 0.9101, \quad \hat{Z}(t^{**}) = 1.7398,$$

and the Pigovian tax is

$$t^* = n\bar{\beta}\gamma\hat{Z} = 3.4795 > t^{**} = 3.4101.$$

Example 2 shows that when $\beta_W < \bar{\beta}$ but $D'(\hat{Z})$ is small enough (i.e., $\gamma = 1$), the political economy equilibrium tax on the externality is below the Pigovian level.

Example 3. We retain the same average environmental preference for each group as in Example 2:

$$\beta_C = 0.02 < \beta_W = 0.18 < \bar{\beta} = 0.2 < \beta_E = 0.52,$$

but now $\gamma = 5$, then the political economy equilibrium tax is

$$t^{**} = 3.9219 \in \left(\mu = 2.5, \frac{2n^2A + \mu(n+2)^2}{3n^2 + 4n + 4} = 3.9535\right).$$

Thus, we have

$$\hat{L}(t^{**}) = 0.8071, \quad \hat{Y}(t^{**}) = 1.7968, \quad \hat{Q}(t^{**}) = 1.4219, \quad \hat{Z}(t^{**}) = 0.3749,$$

and the Pigovian tax is

$$t^* = n\bar{\beta}\gamma\hat{Z} = 3.7486 < t^{**} = 3.9219.$$

Example 3 shows that when $\beta_W < \bar{\beta}$ and $D'(\hat{Z})$ is large enough (i.e., $\gamma = 5$), the political economy equilibrium tax on the externality is above Pigovian level.

2.1.4 The effects of environmental lobbying on tax and waste exports

In this section, we analyse how a strengthening of environmental lobby group – measured by an increase in the number of environmentalists and the joining members' associated environmental valuation – might impact the environmental tax and by extension firms' decision to export waste. This can be interpreted as a situation where increased environmental awareness has enabled environmentalists to mobilize more ordinary people to join forces and exert pressure on governments to take more actions.

Assume that the number of capitalists (m_1) and the total population (n) are fixed, but more workers (m_3) become environmentalists (m_2) and their associated environmental preference (β_W) also increases to β_E. Given $n = m_1 + m_2 + m_3$, we must have

$$\frac{dm_1}{dm_2} = \frac{dn}{dm_2} = 0, \quad \frac{dm_3}{dm_2} = -1, \quad \frac{d\lambda_0}{dm_2} = \frac{1}{n}$$

$$\frac{d\frac{1-\lambda_0}{\delta+\lambda_0}}{dm_2} = \frac{-\frac{1}{n}(\delta+\lambda_0) - \frac{1}{n}(1-\lambda_0)}{(\delta+\lambda_0)^2} = \frac{-\frac{1}{n}(\delta+1)}{(\delta+\lambda_0)^2} < 0$$

$$\frac{d\beta_C}{dm_2} = \frac{d\beta_W}{dm_2} = \frac{d\beta_E}{dm_2} = 0, \quad \frac{dn\bar{\beta}}{dm_2} = \frac{d(m_1\beta_C + m_2\beta_E + m_3\beta_W)}{dm_2} = \beta_E - \beta_M > 0.$$

It follows that the effect of strengthening environmental lobbying on tax is given by

$$\frac{dt}{dm_2} = \frac{\frac{1+\delta}{\delta+\lambda_0}\frac{1}{m_3}\left[m_3(\beta_E - \beta_W)D'(\hat{Z}) - \left(t - n\bar{\beta}D'(\hat{Z})\right)\right]}{\frac{d\Omega}{dt}}. \tag{11}$$

Proof. See Appendix A. □

Since $\frac{d\Omega}{dt} > 0$, the sign of $\frac{dt}{dm_2}$ is determined by the two terms in the square bracket: $m_3(\beta_E - \beta_W)D'(\hat{Z}(t))$ and $\left(t - n\bar{\beta}D'(\hat{Z})\right)$. Note that $(\beta_E - \beta_W)$ measures how much environmental valuation increases when one worker becomes an environmentalist, so the first term $m_3(\beta_E - \beta_W)D'(\hat{Z}(t)) > 0$ captures the marginal environmental savings from this strengthening of environmental lobby group, or the social marginal benefit of environmental movement, whereas the second term $\left(t - n\bar{\beta}D'(\hat{Z})\right)$ captures the political distortion from the social optimal level, therefore representing the social marginal loss from lobbying.

Suppose we are starting with a situation where $t < n\bar{\beta}D'(\hat{Z})$. This corresponds to the above-mentioned case where the capitalists have a dominating lobby power (i.e., when $\beta_W \geq \bar{\beta}$, or $\beta_W < \bar{\beta}$ but $D'(\hat{Z})$ is small enough), which creates a downward distortion of environmental policy that is inefficiently weak. Since $t - n\bar{\beta}D'(\hat{Z}) < 0$, then the numerator must be positive, so we have

$$\frac{dt}{dm_2} > 0,$$

and by extension,

$$\frac{d\hat{Q}}{dm_2} = \frac{d\hat{Q}}{dt}\frac{dt}{dm_2} > 0.$$

This result is highly intuitive. As more people become environmentally concerned and join the environmental lobbying while the number of capitalists is fixed, this translates into more power exercised by the environmental lobby group. As a result, government will respond to this boosted political pressure by increasing the stringency of environmental policy. This ultimately pushes up the cost of disposing waste domestically, thereby resulting in more waste to be exported to other countries. This conclusion is similar to McAusland (2008), which demonstrates that when facing an increased political pressure exercised by the organized interest groups, regulators have an incentive to increase regulation on pollution that is a by-product of consumption activities and thereby induce firms to export waste to lower environmental regulation locations. Eventually, when environmentalists are able to mobilize all the workers to join force, the resulting equilibrium tax will equate the social optimum.

However, if $t > n\bar{\beta}D'(\hat{Z})$, this corresponds to the situation where the environmentalists lobby more aggressively while the capitalists diminish their lobbying efforts (i.e., when $\beta_W < \bar{\beta}$ and $D'(\hat{Z})$ is large enough), creating a upward distorted environmental policy that is inefficiently strict. Now both the terms $m_3(\beta_E - \beta_W)D'(\hat{Z}(t))$ and $t - n\bar{\beta}D'(\hat{Z})$ are positive. If the former exceeds the latter, then still we have

$$\frac{dt}{dm_2} > 0, \quad \frac{d\hat{Q}}{dm_2} = \frac{d\hat{Q}}{dt}\frac{dt}{dm_2} > 0.$$

However, if the former is less than the latter, i.e., $m_3(\bar{\beta}_E - \bar{\beta}_M)D'(\hat{Z}(t)) < \big(t - n\bar{\beta}D'(\hat{Z})\big)$, then we would have

$$\frac{dt}{dm_2} < 0, \quad \frac{d\hat{Q}}{dm_2} = \frac{d\hat{Q}}{dt}\frac{dt}{dm_2} < 0.$$

This is quite surprising as one would expect that a strengthening of environmental lobby groups should always lead to a higher tax. While this result may seem counterintuitive, the main intuition behind it is that we are starting with a situation where the equilibrium tax is already set very high, meaning that the marginal benefit for any extra efforts to increase the environmental stringency would be very small, but the marginal loss of doing so could be significant. While environmentalists enjoys saving the country from suffering too much environmental damage caused by waste, they also derives utility from the consumption of the manufacturing good. When the extra savings from environmental damages cannot exceed their loss from happiness of consumption, they would like to trade off the two and exchange some environmental protection for more consumption, which drives down the tax. As the number of the members increases, the desire for the tradeoff also increases, which further reduces the tax. As the pollution tax decreases, the cost of disposing waste domestically goes down and thereby less waste will be exported to other countries. Eventually when all workers become environmentalists, the equilibrium tax will equate the social optimum level. This result is similar to Aidt (1998) where he demonstrates that the competitive political process and the fact that some lobby groups adjust their economic objectives to reflect environmental concerns will lead to the political internalization of environmental externalities.

We can thus summarize these results in the following proposition:

Proposition 2. *In the political economy equilibrium, if the pollution tax is inefficiently weak, then a strengthening of environmental lobby group will lead to a higher tax and result in more waste to be exported. However, if the pollution tax is inefficiently strict and the marginal benefit of environmental movement is less than the marginal loss from lobbying, then strengthening environmental lobbying may result in a lower tax and less waste to be exported.*

Proposition 2 shows that the effect of environmental movement depends on the political equilibrium pollution tax relative to the efficient Pigovian level, which in turn crucially depends on the strength of environmental lobby group and the degree of environmental damages caused by waste. This provides us some directions for our empirical work that we shall discuss shortly. In the following, we will present the waste demand side – a Foreign country that imports the waste from Home.

2.2 The Foreign country: waste demand

Consider a corresponding small open economy, called Foreign, with a very similar structure to that in Home. For notational convenience, the superscript argument, F, is omitted throughout this entire section, but it should be understood that all variables are denoting the Foreign country to be distinguished from Home.[12] To focus on trade in waste, we assume that the manufactured good is non-traded and cannot be produced in Foreign.

The Foreign country also has two sectors: a clean sector and a waste-disposal sector. Both sectors use labor as the only inputs. The clean sector produces the same numeraire good as Home with constant returns to scale but is less productive than Home. The competitive waste-disposal sector offers Home a "waste absorption" service at a constant price $\mu > 0$ per unit of trash imported, but incurs an increasing treatment cost at $C(I)$, where I is the amount of waste imported, with $C'(I) > 0$ and $C''(I) > 0$. We assume that Foreign is endowed with a fixed supply of labor $\bar{L}$ and labor is perfectly mobile across sectors, and that full employment prevails. Thus, labour becomes irrelevant in firms' problem, and in terms of the conventional trade model, Home exports the numeraire good, and imports Foreign's waste disposal service.

