Interaction between Trade and Environment Policies with Special Interest Politics*

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Abstract

The paper examines interdependencies between trade and environment policies, as they get jointly determined in a political-economy model of a small open economy. Following Grossman and Helpman (1994), the structure of trade protection and environment policy is characterized when government is not a benevolent maximizer of social welfare. Campaign contributions help win the elections and provide it the incentive to distort policies to attract contributions from lobbies. With bargaining over more than one policy instrument, it may trade-off one policy for the other, to strike a balance between favors to lobbies and loss in social welfare. It may tax imports higher to offset the cost of stricter environment regulation or reduce import protection to counter the effect of a lenient environment policy. Interestingly, whilst the government always 'concedes' by providing positive tariff protection to the import-competing sector at home, it may or may *not* give in to lobby's demand for lower pollution tax. Moreover, the equilibrium level of import protection is positively related to the world price of the importable good, a result that ties in with the literature on the political economy of protection to declining industries (Hillman 1982).

Journal of Economic Literature Classifications: D72, F13, F18, H20, H23, Q20, Q28.

Key Words: Trade and environment, small open economy, production externality, special-interest politics, policy interdependencies.

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1 Introduction

The basic tenets of economics view that an effective rule-based system of multilateral trade and investment is welfare improving, because it achieves economic integration by utilizing the principles of competitiveness and comparative advantage. However, in its present form, the efficacy of international trade to accomplish higher welfare for all and sustainable development is a topic of debate worldwide. There is adequate evidence to indicate that, in both international and domestic policy circles, the mobilization of pressure group politics around the economic themes is just as important as the need for analytically legitimate economic claims or rationale.[1] Observably, incumbent governments in representative democracies set policies to maximize 'political support' rather than the welfare of its citizenry.

This paper attempts to examine the impact of political lobbying with reference to trade and environment policies. Specifically, it contains an analysis of *interdependencies* in the determination of trade and environment policies when they meet in the legislative arena, in the presence of special-interest politics.

In theoretical literature, the concerns about how lobbying could distort policies have led to the development of models that view trade or environment policies as an outgrowth of a political process, and that do not lead to maximization of representative agent's welfare. These models treat industry or environmental groups as lobbying for political favours from the incumbent government by offering contributions to it to sway the policy outcomes in their favour. See, for example, Grossman and Helpman (1994, 1995, 1996), henceforth called G-H, and Goldberg and Maggi (1999) in context of trade policy, and Fredriksson (1997a, 1997b), Aidt (1998, 2000), Schleich (1999), Schleich and Orden (2000), Conconi (2003), and Damania et. al. (2003) in the context of environment policy. The contributions are linked to specific policy stance of the government. On the other hand, the government is not a benevolent maximizer of social welfare. It sets policies to maximize political support, taken to be a weighted average of pure social welfare and political contributions from lobbies. Hence, these models are said to follow a 'political support' approach to incorporate political economy considerations. Typically, these do not explicitly model the process of

[1] For instance, multilateral negotiations on trade or environment or both, at the World Trade Organization (WTO) or the Multilateral Environmental Agreements (MEAs) (such as the UN Framework Convention on Climate Change), have not been driven by economic principles alone, but have been mainstreamed (involving non-governmental organizations) and politicized to gain attention at the larger agenda of these institutions.

This holds true for domestic policy circles as well. In developed and developing countries alike, tariff protection offered to domestic import-competing industries (textiles, fertilizers, heavy machinery, metals and minerals), energy and input subsidies to agriculture, job quotas for specific social groups, all point toward an overwhelming influence of political economy on specific government policy stance.

election. It is this approach that we adopt for our analysis.

In the specific context of environment, a majority of the analytical papers focus on lobbying for either trade or environment policy, but *not both* (e.g., Hillman and Ursprung 1992; Fredriksson 1997a, 1997b, 1999; Aidt 1998, 2000; and Damania et al.2003). Broadly speaking, these models analyze trade-environment linkages in terms of the effect of a politically determined trade policy on pollution or, alternatively, the impact of the politically chosen environmental regulation on trade, depending on whether lobbies choose to influence the trade *or* environment policy stance of the government. Even though Damania et al.(2003) focus on the political economy effects of trade liberalization on environment policy-making, they assume trade policy to be exogenous, thus ignoring the endogenous determination of tariff rates.