The economy is also populated by a large number of individuals n, each endowed with $\bar{l}$ units of labor, where $\bar{L} = n\bar{l}$. Each individual i derives utility from the consumption of the numeraire good x_i, but the imported waste itself or the waste treatment process causes environmental damages $D(I)$, so the welfare of individual i is given by

$$W_i(x_i, I) = U(x_i) - \beta_i D(I) = x_i - \beta_i D(I),$$

where for simplicity $U(x_i)$ is assumed to be linear in x_i, and $D(0) = 0, D'(I) > 0, D''(I) \geq 0$, and β_i denotes individual i's preference for a clean environment. Denote $\bar{\beta} = \frac{1}{n}\sum_{i=1}^{n} \beta_i$, then it follows that the social marginal cost of waste is given by

$$\frac{d\sum_{i=1}^{n} W_i}{dI} = n\bar{\beta}D'(I).$$

Among the n individuals in the economy, $m_1 < n$ capitalists own the waste-disposal factories and for simplicity, we assume that each capitalist owns only one waste-disposal factory; m_2 environmentalists have strong preferences for environmental quality, with the remaining $m_3 = n - m_1 - m_2$ workers having moderate preferences for environmental quality. Let β_C, β_E and β_W denote the environ-

[12]For example, the number of population n should be interpreted as n^F, and the environmental preference β_i should be understood as β_i^F, etc.

mental preference for each capitalist, environmentalist and worker, respectively, with $\beta_C \leq \beta \leq \beta_E$ and $\beta_W \in [\beta_C, \beta_E]$, but whether β_W is larger than $\bar{\beta}$ remains unknown. Suppose capitalists and environmentalists can overcome the free-riding problem and are formed as organized lobby groups to further their interest by taking collective actions to influence the government's policies. Within the context, the government imposes an ad valorem tariff rate τ on the imported waste to avoid the country from becoming a garbage dump and distributes all the tariff revenue to its citizens as a lump sum transfer. Following Grossman and Helpman (1994), we adopt the structure of a two-stage common agency game between the lobbies and the government. In the first stage, each of the organized lobby groups confronts the incumbent government with contribution schedules, $\psi_h(\tau)$, that are contingent on the government's choice of tariff rate on waste, while ordinary workers are not organized and do not take any actions. In the second stage, the government takes the announced contribution schedules as given and chooses τ to maximize a weighted sum of social welfare $J(\tau)$ and its receipt of campaign contributions:

$$\max_{\tau} G(\tau) = \delta J(\tau) + \sum_{h \in \Lambda} \psi_h(\tau),$$

where $\delta > 0$ is an exogenously given weight that the government places on the aggregate social welfare relative to total campaign contributions.

Taking as given the per unit waste disposal fee μ and the tariff rate τ on the imported waste, the waste-disposal firms must decide on how much waste to be imported, so firms solve the following profit maximization problem

$$\max_{I>0} \Pi = (1-\tau)\mu I - C(I).$$

The first order condition with respect to I yields

$$(1-\tau)\mu = C'(I), \tag{12}$$

which says that at the optimal waste import level $\hat{I}(\tau)$, the marginal benefit must be equal to the marginal cost of importing waste. The equilibrium waste demand, $\hat{I}$, can thus be implicitly expressed as a function of τ. Totally differentiate (12) with respect to $\hat{I}$ and τ yields

$$\frac{d\hat{I}}{d\tau} = -\frac{\mu}{C''(I)} < 0.$$

Given $\hat{I}(\tau)$, the maximized aggregate profit of waste-disposing firms is

$$\hat{\Pi}(\tau) = (1-\tau)\mu\hat{I}(\tau) - C(\hat{I}(\tau)).$$

Each consumer derives income from working at either sector and receives an equally distributed lump-sum government transfer of the tariff revenue, but an capitalist earns an extra income from the ownership of the waste-disposal factories. Therefore, the income of a representative capitalist is

$$M_k = \hat{\Pi}/m_1 + \bar{l} + \tau\mu\hat{I}/n,$$

and the income of a representative non-capitalist is

$$M_j = \bar{l} + \tau\mu\hat{I}/n.$$

Given the linearity of the utility function, the welfare of each group is thus

$$J_1(\tau) = m_1\left[\hat{\Pi}(\tau)/m_1 + \bar{l} + \tau\mu\hat{I}(\tau)/n\right] - m_1\beta_C D(\hat{I}(\tau)),$$

$$J_2(\tau) = m_2\left[\bar{l} + \tau\mu\hat{I}(\tau)/n\right] - m_2\beta_E D(\hat{I}(\tau)),$$

$$J_3(\tau) = m_3\left[\bar{l} + \tau\mu\hat{I}(\tau)/n\right] - m_3\beta_W D(\hat{I}(\tau)),$$

and the social welfare is the sum of the three groups:

$$J(\tau) = \sum_{i=1}^{3} J_i(\tau) = \bar{L} + \tau\mu\hat{I}(\tau) + \hat{\Pi}(\tau) - n\bar{\beta}D(\hat{I}(\tau)),$$

where by definition,

$$n\bar{\beta} = m_1\beta_C + m_2\beta_E + m_3\beta_W.$$

Note that

$$\frac{dJ_1}{d\tau} = \frac{d\hat{\Pi}(\tau)}{d\tau} + \frac{m_1\mu}{n}\left(\hat{I}(\tau) + \tau\frac{d\hat{I}(\tau)}{d\tau}\right) - m_1\beta_C D'(\hat{I}(\tau))\frac{d\hat{I}(\tau)}{d\tau},$$

$$\frac{dJ_2}{d\tau} = \frac{m_2\mu}{n}\left(\hat{I}(\tau) + \tau\frac{d\hat{I}(\tau)}{d\tau}\right) - m_2\beta_E D'(\hat{I}(\tau))\frac{d\hat{I}(\tau)}{d\tau},$$

$$\frac{dJ_3}{d\tau} = \frac{m_3\mu}{n}\left(\hat{I}(\tau) + \tau\frac{d\hat{I}(\tau)}{d\tau}\right) - m_3\beta_W D'(\hat{I}(\tau))\frac{d\hat{I}(\tau)}{d\tau},$$

$$\frac{d\hat{\Pi}(\tau)}{d\tau} = -\mu\hat{I}(\tau) + \left[\underbrace{(1-\tau)\mu - C'(\hat{I}(\tau))}_{=0 \text{ from FOC of firms}}\right]\frac{d\hat{I}(\tau)}{d\tau} = -\mu\hat{I}(\tau) < 0,$$

and thus

$$\begin{aligned}\frac{dJ}{d\tau} &= \frac{d\hat{\Pi}(\tau)}{d\tau} + \mu\left(\hat{I}(\tau) + \tau\frac{d\hat{I}(\tau)}{d\tau}\right) - n\bar{\beta}D'(\hat{I}(\tau))\frac{d\hat{I}(\tau)}{d\tau} \\ &= \left(\mu\tau - n\bar{\beta}D'(\hat{I}(\tau))\right)\frac{d\hat{I}(\tau)}{d\tau}.\end{aligned}$$

2.2.1 Social Optimal Tariff

Without any political distortion, a benevolent government chooses the tariff rate to maximize the aggregate social welfare, i.e.,

$$\frac{dJ(\tau)}{d\tau} = \left(\mu\tau - n\bar{\beta}D'(\hat{I}(\tau))\right)\frac{d\hat{I}(\tau)}{d\tau} = 0,$$

which yields

$$\tau^* = \frac{n\bar{\beta}D'(\hat{I})}{\mu}.$$

Note that μ is the waste disposal price Home has to pay to Foreign for each unit of waste imported and $n\bar{\beta}D'(\hat{I})$ is the social marginal cost of waste. That is, the social optimal tariff rate is equal to ratio of the marginal social cost of waste over the private marginal cost of waste.

2.2.2 Political Economy Tariff

In this section, we investigate how the pressure exercised by an organized environmental and industry lobby group could result in a political economy equilibrium and characterize the government's optimal choice of the tariff rate on waste. Following Bernheim and Whinston (1986), we focus on the interior equilibrium contribution schedules that truthfully reflect the gains expected by the pressure groups such that $\psi_h(\tau) = J_h(\tau) - B_h$, where $B_h > 0$ is a constant. Then, τ^* must be the solution of the problem

$$\max_{\tau} \hat{G}(\tau) = \delta J(\tau) + \left[J_1(\tau) - B_1 + J_2(\tau) - B_2\right].$$

The first-order condition yields

$$\frac{d\hat{G}(\tau)}{d\tau} = \frac{dJ_1}{d\tau} + \frac{dJ_2}{d\tau} + \delta\frac{dJ}{d\tau} = 0.$$

That is,

$$-\mu\hat{I}(\tau) + \frac{(m_1+m_2)\mu}{n}\left(\hat{I}(\tau) + \tau\frac{d\hat{I}(\tau)}{d\tau}\right) - (m_1\beta_C + m_2\beta_E)D'(\hat{I}(\tau))\frac{d\hat{I}(\tau)}{d\tau}$$

$$+\delta\Big(\mu\tau - n\bar{\beta}D'(\hat{I}(\tau))\Big)\frac{d\hat{I}(\tau)}{d\tau} = 0.$$

Use the result of

$$m_1\beta_C + m_2\beta_E = n\bar{\beta} - m_3\beta_W = \frac{m_1+m_2+m_3}{n}n\bar{\beta} - m_3\beta_W = \frac{m_1+m_2}{n}n\bar{\beta} - \frac{m_3}{n}(n\beta_W - n\bar{\beta}),$$

the equation reduces to

$$-\frac{m_3}{n}\mu\hat{I}(\tau) + \left[\frac{m_1+m_2}{n}\mu\tau - \left(\frac{m_1+m_2}{n}n\bar{\beta} - \frac{m_3}{n}(n\beta_W - n\bar{\beta})\right)D'(\hat{I}(\tau))\right]\frac{d\hat{I}(\tau)}{d\tau}$$

$$+\delta\Big(\mu\tau - n\bar{\beta}D'(\hat{I}(\tau))\Big)\frac{d\hat{I}(\tau)}{d\tau} = 0.$$

Define

$$\lambda_0 = \frac{m_1+m_2}{n}, \quad 1-\lambda_0 = \frac{m_3}{n},$$

then we have

$$-(1-\lambda_0)\mu\hat{I}(\tau) + \left[\lambda_0\Big(\mu\tau - n\bar{\beta}D'(\hat{I}(\tau))\Big) + (1-\lambda_0)(n\beta_W - n\bar{\beta})D'(\hat{I}(\tau))\right]\frac{d\hat{I}(\tau)}{d\tau}$$

$$+\delta\Big(\mu\tau - n\bar{\beta}D'(\hat{I}(\tau))\Big)\frac{d\hat{I}(\tau)}{d\tau} = 0.$$

Combine terms, then

$$\frac{d\hat{G}(\tau)}{d\tau} = (1-\lambda_0)\left[-\mu\hat{I}(\tau) + (n\beta_W - n\bar{\beta})D'(\hat{I}(\tau))\frac{d\hat{I}(\tau)}{d\tau}\right] + (\lambda_0+\delta)\Big(\mu\tau - n\bar{\beta}D'(\hat{I}(\tau))\Big)\frac{d\hat{I}(\tau)}{d\tau} = 0.$$

Therefore, when both environmentalists and capitalists are organized, the political economy equilibrium tariff rate τ^{**} is characterized by the following equation:

$$\frac{\frac{d\hat{G}(\tau)}{d\tau}}{(\lambda_0+\delta)\frac{d\hat{I}}{d\tau}} = \Omega \equiv \Big[\mu\tau - n\bar{\beta}D'(\hat{I})\Big] + \frac{1-\lambda_0}{\delta+\lambda_0}\left[(n\beta_W - n\bar{\beta})D'(\hat{I}) + \frac{d\hat{\Pi}}{d\hat{I}}\right] = 0, \qquad (13)$$

where

$$\frac{d\hat{\Pi}}{d\hat{I}} = \frac{\frac{d\hat{\Pi}(\tau)}{d\tau}}{\frac{d\hat{I}(\tau)}{d\tau}} = \frac{-\mu\hat{I}(\tau)}{\frac{d\hat{I}(\tau)}{d\tau}} > 0.$$

Note that for τ^{**} to be a maximum, we need to ensure that the second order condition of the government's maximization with respect to τ is negative, i.e.,

$$\frac{d^2\hat{G}(\tau)}{d\tau^2} = (\lambda_0 + \delta)\frac{d^2\hat{I}}{d\tau^2}\Omega + (\lambda_0 + \delta)\frac{d\hat{I}}{d\tau}\frac{d\Omega}{d\tau} < 0.$$

Since $\Omega = 0$ and $\frac{d\hat{I}}{d\tau} < 0$, we must have

$$\frac{d\Omega}{d\tau} = \mu - n\bar{\beta}D''(\hat{I})\frac{d\hat{I}}{d\tau} + \frac{1-\lambda_0}{\delta+\lambda_0}\left((n\beta_W - n\bar{\beta})D''(\hat{I})\frac{d\hat{I}}{d\tau} + \frac{\frac{d^2\hat{\Pi}}{d\tau}\frac{d\hat{I}}{d\tau} - \frac{d\hat{\Pi}}{d\tau}\frac{d^2\hat{I}}{d\tau^2}}{(\frac{d\hat{I}}{d\tau})^2}\right) < 0.$$

Up to now, equation (13) should look very familiar. Clearly, the political chosen tariff rate is indeterminate in size relative to the social optimal tariff rate. Following our earlier discussion on the Home country, we can directly summarize the relationship between the political economy equilibrium tariff and the social optimal one in the following proposition.

Proposition 3. *If group 3 is not organized, when $\beta_W \geq \bar{\beta}$, or $\beta_W < \bar{\beta}$ but $D'(\hat{I})$ is small enough, the political economy equilibrium tariff on the imported externality is below the social optimal one. However, when $\beta_W < \bar{\beta}$ and $D'(\hat{I})$ is large enough, the political tariff can be equal or above the social optimum.*

In the former case, because of the relative lower valuations for environmental damages and the additional incentive to counter the negative impact of higher tariff rate on profits that is missing in environmentalists' welfare calculation, the capitalists will launch massive lobbying blitz for a lower tariff, which eventually dominates any countervailing efforts from environmentalists. In the latter case, the significant environmental damages caused by imported waste play a much bigger role in both groups' welfare consideration, inducing capitalists to diminish their lobby efforts for a lower tariff, while triggering a more aggressive lobbying response by environmentalists for a higher tariff. The resulting tariff rate can thus be equal or higher than the social optimum.

We illustrate the above findings with some specific functional forms and numerical examples in the following. Suppose the cost function and damage function both take the quadratic forms:

$$C(I) = \frac{1}{2}I^2, \quad D(I) = \frac{\alpha}{2}I^2,$$

which will allow us to obtain an analytical solution. Then, we have

$$C'(I) = I, \quad D'(I) = \alpha I.$$

From equation (12), we can obtain the optimal imported waste as

$$\hat{I}(\tau) = (1 - \tau)\mu,$$

and thus

$$\frac{d\hat{I}}{d\tau} = -\mu, \quad \frac{d\hat{\Pi}}{d\tau} = -\mu\hat{I}, \quad \frac{d\hat{\Pi}}{d\hat{I}} = \frac{\frac{d\hat{\Pi}(\tau)}{d\tau}}{\frac{d\hat{I}(\tau)}{d\tau}} = \hat{I}.$$

Therefore, equation (13) becomes

$$\left[\mu\tau - n\bar{\beta}\alpha\hat{I}\right] + \frac{1-\lambda_0}{\delta+\lambda_0}\left[(n\beta_W - n\bar{\beta})\alpha\hat{I} + \hat{I}\right] = 0.$$

For numerical illustrations, we retain some of the same parameter values used in Home:

$$n = 10, \quad \mu = 2.5, \quad m_1 = 3, \quad m_2 = 2, \quad m_3 = 5, \quad \delta = 0.5.$$

Thus,

$$\lambda_0 = \frac{m_1 + m_2}{n} = 0.5, \quad \frac{1-\lambda_0}{\delta+\lambda_0} = \frac{0.5}{0.5+0.5} = 0.5$$

Example 4. Suppose the average environmental preference for each group is such that

$$\beta_C = 0.01 < \bar{\beta} = 0.2 < \beta_W = 0.25 < \beta_E = 0.36,$$

and $\alpha = 3$, then the political economy equilibrium tariff rate can be solved as

$$\tau^{**} = 0.8261 \in [0, 1].$$

Thus, the optimal imported waste is

$$\hat{I} = 0.4348,$$

and the social optimal tariff rate is

$$\tau^{*} = \frac{n\bar{\beta}\alpha\hat{I}}{\mu} = 1.0435 > \tau^{**} = 0.8261.$$

Example 4 shows that when $\beta_W \geq \bar{\beta}$, the political economy equilibrium tariff rate on the imported externality is below the social optimal one.

Example 5. Suppose the average environmental preference for each group is such that

$$\beta_C = 0.02 < \beta_W = 0.18 < \bar{\beta} = 0.2 < \beta_E = 0.52,$$

and $\alpha = 1$, then the political economy equilibrium tariff rate can be solved as

$$\tau^{**} = 0.6154 \in [0, 1].$$

Thus, the optimal imported waste is

$$\hat{I} = 0.9615,$$

and the social optimal tariff rate is

$$\tau^* = \frac{n\bar{\beta}\alpha\hat{I}}{\mu} = 0.7692 > \tau^{**} = 0.6154.$$

Example 5 shows that when $\beta_W < \bar{\beta}$ but $D'(\hat{I})$ is small enough (i.e., $\alpha = 1$), the political economy equilibrium tariff rate on the imported externality is below the social optimal one.

Example 6. We retain the same average environmental preference for each group as in Example 5:

$$\beta_C = 0.02 < \beta_W = 0.18 < \bar{\beta} = 0.2 < \beta_E = 0.52,$$

but now $\alpha = 5$, then the political economy equilibrium tariff rate is

$$\tau^{**} = 0.9091 \in [0, 1].$$

Thus, the optimal imported waste is

$$\hat{I} = 0.2273,$$

and the social optimal tariff rate is

$$\tau^* = \frac{n\bar{\beta}\alpha\hat{I}}{\mu} = 0.9091 = \tau^{**}.$$

Example 6 shows that when $\beta_W < \bar{\beta}$ and $D'(\hat{I})$ is large enough (i.e., $\alpha = 5$), the political economy equilibrium tariff rate on the imported externality is identical to the social optimal one.