Clearly, in real economies, lobbies have stakes in both the trade and environment policies, and therefore, it is more appropriate to postulate that they negotiate with the government over both. For example, organized industry groups in the import-competing sector stand to lose from stricter pollution regulation on account of higher costs of production, and benefit from enhanced import-protection. Accordingly, they have the incentive to press the government to reduce pollution taxes and raise tariffs on imports. Just the opposite holds true for environmentally motivated groups. A change in a basic parameter facing an economy may induce the politically motivated government to reduce/ increase both trade protection and pollution tax or to reduce one and increase the other. Endogenous determination of trade and environment policies and characterization of policy interdependencies is the focus of this paper.

Some of the earlier research that endogenizes trade and domestic policies in the presence of lobbying include the analytical papers by Schleich (1999) and Conconi (2003). Both the papers utilize the G-H political economy model in the context of small- and large-open economies respectively. Schleich (1999) focuses on the characterization of situations where endogenously-determined trade polices alone would lead to better environment than production (or environmental) policy. The focus is not on the policy interdependencies in the presence of lobbying. Conconi (2003) considers the role of environmental and industry lobbying on trade and environmental policies, and hence, on transboundary pollution spillover, specifically emission leakages, via the terms-of-trade changes. A significant result is that emissions leakage may reduce the incentive of environmental lobbies for stringent environmental policy, and cause a reduction in environmental taxes at the political equilibrium. Again, the focus there is not on characterizing the policy interdependencies at the politically determined equilibrium. In comparison, this paper carries out a more focussed analysis of the interaction between the trade and environment policy instruments, in the context of a small import-competing industry.

Further, similar to G-H model, Fredriksson (1997a, 1997b), Schleich (1999), Damania et al. (2003) and Conconi (2003) assume that the government does not have any bargaining power vis-á-vis the lobbies. In other words, the lobbies are the 'principals' having all bargaining power and the government is the 'agent' having zero bargaining power. We improve upon this by assuming that both the government and the lobby possess positive bargaining power vis-á-vis each other. The concept of Nash-bargaining is used to capture this.

Additionally, the paper studies the impact on equilibrium trade and environmental policies (and interdependencies between them) of exogenous changes in basic parameters facing the economy.

In the absence of lobbying, it is seen that free trade and a Pigouvian tax constitute the first-best policy package for a small-open economy. This is our benchmark. Present lobbying, and interesting deviations emerge. In some instances, they are apparently counter-intuitive. The major findings of the analysis of this paper are as follows:

1. When only the environment policy is 'political' – i.e. politically manipulable by the industry lobby – the pollution tax is set at a level lower than that of the Pigouvian tax. If, instead, the lobby can influence trade policy only, the government provides a positive level of protection to the domestic import-competing sector.[2]

   But, when both trade and environment policies are political, there is strategic interaction between the two instruments, and it displays asymmetry. The pollution tax is a strategic complement of import tariff, i.e., government offsets a higher import tariff by raising the level of the pollution tax. However, tariff is a strategic substitute of pollution tax: an increase in the pollution tax induces the government to lower the level of import protection. (The reason behind this asymmetry will be discussed later.)

2. Given that both policy instruments are political, compared to the benchmark case, the government 'concedes' with respect to trade policy - i.e. it offers a positive tariff protection. But surprisingly it *may not* concede on environment policy, i.e. it may supplement a protectionist trade policy with a pollution tax *higher* than the Pigouvian level. This happens despite the absence of an environmental

[2]These implications are quite intuitive and straightforward to see.

lobby.[3]

However, there is an upper bound on the tariff protection. Similarly, when equilibrium pollution tax is higher than the Pigouvian tax, there is *cap* on the magnitude by which it could exceed the latter. The pollution at the political equilibrium is always higher than the socially optimal level, irrespective of environment policy being more or less stringent at the political equilibrium than at the social optimum.