2.2.3 The effects of environmental lobbying on tariff and waste imports

In this section, we analyse how the environmental movement might impact the import tariff and by extension firms' decision to import waste. Following our conclusion from Home, it's not hard to obtain the effect of environmental lobbying on tariff as

$$\frac{d\tau}{dm_2} = \frac{\frac{1+\delta}{\delta+\lambda_0}\frac{1}{m_3}\left[m_3(\beta_E - \beta_W)D'(\hat{I}) - \left(\mu\tau - n\bar{\beta}D'(\hat{I})\right)\right]}{\frac{d\Omega}{d\tau}},$$

and we can observe the following:

Proposition 4. *In the political economy equilibrium, if the import tariff is inefficiently weak, then a strengthening of environmental lobby group will lead to a higher tariff and result in less waste to be imported. However, if the import tariff is inefficiently strict and the marginal benefit of environmental movement is less than the marginal loss from lobbying, then strengthening environmental lobbying may result in a lower tariff and more waste to be imported.*

In the former case, as more people become environmentally concerned and join the environmental lobbying while the number of capitalists is fixed, this translates into more power exercised by the environmental lobby group. As a result, government will respond to this boosted political pressure by increasing the tariff rate, which effectively deters more waste to be imported. In the latter case, we are starting with a situation where the tariff is already set very high, which means that the marginal benefit for any extra efforts to increase the tariff would be very small, but the marginal loss of doing so could be significant. When the extra savings from environmental damages cannot exceed their loss of income (or utility from consumption), environmentalists would like to sacrifice some environmental protection for more income, which pushes down the tariff rate. As the number of the members increases, the desire for the tradeoff also increases, which further reduces the tariff. As the tariff decreases, more waste will be imported. Eventually when all workers become environmentalists, the equilibrium tariff rate will be equal to the social optimum level, leading to a political internalization of environmental externality (Aidt, 1998).

3 Empirical design and strategies

The simple model presented above provides us some insights on the relationship between the strength of the environmental lobby group, the policy stringency and firms' decision on waste exports/imports. However, the theory does not give unambiguous predictions without making any further assumptions. To better understand the role played by environmental lobbying on trade in waste, we take the theory seriously and bring it to data for empirical clarity. We implement the following regression specification:

$$\ln Y_{ijt} = \beta_t + \beta_1 \ln \text{ENGO}_{it} + \beta_2 \ln \text{ENGO}_{jt} + \beta_3 \boldsymbol{X} + \varepsilon_{ijt},$$

where Y_{ijt} is the aggregate waste exports in tonnes from country i to country j in year t, β_t is the year fixed effect to control for any changes between country pairs, ENGO_{it} and ENGO_{jt} are the main variables of interest – the strength of the environmental lobby group at country i and country j respectively in year t, $\boldsymbol{X}$ is a vector of control variables, and ε_{ijt} is the unobserved error term.[13] All the variables are in the log forms.

The control variables might include a set of time-varying country-specific characteristics as well as time-invariant bilateral characteristics that are all potentially correlated with both waste trade flows among country pairs and the probability that more people become environmentalists. Examples might include (i) the countervailing effects of industry lobby group and population as suggested by the model; (ii) the traditional gravity variable – GDP that captures the scale effect – as larger countries typically generate larger volumes of waste and have more available disposal capacity, and thus more waste should be traded; (iii) geographic and cultural factors such as bilateral distance between country pairs, whether countries share a common border, a common official language, or have ever had colonial ties, etc; (iv) trade facilitation factors such as whether both countries are members of the WTO or in some regional trade agreements; (v) capital-labor ratios in Baggs (2009) that reflect the technological capabilities of the recycling sectors across countries; (vi) whether both countries ratified the Basel Convention (Kellenberg and Levinson, 2014), which is aimed at reducing trade in hazardous waste to countries that were unable to safely and adequately recycle or dispose of it. Thus, a full regression specification that includes all these variables is:

$$\begin{aligned}\ln Y_{ijt} = {} & \beta_t + \beta_1 \ln \text{ENGO}_{it} + \beta_2 \ln \text{ENGO}_{jt} + \beta_3 \ln \text{Industry}_{it} + \beta_4 \ln \text{Industry}_{jt} \\ & + \beta_5 \ln \text{Pop}_{it} + \beta_6 \ln \text{Pop}_{jt} + \beta_7 \ln \text{GDP}_{it} + \beta_8 \ln \text{GDP}_{jt} + \beta_9 \ln \text{KL}_{it} + \beta_{10} \ln \text{KL}_{jt} \\ & + \beta_{11} \ln \text{Distance}_{ij} + \beta_{12} \text{Contiguity}_{ij} + \beta_{13} \text{Language}_{ij} + \beta_{14} \text{Colony}_{ij} \\ & + \beta_{15} \text{RTA}_{ijt} + \beta_{16} \text{WTO}_{ijt} + \beta_{17} \text{Basel}_{ijt} + e_{ijt},\end{aligned}$$

[13] It would be ideal to also include the country-year fixed effects (i.e., exporter-year and importer-year fixed effects – β_{it} and β_{jt}) and country-pair fixed effects (i.e., β_{ij}) as suggested by Baier and Bergstrand (2007) to control for any unobserved time-varying country-specific characteristics and as well as unobserved time-invariant bilateral characteristics. However, we would be unable to include the country-year fixed effects, since all the time-varying country-specific characteristics can be captured by β_{it} and β_{jt}, and consequently, our main variables of interest would drop out because they are collinear with the country-year fixed effects. Also, the inclusion of bilateral fixed effects seems to produce spurious results, as most of the estimated coefficients are either in the unexpected signs or insignificant. (Regression results are available upon request.) One possible reason could be that the endogeneity issue mainly comes from any time-varying country-specific characteristics instead of any time-invariant bilateral country characteristics, as the latter seems to be less important in determining whether more people are becoming environmentalists or not.

where $\text{Industry}_{it}, \text{Industry}_{jt}, \text{Pop}_{it}, \text{Pop}_{jt}, \text{GDP}_{it}, \text{GDP}_{jt}$ and $\text{KL}_{it}, \text{KL}_{jt}$ denote country i and j's industry lobbying strength, population, gross domestic product and capital-labour ratio in year t, respectively; Distance_{ij} is the geographical distance between country i and j; Contiguity_{ij}, Language_{ij} and Colony_{ij} are dummy variables indicating whether countries i and j share a common border, a common official language, or have ever had colonial ties; RTA_{ijt}, WTO_{ijt} and Basel_{ijt} are dummy variables indicating whether both country i and j are in some regional trade agreements, are members of the WTO, and are ratified members of the Basel Convention in year t.

It should be noted here that we do not seek to directly test the relationship between the strength of environmental lobby group and policy stringency, but rather infer it from our empirical work. Several reasons may justify why we do so. First, the theory establishes a one-to-one relationship between the policy stringency and waste exports/imports, i.e., $\frac{d\hat{Q}}{dt} > 0$ and $\frac{d\hat{I}}{d\tau} < 0$. Thus, upon identifying the relationship between environmental lobbying strength and waste exports/imports, it should be straightforward to infer the outlined relationship. Second, there is no explicit measurement of environmental tax on waste, and attempting to collect this information for a cross-country time-series study is prohibitively challenging. Third, though tariff data on waste is largely available,[14] it turns out to be very poor and information on many waste categories is missing. Also, as argued by Gawande and Krishna (2003), the trade barriers used in practice are a complicated combination of tariff and nontariff barriers, and trade protection has been heavily dominated in recent decades by the use of nontariff barriers. Given the particular nature of waste, it's not hard to imagine that most of the waste categories will be subject to nontariff barriers. Therefore, the use of available average or aggregate data to proxy for the country's overall ad valorem import tariff on waste will be unreliable.

3.1 Data

We build the sample for our empirical analysis from a variety of sources. Below is a detailed description on how each variable is sourced and constructed.

Waste exports We retrieve information of waste exports from the UN Comtrade database for the years between 1992 and 2019.[15] Upon searching the key words "waste", "scrap", "slag", "residue",

[14]The tariff data on waste can be directly obtained from the WTO Tariff Download Facility, which contains comprehensive information on Most-Favoured-Nation (MFN) applied and bound tariffs at the standard codes of the Harmonized System (HS) for all WTO members. This information is sourced from submissions made to the WTO Integrated Data Base (IDB) for applied tariffs and imports and from the Consolidated Tariff Schedules (CTS) database for the bound duties of all WTO members. See more at https://www.wto.org/english/tratop_e/tariffs_e/tariff_data_e.htm.

[15]The bilateral waste data dates back to 1962 from the UN Comtrade database. But the Harmonized System(HS) Codes for commodity classification was not uniformly adopted until 1992. Even though several countries retrospectively reported trade data from prior years using the 1992 HS codes, we believe many countries didn't and this may yield inconsistencies on the description of the product traded and potentially some measurement errors. Thus, we choose to

and "ash" as the primary descriptors of the product in the six-digit HS codes, we obtain the waste exports for a total of 84 categories, which can be found in Table 1 of Appendix B.[16] For each of the 84 waste products, there are two measures of trade between country-pairs – the total weight (in kg) and the total value (in US dollars). We use the size of waste as the main observation suggested by the model, and then sum up the total weight of waste traded between country-pairs across all 84 HS categories, yielding the aggregate waste exports between country pairs for each year. This comprises our original waste trade dataset of 196 countries for 28 years.

Strength of environmental lobby group There is no direct measure for the strength of the environmental lobby group within a country. We use the number of environmental NGOs as a proxy, c.f. Binder and Neumayer (2005); Fredriksson et al. (2005). However, unlike the cross-country approach taken by Fredriksson et al. (2005) that focuses on a specific year and the panel study of Binder and Neumayer (2005) that focuses on a limited set of countries with time dimension covering 1977-1988 for which environmental protectionism hasn't become pronounced, we provide a novel dataset that covers a large number of countries with more recent time periods that better capture the growing trend of global environmental awareness. More specifically, we derive information on the number of environmental NGOs in a given country from two independent sources – *The Directory* and *The Encyclopedia*. *The Directory*, first released by the Sierra Club in 1973 and published regularly thereafter, provides basic information on governmental and nongovernmental environmental organizations across the world, including name, address, contact information, and founding date. Organizations listed in the Directory include citizens' environmental groups, environmentally oriented development organizations, and academic research centers involved in either environmental policy work or information dissemination. We then document the number of environmental NGOs for each country given the available information from this source. *The Encyclopedia* includes a broad range of nongovernmental organizations from around the world, which is documented in the Gale Group's Associations

start with data in year 1992. Another reason is that environmental protectionism didn't become pronounced until more recently.

[16] An alternative source of waste trade data can be obtained from the Basel Convention, whose goal was to reduce trade in international hazardous waste to countries that were unable to safely and adequately recycle or dispose of it. Under the rules of the Convention, member countries are required to self-report data on their shipments of hazardous waste to the Basel Convention Secretariat each year. This self-reported hazardous waste trade data has been used by Baggs (2009) to explore the role that differences in the size of the economy (measured by GDP), capital/labor ratios, and GDP per capita (proxy for regulatory stringency) across countries play in determining bilateral trade in hazardous waste. But as Kellenberg (2012) has pointed out, including only hazardous waste defined under the classification of the Basel Convention may miss a large proportion of other waste categories that may seem harmless but pose severe environmental and health consequences when disposed improperly, and countries may have an incentive to under-report the true extent of hazardous waste shipments, particularly when being shipped to low environmental regulation countries. Nevertheless, as we shall discuss later, we identify 24 categories of waste in Table 2 of Appendix B that would definitely be considered as hazardous under the Basel Convention, and use this reduced sample for a robustness check.

Unlimited database (Gale, 2001, 2012). We use Gale's keywords to identify groups that have an environmental focus, which gives us another dataset of environmental NGOs. We then combine these two data sets, filling in any missing information from either source and correcting for any mismatch between the two sources. This yields a final coverage of 213 countries from 1971 to 2011 on environmental NGOs.[17]

Other variables There is no direct measure for the countervailing effects of the industry lobby group within a country as well. We choose to employ the commercial energy use (kg of oil equivalent per capita) as a proxy. This data along with other country-specific characteristics including GDP, population and labour force are obtained from the World Development Indicators Database, which covers 264 countries from 1960 to 2020. The capital stock data is sourced from International Monetary Fund (IMF), which provides three types of capital stock – general government capital stock, private capital stock and public-private partnership capital stock – over the period of 1960-2019 for 170 countries.[18] We then derive the aggregate country-level capital stock by summing up these three types, and divide it by the labour force to get the capital-labour ratio across countries. The bilateral variables such as distance, contiguity, former colonial relationships, and common language are obtained from the CEPII website, which consists of 224 unique bilateral country pairs.[19] Data on Basel Convention ratification status comes from the Basel Convention website, which includes a total of 188 signatories with only Haiti and the USA as the two exceptions.[20] Data on WTO membership is directly taken from the WTO website, which covers information on 164 members and 25 observers. [21] Data on whether a bilateral country-pair was in one of the regional trade agreements was obtained from Prof. Mario Larch's website, which covers all multilateral and bilateral regional trade agreements (RTA) as notified to the World Trade Organization for the last 70 years from 1950 to 2019 between 280 country-pairs. [22]

Having obtained all the data that is needed for our empirical analysis and considering the limitations of each dataset, we focus on 122 countries that had at least some positive quantity of waste trade for the period from 1992 to 2011. Thus, in total there are $295,240 (= 122 \times 121 \times 20)$ possible observations. After omitting country pairs with 0 trade and missing data for other variables, we are

[17] I am deeply indebted to Professor Wesley Longhofer from Emory University for sharing his Environmental NGO data with me. For a more detailed description of some of the data limitations, please refer to Longhofer and Schofer (2010) and Longhofer et al. (2016).

[18] See https://data.imf.org/?sk=1CE8A55F-CFA7-4BC0-BCE2-256EE65AC0E4.

[19] See the dist-cepii.dta data file, http://www.cepii.fr/anglaisgraph/bdd/distances.htm.

[20] See http://www.basel.int/Countries/StatusofRatifications/PartiesSignatories/tabid/4499/Default.aspx

[21] See https://www.wto.org/english/thewto_e/whatis_e/tif_e/org6_e.htm.

[22] See https://www.ewf.uni-bayreuth.de/en/research/RTA-data/index.html.

left with $70,757$ observations.

3.2 Results

In this section, we present the regression results estimated using ordinary least squares (OLS) with robust standard errors clustered by country pairs in the above specifications. Column 1 of Table 3 in Appendix C presents results for the most basic regression specification, while columns 2-7 document results for specifications with more control variables included.

In columns 1-3, the coefficients on the environmental lobbying strength in both Home and Foreign are all positive. However, as we add more control variables through column 4-7, those on Foreign become negative and significant, indicating that our previous specifications may be subject to some endogeneity bias. Model 6 or 7 will be our preferred regression specification, as most of the estimated coefficients are significant and the signs are expected by theory. In particular, the coefficients on our main variables of interest – the strength of the environmental lobby group in Home/Foreign – are positive/negative and statistically significant at the 1% level, suggesting that a strong environmental lobby group in Home/Foreign will result in more/less waste to be shipped from Home to Foreign. This result further confirms a positive relationship between the strength of the environmental lobby group and policy stringency.

The coefficients on other variables such as population, GDP, distance, contiguity, language, and colony are all statistically significant at either the 5% or 1% level and are quite consistent with the empirical trade literature, where more waste is traded among countries that have larger population, higher GDP, are closer together, share a common border, a common language or were once in a colonial relationship, and are members of the WTO. The negative/positive and significant coefficients observed for the capital-labour ratio of the exporter/importer are also consistent with Antweiler, Copeland and Taylor (2001) and Baggs (2009), confirming that more capital-intensive countries also tend to import more waste for disposal within their borders. The coefficient on Basel is negative and statistically significant, which is expected as when both countries ratified the Basel Convention that aims to reduce toxic waste movements, countries are expected to trade less waste. The positive but insignificant coefficient on RTA is a little surprising – as one would expect that countries both in some regional trade agreements should trade more.

Finally, the coefficients on Industry in Home/Foreign are positive/negative and statistically significant at the 1% level, implying that a strong industry lobby group in Home/Foreign will result in more/less waste to be shipped from Home to Foreign. This finding is quite surprising, as one would expect the exact opposite that a powerful industry lobby group should lead to a lower tax/tariff in

Home/Foreign and thereby less/more waste will be exported from Home to Foreign. While this result may seem counterintuitive, the main intuition behind it is that though capitalists often perceive less stringent environmental regulations as more beneficial, they may diminish their lobby efforts for a lower tax or even lobby in the same direction as environmentalists for a higher tax when environmental damages play a pivotal role in their welfare calculation. Waste, as one of the dirtiest goods imaginable, poses several threats to the environment when not disposed of in sustainable ways, generating air and water pollution, contaminating soils, and exposing humans to pathogens and hazardous materials, etc. When damages caused by waste reach some threshold points where the losses may outweigh any gains from the profits due to a lower tax/tariff, capitalists would find that a more stringent policy is actually more beneficial. This result provides an alternative explanation as to why many polluting firms may support more stringent environmental regulations as often observed in reality.[23] Whereas Grey (2018) demonstrates that the main reason behind corporate lobbying for environmental protection is that they can steal market share from their rivals, we argue that when environmental damages such as those caused by waste affect an individual's well-being more closely and directly and thereby play a role in the welfare calculation, more stringent environmental regulations are likely to gain political support from firms. Another possible reason could be that firms can receive part of the revenue raised from environmental taxes in Home or import tariff in Foreign as a refund to their waste exports or imports, thus incentivizing them to lobby for a higher tax or tariff. A similar result can be found in Fredriksson and Sterner (2005) in which they show that when firms can capture the revenue from environmental taxes, some firms may even lobby for a higher pollution tax rate. As the pollution tax in Home increases, the costs of disposing waste domestically go up and more waste will exported to other countries, whereas in Foreign, a higher tariff rate will deter firms from importing more waste.

3.3 Robustness check and Discussion

In the above regressions, the total number of environmental NGOs within a country is used to proxy for the strength of the environmental lobby group in that country. One may argue that this measure must contain international environmental NGOs that typically share a global view, and thus the assumption of the "not-in-my-back-yard" environmentalists who only care about domestic environmental protection may not hold. To address this concern, we exclude organizations that are branches of international environmental NGOs, yielding a dataset consisting only of the number of domestic

[23] For example, the US firm DuPont is believed to play a pivot role in the success of the Montreal Protocol aiming at a total phase out of CFCs for ozone protection (Barrett, 2003). During the 2015 Paris Agreement, many oil and gas producers have proposed the introduction of an ambitious global carbon price to reduce emissions (Grey, 2018).

environmental NGOs for each country. We then rerun another set of regressions using the number of domestic environmental NGOs as the proxy for the environmental lobbying strength and report these results in Table 4. As can be observed, the results reported in Table 4 do not significantly change much from Table 3 and therefore our previous conclusion still holds true.

There may be also some concerns about the use of all 84 categories of waste listed in Table 1, since some of them may not be considered as strictly for disposal that Home would have to pay a price to be exported to Foreign, e.g., paper or metal scraps. Instead, many waste products may constitute raw material inputs that can be recycled into industrial and manufacturing processes in developing countries where resources are scarce or non-existent, and exporters would receive money from selling such waste. To ease this concern, we identify 24 of the 84 original waste categories in which the product descriptions in the 6-digit HS code match closely to ones listed in ANNEX VIII of the Basel Convention, which would be classified as "hazardous" and by definition should be exported strictly for disposal and require a payment to do so.[24] We list these hazardous waste products in Table 2 with self-created concordances linking the HS codes and the Basel Convention ANNEX VIII codes. Note that each of the 24 waste categories certainly contain components that are deemed hazardous under the Basel Convention. Regression results using this reduced sample with the total and domestic numbers of environmental NGOs as a proxy for the environmental strength are presented in Table 5 and 6, respectively. Though the coefficient of ENGO in Home is not significant in Table 5, results from Table 6 strongly support our previous conclusion.