3. Some of the comparative statics of the model are as follows. As long as there is only one organized lobby, the relative bargaining strengths of the government and the lobby do not impact the equilibrium level of tax or tariff. They merely determine the division of the surplus between the two groups.[4] Further, an exogenous increase in the social preference for 'cleaner' environment induces the government to raise the tax on pollution and lower the tariff protection. Clearly, the impact on the environment is positive.

   The equilibrium level of import protection (measured as the difference between the domestic and world price of the importable good) is positively related to the world price of the importable good. The pollution tax may be inversely or positively related to the world price conditional on the price elasticity of output of the importable good. The effect of increase in the world price of the importable good on environment is negative, however.

   In response to an exogenous increase in the relative weight on political contributions, the government raises the level of tariff protection. The effect on the environment policy is not clear, however. The level of pollution always increases.

2 The Framework

Our analytical framework follows G-H (1994). Organized industrial lobbies offer contribution schedules to affect the policy stance of an electorally motivated government, and the government decides on its policies given these schedules. However, our model differs from theirs in three ways. First, instead of many industries at a time, we focus on one industry. Hence there is only one lobby. Second, we assume that the

[3] A similar result is also derived by Aidt (1998), but it holds only for the specific case of competition between functionally specialized lobby groups – producer lobbies that care only for profits and green lobbies that advocate environmental protection alone. Conconi (2003) also derives the possibility of environmental tax being higher than the optimal Pigouvian tax, but this is shown to hold only when there are cross pollution spillovers and international coordination in environment policies.

[4] Goldberg and Maggi (1999) also derive a similar result.

industrial lobby in the import-competing sector is capable of influencing more than one (related) policy at the same time. These are trade and environment policies. Third, the government is not simply at the 'receiving end' but wields a positive bargaining power vis-á-vis the lobby. The analysis focuses on a small open economy trading at given world prices. We call it the 'home country'.

2.1 The economy

It has two production sectors. One produces a non-polluting numeraire good Y, which uses only labour as the input. The other produces good X using three inputs - labour, a sector-specific capital or land, and a sector-specific pollution-causing environmental/ natural resource. Whilst labour is mobile between the two production sectors, sector-specific capital and natural resource are sectorally immobile. Perfect competition prevails in both sectors.

Good X is the home country's importable, with net imports represented by M_x. The price of good Y is normalized to one. The relative world price of good X is denoted by p^w. Denoting the import tariff rate by t, the domestic price of good X, by arbitrage, is $p = p^w(1+t) \equiv p(t)$.

Three groups inhabit the economy: workers (f), industrialists (i), and the government (g). Full employment of labour and specific capital is assumed. Let the total population of workers be $\bar{L}$. Only workers supply labour to the production sectors, with each offering one unit; $\bar{L} = L_x + L_y$, where L_x and L_y are the number of workers employed in sectors X and Y. The wage rate is denoted by w. Industrialists are the owners of the stock of sector-specific fixed factor, $\bar{K}_x$, and, therefore, have stakes in the reward/ profit to the specific factor, represented by π. Moreover, workers are the only consumers of the two goods, X and Y, whilst industrialists consume only the numeraire good.[5]

The government does not regulate the physical quantity of the environmental resource, but, instead sets its charge (price), τ. (This is similar to C-T (Copeland and Taylor) 1994, 1995a; Schleich 1999 and Damania et al.2003.) The supply of the environmental resource is perfectly elastic. Hence, the equilibrium quantity of environmental resource used, N_x, is demand-determined.

Tariff, t, is the other policy variable that the government controls. The total revenues collected are equal to $\tau N_x + tp^w M_x$. These are transferred back to the economy in a lumpsum fashion. The government

[5]This is somewhat similar to the model of Roberts (1987) in a very different context, which assumes that a group of workers producing good i only consume goods produced by other workers. In the context of environment, this is the same as Aidt (1998) which considers the case of functionally specialized producers' and environmental lobbies.

does not make any direct transfers to the firm. The pollution charge, the tariff or both are determined in the political-game.