These robust tests further validate our claim that a strong environmental lobby group in Home-/Foreign will result in more/less waste to be shipped from Home to Foreign, thereby confirming a positive relationship between the environmental lobbying strength and policy stringency. This finding suggests that strengthening environmental NGOs in developed countries may not be a panacea to the waste problem, but rather result in more waste to be exported and may cause further environmental degradation in the developing world. This result resembles the so-called "Green Paradox" (Sinn, 2008; Jensen et al., 2015; Van der Ploeg and Withagen, 2015), in which increased environmental stringency leads to accelerated fossil fuel extraction and therefore greater pollution. Similarly, within the waste trade context, a well-intended movement to strengthen environmental protection leads to increased domestic environmental stringency and more waste – often highly toxic– to be shipped to countries that are less equipped to deal with it, possibly exacerbating the environmental damages.

[24]The 6-digit HS code waste data collected from the UN Comtrade database are mainly based on product description and do not address the severity the type of waste may pose to the environment. To determine the toxicity of a particular waste, we rely on sources from the Basel Convention which explicitly defines a "hazardous" waste if it contains one of the several following characteristics: explosive, flammable, oxidizing, poisonous, infectious, corrosive, toxic, ecotoxic, etc. The hazardous waste characteristics are listed in ANNEX III of the Basel Convention. See more at https://www.basel.int/Portals/4/Basel%20Convention/docs/text/BaselConventionText-e.pdf.

However, the good news is that doing so in developing countries may prove fruitful, as it effectively deters more waste from being imported. Therefore, one policy implication from these results is that it may be worthwhile for international donor organizations to provide support for the development of environmental NGOs in developing countries (Binder and Neumayer, 2005; Fredriksson et al., 2005). As for developed countries, increasing the already stringent environmental standards may not solve the waste problem, but instead more resources should be spent on promoting new clean technologies, increasing the recycling use of waste and improving the enforcement of environmental laws, etc.

4 Conclusion

In this paper, we employ a common agency framework to investigate the role played by lobby groups on international trade in waste, an externality generated by production activities in a developed-country market, called Home, that can be exported to a developing country, called Foreign, for disposal but with a fee. The model assumes that groups have heterogeneous preferences for environmental quality and that the environmental/trade policy on the externality is endogenously determined by a political economy process characterized by balancing the competing interests of an organized environmental and industry lobby group. We show that the politically chosen tax/tariff in the Home-/Foreign can be below, equal to or above the socially optimal level, depending on the ranking of environmental attitudes and the degree of pollution damages from waste. Further, bringing theory to data to provide some empirical clarity on the effect of environmental movement, we find that a strong environmental lobby group in Home/Foreign will result in more/less waste to be exported from Home to Foreign. These empirical findings suggest that there may exist a waste “Green Paradox". Therefore, strengthening environmental NGOs in developed countries may not be a panacea to the waste problem. However, doing so in developing countries could prove more fruitful, as it effectively deters more waste from being imported.

Our results might bear some implications for other transboundary pollution problems such as climate change. One commonly proclaimed approach to slow down global warming is to drastically increase the carbon tax on fossil fuels. With frequent extreme weather conditions and the substantial losses brought by climate change, recent environmental movements have often pressured governments to do so. However, as suggested by our paper and the large growing literature on green paradox, calling for more stringent regulations seems to cause unintended consequences and may lead to further environmental degradation. Therefore, a rigorous analysis is needed when investigating the role of environmental lobby groups.

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Appendices

A Effect of environmental movement

Proof. Rewrite equation (10) as

$$t = n\bar{\beta}D'(\hat{Z}(t)) - \frac{1-\lambda_0}{\delta+\lambda_0}\Big[(n\beta_W - n\bar{\beta})D'(\hat{Z}(t)) + \frac{d\hat{\Pi}/dt}{d\hat{Z}/dt}\Big],$$

then

$$\frac{dt}{dm_2} = (\beta_E - \beta_W)D'(\hat{Z}(t)) + n\bar{\beta}D''(\hat{Z}(t))\frac{d\hat{Z}}{dt}\frac{dt}{dm_2} + \frac{\frac{1}{n}(\delta+1)}{(\delta+\lambda_0)^2}\Big[(n\beta_W - n\bar{\beta})D'(\hat{Z}(t)) + \frac{d\hat{\Pi}/dt}{d\hat{Z}/dt}\Big]$$

$$-\frac{1-\lambda_0}{\delta+\lambda_0}\Big[-(\beta_E - \beta_W)D'(\hat{Z}(t)) + (n\beta_W - n\bar{\beta})D''(\hat{Z}(t))\frac{d\hat{Z}}{dt}\frac{dt}{dm_2} + \frac{\frac{d^2\hat{\Pi}}{dt}\frac{dt}{dm_2}\frac{d\hat{Z}}{dt} - \frac{d\hat{\Pi}}{dt}\frac{dt}{dm_2}\frac{d^2\hat{Z}}{dt^2}}{(\frac{d\hat{Z}}{dt})^2}\Big].$$

Combine terms on the right hand, we have

$$\frac{dt}{dm_2} = \frac{1+\delta}{\delta+\lambda_0}(\beta_E - \beta_W)D'(\hat{Z}(t)) + \frac{(1+\delta)n\bar{\beta} - (1-\lambda_0)n\beta_W}{\delta+\lambda_0}D''(\hat{Z}(t))\frac{d\hat{Z}}{dt}\frac{dt}{dm_2}$$

$$+\frac{\frac{1}{n}(\delta+1)}{(\delta+\lambda_0)^2}\Big[(n\beta_W - n\bar{\beta})D'(\hat{Z}(t)) + \frac{d\hat{\Pi}/dt}{d\hat{Z}/dt}\Big] - \frac{1-\lambda_0}{\delta+\lambda_0}\frac{\frac{d^2\hat{\Pi}}{dt}\frac{d\hat{Z}}{dt} - \frac{d\hat{\Pi}}{dt}\frac{d^2\hat{Z}}{dt^2}}{(\frac{d\hat{Z}}{dt})^2}\frac{dt}{dm_2}.$$

Now, combine the term dt/dm_2, then

$$\Big[1 - \frac{(1+\delta)n\bar{\beta} - (1-\lambda_0)n\beta_W}{\delta+\lambda_0}D''(\hat{Z}(t))\frac{d\hat{Z}}{dt} + \frac{1-\lambda_0}{\delta+\lambda_0}\frac{\frac{d^2\hat{\Pi}}{dt}\frac{d\hat{Z}}{dt} - \frac{d\hat{\Pi}}{dt}\frac{d^2\hat{Z}}{dt^2}}{(\frac{d\hat{Z}}{dt})^2}\Big]\frac{dt}{dm_2}$$

$$= \frac{1+\delta}{\delta+\lambda_0}(\beta_E - \beta_W)D'(\hat{Z}(t)) + \frac{\frac{1}{n}(\delta+1)}{(\delta+\lambda_0)^2}\Big[(n\beta_W - n\bar{\beta})D'(\hat{Z}(t)) + \frac{d\hat{\Pi}/dt}{d\hat{Z}/dt}\Big].$$

That is,

$$\frac{dt}{dm_2} = \frac{\frac{1+\delta}{\delta+\lambda_0}(\beta_E - \beta_W)D'(\hat{Z}(t)) + \frac{\frac{1}{n}(\delta+1)}{(\delta+\lambda_0)^2}\Big[(n\beta_W - n\bar{\beta})D'(\hat{Z}(t)) + \frac{d\hat{\Pi}/dt}{d\hat{Z}/dt}\Big]}{1 - \frac{(1+\delta)n\bar{\beta} - (1-\lambda_0)n\beta_W}{\delta+\lambda_0}D''(\hat{Z}(t))\frac{d\hat{Z}}{dt} + \frac{1-\lambda_0}{\delta+\lambda_0}\frac{\frac{d^2\hat{\Pi}}{dt}\frac{d\hat{Z}}{dt} - \frac{d\hat{\Pi}}{dt}\frac{d^2\hat{Z}}{dt^2}}{(\frac{d\hat{Z}}{dt})^2}}.$$

Note that the denominator is exactly $\frac{d\Omega}{dt}$ as we derived earlier:

$$\frac{d\Omega}{dt} \equiv 1 - n\bar{\beta}D''(\hat{Z})\frac{d\hat{Z}}{dt} + \frac{1-\lambda_0}{\delta+\lambda_0}\bigg((n\beta_W - n\bar{\beta})D''(\hat{Z})\frac{d\hat{Z}}{dt} + \frac{\frac{d^2\hat{\Pi}}{dt}\frac{d\hat{Z}}{dt} - \frac{d\hat{\Pi}}{dt}\frac{d^2\hat{Z}}{dt^2}}{(\frac{d\hat{Z}}{dt})^2}\bigg) > 0,$$

and the second term in the numerator can be rewritten from equation (10) as

$$\left[(n\beta_W - n\bar{\beta})D'(\hat{Z}) + \frac{d\hat{\Pi}}{d\hat{Z}}\right] = -\frac{\delta+\lambda_0}{1-\lambda_0}\left[t - n\bar{\beta}D'(\hat{Z})\right] = -\frac{n}{m_3}(\delta+\lambda_0)\left[t - n\bar{\beta}D'(\hat{Z})\right].$$

Therefore,

$$\frac{dt}{dm_2} = \frac{\frac{1+\delta}{\delta+\lambda_0}(\beta_E - \beta_W)D'(\hat{Z}) - \frac{1+\delta}{(\delta+\lambda_0)}\frac{1}{m_3}\left[t - n\bar{\beta}D'(\hat{Z})\right]}{\frac{d\Omega}{dt}},$$

or

$$\frac{dt}{dm_2} = \frac{\frac{1+\delta}{\delta+\lambda_0}\frac{1}{m_3}\left[m_3(\beta_E - \beta_W)D'(\hat{Z}) - \left(t - n\bar{\beta}D'(\hat{Z})\right)\right]}{\frac{d\Omega}{dt}}.$$

□

B Waste Description

Table 1: 84 Categories of Internationally Traded Waste by HS code

HS Code	Commodity Description
050100	Animal products; hair, human, unworked, whether or not washed or scoured, and waste of human hair
050210	Animal products; hair and bristles, of pigs, hogs or boars, and waste thereof
050290	Animal products; badger hair and other brush making hair and waste of such bristles or hair, n.e.c. in heading no. 0502 (excluding horsehair)
050590	Animal products; skins and other parts of birds, feathers and down (not for stuffing), powder and waste of such, not further worked than cleaned, disinfected or treated for preservation
050690	Animal products; bones and horn-cores and powder or waste of such, unworked, defatted, simply prepared (not cut to shape), or treated with acid or degelatinised, n.e.c. in heading no. 0506
180200	Cocoa; shells, husks, skins and other cocoa waste
230320	Beet-pulp, bagasse and other waste of sugar manufacture; whether or not in the form of pellets
230330	Brewing or distilling dregs and waste; whether or not in the form of pellets
230800	Vegetable materials and vegetable waste, vegetable residues and by-products; whether or not in the form of pellets, of a kind used in animal feeding, not elsewhere specified or included
251720	Macadam of slag, dross or similar industrial waste; whether or not incorporating the materials in item no. 2517.10
252530	Mica; waste
261800	Slag, granulated (slag sand); from the manufacture or iron or steel

(To be continued)

HS Code	Commodity Description
261900	Slag, dross; (other than granulated slag), scalings and other waste from the manufacture of iron or steel
262011	Slag, ash and residues; (not from the manufacture of iron or steel), containing mainly zinc, hard zinc spelter
262019	Slag, ash and residues; (not from the manufacture of iron or steel), containing mainly zinc, other than hard zinc spelter
262021	Slag, ash and residues; (not from the manufacture of iron or steel), containing mainly lead; leaded gasoline sludges and leaded anti-knock compound sludges
262029	Slag, ash and residues; (not from the manufacture of iron or steel), containing mainly lead; excluding leaded gasoline sludges and leaded anti-knock compound sludges
262030	Slag, ash and residues; (not from the manufacture of iron or steel), containing mainly copper
262040	Slag, ash and residues; (not from the manufacture of iron or steel), containing mainly aluminium
262060	Slag, ash and residues; (not from the manufacture of iron or steel), containing arsenic, mercury, thallium or their mixtures, of a kind used for the extraction of arsenic or those metals or for the manufacture of their chemical compounds
262091	Slag, ash and residues; (not from the manufacture of iron or steel), containing antimony, beryllium, cadmium, chromium or their mixtures
262099	Slag, ash and residues; (not from the manufacture of iron or steel), containing mainly metals or their compounds, n.e.c. in heading no. 2620
262110	Slag and ash; ash and residues from the incineration of municipal waste
262190	Slag and ash n.e.c. in chapter 26; including seaweed ash (kelp) but excluding ash and residues from the incineration of municipal waste
271091	Waste Oils; of petroleum or obtained from bituminous minerals, not crude; and preparations n.e.c., weight 70% or preparations of the same, containing polychlorinated biphenyls (PCBs), polychorinated terphenyls (PCTs) or polybrominated biphenyls (PBBs)
271099	Waste Oils; of petroleum or obtained from bituminous minerals, not crude and preparations n.e.c., weight 70% or preparations of the same, not containing polychlorinated biphenyls (PCBs), polychorinated terphenyls (PCTs) or polybrominated biphenyls (PBBs)
300692	Pharmaceutical goods; waste pharmaceuticals
382510	Residual products of the chemical or allied industries, not elsewhere specified or included; municipal waste
382530	Residual products of the chemical or allied industries, not elsewhere specified or included; clinical waste
382541	Residual products of the chemical or allied industries, not elsewhere specified or included; halogenated waste organic solvents

(To be continued)

HS Code	Commodity Description
382549	Residual products of the chemical or allied industries, not elsewhere specified or included; waste organic solvents, other than halogenated
382550	Residual products of chemical or allied industries, not elsewhere specified or included; wastes of metal pickling liquors, hydraulic fluids, brake fluids and anti-freeze fluids
382561	Residual products of the chemical or allied industries, not elsewhere specified or included; (other than sewage sludge, municipal waste or waste covered in 27.10); other wastes n.e.c. in 3825; those mainly containing organic constituents
382569	Residual products of the chemical or allied industries, not elsewhere specified or included; (other than sewage sludge, municipal waste or waste covered by 27.10); other wastes n.e.c. in 3825; except those mainly containing organic constituents
391510	Ethylene polymers; waste, parings and scrap
391520	Styrene polymers; waste, parings and scrap
391530	Vinyl chloride polymers; waste, parings and scrap
391590	Plastics n.e.c. in heading no. 3915; waste, parings and scrap
400400	Rubber; waste, parings and scrap of rubber (other than hard rubber) and powders and granules obtained therefrom
401700	Rubber; ebonite and other hard rubbers in all forms, including waste and scrap, and articles of hard rubber
411520	Leather; parings and other waste, of leather or composition leather; not suitable for the manufacture of leather articles; leather dust, powder and flour
450190	Cork; waste cork, crushed, granulated or ground cork
470710	Paper or paperboard; waste and scrap, of unbleached kraft paper or paperboard or corrugated paper or paperboard
470720	Paper or paperboard; waste and scrap, paper or paperboard made mainly of bleached chemical pulp, not coloured in the mass
470730	Paper or paperboard; waste and scrap, paper or paperboard made mainly of mechanical pulp (e.g. newspapers, journals and similar printed matter)
470790	Paper or paperboard; waste and scrap, of paper or paperboard n.e.c. in heading no. 4707 and of unsorted waste and scrap
500300	Silk waste (including cocoons unsuitable for reeling, yarn waste and garnetted stock)
510320	Wool and hair; waste of wool or of fine animal hair, including yarn waste, but excluding garnetted stock and noils of wool or of fine animal hair
520210	Cotton; yarn waste (including thread waste)
520291	Cotton; garnetted stock waste
520299	Cotton; waste other than garnetted stock and yarn (including thread) waste
530130	Flax; tow and waste, including yarn waste and garnetted stock

(To be continued)

HS Code	Commodity Description
550510	Fibres; waste (including noils, yarn waste and garnetted stock), of synthetic fibres
550520	Fibres; waste (including noils, yarn waste and garnetted stock), of artificial fibres
700100	Glass; cullet and other waste and scrap of glass, glass in the mass
711230	Waste and scrap of precious metal or of metal clad with precious metal; ash containing precious metal or precious metal compounds
711291	Waste and scrap of precious metals; of gold, including metal clad with gold but excluding sweepings containing other precious metals
711292	Waste and scrap of precious metals; of platinum, including metal clad with platinum but excluding sweepings containing other precious metals
711299	Waste and scrap of precious metals; waste and scrap of precious metals including metal clad with precious metals, other than that of gold and platinum and excluding ash which contains precious metal or precious metal compounds
720410	Ferrous waste and scrap; of cast iron
720421	Ferrous waste and scrap; of stainless steel
720429	Ferrous waste and scrap; of alloy steel (excluding stainless)
720430	Ferrous waste and scrap; of tinned iron or steel
720441	Ferrous waste and scrap; turnings, shavings, chips, milling waste, sawdust, fillings, trimmings and stampings, whether or not in bundles
720449	Ferrous waste and scrap; n.e.c. in heading no. 7204
740400	Copper; waste and scrap
750300	Nickel; waste and scrap
760200	Aluminium; waste and scrap
780200	Lead; waste and scrap
790200	Zinc; waste and scrap
800200	Tin; waste and scrap
810197	Tungsten (wolfram); waste and scrap
810297	Molybdenum; waste and scrap
810330	Tantalum; waste and scrap
810420	Magnesium; waste and scrap
810530	Cobalt; waste and scrap
810730	Cadmium; waste and scrap
810830	Titanium; waste and scrap
810930	Zirconium; waste and scrap
811020	Antimony; waste and scrap
811213	Beryllium; waste and scrap
811222	Chromium; waste and scrap
811252	Thallium; waste and scrap

(To be continued)

HS Code	Commodity Description
854810	Waste and scrap of primary cells, primary batteries and electric accumulators; spent primary cells, spent primary batteries and spent electric accumulators

Table 2: Concordances between HS codes and Basel Convention ANNEX VIII code

HS Code	Commodity Description	Basel Convention code
262011, 262019	Slag, ash and residues containing mainly zinc	A1070, A1080
262021, 262029	Slag, ash and residues containing mainly lead	A1080
262030	Slag, ash and residues containing mainly copper	A1090
262060	Slag, ash and residues containing arsenic, mercury, thallium or their mixtures	A1030
262091	Slag, ash and residues containing antimony, beryllium, cadmium, chromium or their mixtures	A1020
262110, 382510	Municipal waste; Slag, ash and residues from the incineration of municipal waste;	Y46, Y47 †
271091, 271099	Waste oils	A4060
300692	Waste pharmaceuticals	A4010
382530	Clinical waste	A4020
382541, 382549	Waste organic solvents	A3130, A3140, A3150
382550	wastes of metal pickling liquors, hydraulic fluids, brake fluids and anti-freeze fluids	A1060
382561, 382569	Residual products of the chemical or allied industries	A3130, A4140, A4150
780200	Lead; waste and scrap	A1010
810730	Cadmium; waste and scrap	A1010
811020	Antimony; waste and scrap	A1010
811213	Beryllium; waste and scrap	A1010
811252	Thallium; waste and scrap	A1010
854810	Waste and scrap of primary and spent cells, batteries and electric accumulators	A1160, A1170, A1180

† These two types of waste are not listed in ANNEX VIII of the Basel Convention, but they are listed as hazardous waste that requires special consideration in ANNEX II.

C Regression Results

Table 3: Waste regression specifications using total ENGO

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
ln (ENGO exporter)	0.525***	0.354***	0.307***	0.403***	0.404***	0.321***	0.263***
	(0.045)	(0.049)	(0.055)	(0.064)	(0.065)	(0.054)	(0.054)
ln (ENGO importer)	0.756***	0.752***	0.052	-0.471***	-0.431***	-0.762***	-0.824***
	(0.041)	(0.044)	(0.051)	(0.058)	(0.059)	(0.052)	(0.052)
ln (Industry exporter)		0.384***	0.539***	0.784***	0.784***	0.637***	0.762***
		(0.047)	(0.052)	(0.085)	(0.086)	(0.074)	(0.075)
ln (Industry importer)		0.026	0.642***	-0.385***	-0.456***	-0.641***	-0.531***
		(0.044)	(0.048)	(0.080)	(0.082)	(0.071)	(0.071)
ln (Population exporter)			0.144***	0.307***	0.306***	0.238***	0.363***
			(0.030)	(0.062)	(0.072)	(0.060)	(0.061)
ln (Population importer)			0.724***	-0.052	0.151**	0.084	0.201***
			(0.031)	(0.057)	(0.073)	(0.066)	(0.064)
ln (GDP exporter)				-0.187***	-0.185**	0.179***	0.073
				(0.071)	(0.081)	(0.066)	(0.067)
ln (GDP importer)				1.009***	0.791***	1.262***	1.164***
				(0.065)	(0.079)	(0.070)	(0.069)
ln (Capital/labour exporter)					-0.002	-0.195***	-0.158***
					(0.066)	(0.060)	(0.060)
ln (Capital/labour importer)					0.345***	0.175**	0.205***
					(0.078)	(0.069)	(0.068)
ln (Distance)						-1.381***	-1.411***
						(0.039)	(0.045)
Common border						1.451***	1.391***
						(0.151)	(0.150)
Common language						0.702***	0.617***
						(0.092)	(0.091)
Colonial ties						0.686***	0.778***
						(0.153)	(0.152)
WTO							0.838***
							(0.089)
RTA							0.109
							(0.078)
Basel							-0.364***
							(0.085)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	71205	71169	71169	70797	70757	70757	70757
R^2	0.050	0.056	0.114	0.138	0.140	0.300	0.305

Robust standard errors in parentheses, clustered at country-pairs
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 4: Waste regression specifications using domestic ENGO

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
ln (ENGO exporter)	0.504***	0.356***	0.282***	0.298***	0.294***	0.348***	0.330***
	(0.044)	(0.050)	(0.052)	(0.052)	(0.052)	(0.044)	(0.044)
ln (ENGO importer)	0.458***	0.403***	-0.106**	-0.363***	-0.313***	-0.332***	-0.351***
	(0.041)	(0.045)	(0.047)	(0.050)	(0.050)	(0.043)	(0.043)
ln (Industry exporter)		0.512***	0.768***	0.890***	0.908***	0.766***	0.844***
		(0.063)	(0.069)	(0.112)	(0.115)	(0.096)	(0.097)
ln (Industry importer)		0.205***	0.902***	-0.302***	-0.433***	-0.750***	-0.678***
		(0.062)	(0.063)	(0.109)	(0.113)	(0.099)	(0.099)
ln (Population exporter)			0.201***	0.266***	0.227***	0.243***	0.340***
			(0.035)	(0.075)	(0.085)	(0.072)	(0.074)
ln (Population importer)			0.821***	-0.028	0.337***	0.358***	0.458***
			(0.035)	(0.072)	(0.095)	(0.087)	(0.086)
ln (GDP exporter)				-0.051	-0.006	0.208***	0.111
				(0.079)	(0.090)	(0.075)	(0.076)
ln (GDP importer)				1.032***	0.643***	0.912***	0.813***
				(0.079)	(0.100)	(0.090)	(0.090)
ln (Capital/labour exporter)					-0.072	-0.234***	-0.182**
					(0.082)	(0.076)	(0.078)
ln (Capital/labour importer)					0.641***	0.592***	0.654***
					(0.113)	(0.098)	(0.097)
ln (Distance)						-1.412***	-1.442***
						(0.048)	(0.054)
Common border						1.649***	1.632***
						(0.190)	(0.187)
Common language						0.882***	0.805***
						(0.118)	(0.118)
Colonial ties						0.663***	0.723***
						(0.182)	(0.181)
WTO							0.649***
							(0.123)
RTA							0.026
							(0.097)
Basel							-0.441***
							(0.113)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	48772	48742	48742	48430	48393	48393	48393
R^2	0.046	0.057	0.139	0.166	0.169	0.338	0.341

Robust standard errors in parentheses, clustered at country-pairs
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 5: Robustness check using 24 categories of hazardous waste and total ENGO

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
ln (ENGO exporter)	-0.006	-0.040	-0.348***	0.038	0.012	0.063	0.021
	(0.058)	(0.064)	(0.075)	(0.086)	(0.087)	(0.075)	(0.075)
ln (ENGO importer)	0.480***	0.406***	0.144**	-0.150*	-0.135	-0.415***	-0.486***
	(0.060)	(0.063)	(0.073)	(0.088)	(0.089)	(0.076)	(0.075)
ln (Industry exporter)		0.092	0.433***	1.242***	1.274***	1.332***	1.424***
		(0.073)	(0.082)	(0.124)	(0.130)	(0.117)	(0.117)
ln (Industry importer)		0.199***	0.471***	-0.095	-0.128	-0.138	-0.040
		(0.061)	(0.065)	(0.099)	(0.104)	(0.095)	(0.096)
ln (Population exporter)			0.352***	0.964***	0.846***	0.892***	0.968***
			(0.049)	(0.092)	(0.103)	(0.095)	(0.097)
ln (Population importer)			0.286***	-0.134*	-0.066	0.057	0.181**
			(0.040)	(0.071)	(0.088)	(0.079)	(0.079)
ln (GDP exporter)				-0.798***	-0.674***	-0.478***	-0.558***
				(0.095)	(0.110)	(0.099)	(0.101)
ln (GDP importer)				0.548***	0.476***	0.688***	0.581***
				(0.082)	(0.099)	(0.087)	(0.087)
ln (Capital/labour exporter)					-0.200*	-0.357***	-0.351***
					(0.119)	(0.120)	(0.121)
ln (Capital/labour importer)					0.121	-0.005	0.047
					(0.101)	(0.087)	(0.086)
ln (Distance)						-1.086***	-1.049***
						(0.057)	(0.066)
Common border						0.688***	0.642***
						(0.199)	(0.196)
Common language						0.953***	0.858***
						(0.132)	(0.132)
Colonial ties						0.071	0.177
						(0.162)	(0.160)
WTO							0.730***
							(0.120)
RTA							0.329***
							(0.115)
Basel							-0.461***
							(0.121)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	24194	24177	24177	24068	24047	24047	24047
R^2	0.073	0.076	0.098	0.116	0.116	0.224	0.229

Robust standard errors in parentheses, clustered at country-pairs

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 6: Robustness check using 24 categories of hazardous waste and domestic ENGO

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
ln (ENGO exporter)	0.115**	0.102*	-0.066	0.096	0.080	0.164***	0.149***
	(0.052)	(0.057)	(0.064)	(0.065)	(0.067)	(0.058)	(0.058)
ln (ENGO importer)	0.281***	0.178***	-0.058	-0.210***	-0.189**	-0.206***	-0.229***
	(0.058)	(0.064)	(0.070)	(0.075)	(0.076)	(0.065)	(0.066)
ln (Industry exporter)		0.064	0.376***	1.184***	1.223***	1.225***	1.349***
		(0.094)	(0.106)	(0.165)	(0.174)	(0.152)	(0.152)
ln (Industry importer)		0.350***	0.698***	-0.012	-0.079	-0.218*	-0.084
		(0.084)	(0.088)	(0.135)	(0.143)	(0.128)	(0.129)
ln (Population exporter)			0.304***	0.879***	0.756***	0.881***	1.003***
			(0.055)	(0.110)	(0.129)	(0.120)	(0.123)
ln (Population importer)			0.358***	-0.142	0.015	0.182*	0.363***
			(0.045)	(0.088)	(0.114)	(0.101)	(0.102)
ln (GDP exporter)				-0.705***	-0.579***	-0.482***	-0.620***
				(0.108)	(0.134)	(0.123)	(0.126)
ln (GDP importer)				0.598***	0.433***	0.531***	0.343***
				(0.096)	(0.121)	(0.106)	(0.108)
ln (Capital/labour exporter)					-0.211	-0.288*	-0.258
					(0.170)	(0.166)	(0.168)
ln (Capital/labour importer)					0.282*	0.215*	0.316***
					(0.148)	(0.122)	(0.122)
ln (Distance)						-1.147***	-1.173***
						(0.067)	(0.078)
Common border						0.955***	0.906***
						(0.238)	(0.233)
Common language						1.256***	1.136***
						(0.159)	(0.160)
Colonial ties						-0.143	-0.052
						(0.189)	(0.186)
WTO							1.087***
							(0.163)
RTA							0.131
							(0.140)
Basel							-0.516***
							(0.163)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	18124	18111	18111	18022	18001	18001	18001
R^2	0.073	0.078	0.102	0.119	0.120	0.249	0.256

Robust standard errors in parentheses, clustered at country-pairs
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$