Sector Y uses constant-returns production technology, and by choosing units appropriately the labour-output coefficient is assumed to be one. The supply of labour is sufficiently large as to imply a positive output of the numeraire good in equilibrium. With perfect competition and free entry and exit, the equilibrium wage rate, w, is driven down to one in terms of the numeraire good Y. Sector X also uses a constant-returns technology in the three inputs, L_x, K_x, and N_x, and is Cobb-Douglas in form. With $\tilde{Q}_x$ denoting the output of good X, we have $\tilde{Q}_x = {L_x}^{\alpha}{N_x}^{\beta}\bar{K}_x^{1-\alpha-\beta}$. This could be re-expressed as

$$\frac{\tilde{Q}_x}{\bar{K}_x^{1-\alpha-\beta}} \equiv Q_x \quad = \quad {L_x}^{\alpha}{N_x}^{\beta}, \tag{1}$$

by normalizing $\bar{K}_x$ to one.

Profit maximization by firms yields the supply function $Q_x = Q_x(p(t), \tau)$, factor demand functions, $N_x = N_x(p(t), \tau)$ and $L_x = L_x(p(t), \tau)$, and the indirect profit function, $\pi = \pi(p(t), \tau)$. The specific analytical solutions are:

$$\begin{aligned}
Q_x &= \left(\frac{\alpha+\beta}{\kappa_x}\right)^{\frac{\alpha+\beta}{1-\alpha-\beta}} p(t)^{\frac{\alpha+\beta}{1-\alpha-\beta}} \tau^{-\frac{\beta}{1-\alpha-\beta}}; && (2)\\
N_x &= \left(\frac{\alpha}{\beta}\tau\right)^{-\frac{\alpha}{\alpha+\beta}} Q_x^{\frac{1}{\alpha+\beta}} \equiv \beta\left(\frac{\alpha+\beta}{\kappa_x}\right)^{\frac{\alpha+\beta}{1-\alpha-\beta}} p(t)^{\frac{1}{1-\alpha-\beta}} \tau^{-\frac{1-\alpha}{1-\alpha-\beta}}; && (3)\\
L_x &= \left(\frac{\alpha}{\beta}\tau\right)^{\frac{\beta}{\alpha+\beta}} Q_x^{\frac{1}{\alpha+\beta}} \equiv \alpha\left(\frac{\alpha+\beta}{\kappa_x}\right)^{\frac{\alpha+\beta}{1-\alpha-\beta}} p(t)^{\frac{1}{1-\alpha-\beta}} \tau^{-\frac{\beta}{1-\alpha-\beta}}; \quad \text{and} && (4)\\
\pi &= (1-\alpha-\beta)\left(\frac{\alpha+\beta}{\kappa_x}\right)^{\frac{\alpha+\beta}{1-\alpha-\beta}} p(t)^{\frac{1}{1-\alpha-\beta}} \tau^{-\frac{\beta}{1-\alpha-\beta}}, && (5)
\end{aligned}$$

where $\kappa_x \equiv (\alpha/\beta)^{\frac{\beta}{\alpha+\beta}} + (\alpha/\beta)^{\frac{-\alpha}{\alpha+\beta}}$. Note that the amount of pollution is indicated by the magnitude of N_x. Also, the price elasticity of output exceeds or falls short of one as $\alpha+\beta \gtrless 1/2$. As will be seen, some results of our analysis are conditional on whether $\alpha+\beta \gtrless 1/2$.

By Hotelling's lemma,

$$\frac{\partial \pi}{\partial p(t)} = Q_x(\cdot), \quad \text{and} \quad \frac{\partial \pi}{\partial \tau} = -N_x(\cdot). \tag{6}$$

Moreover, given Cobb-Douglas technology:

$$\frac{\tau N_x}{p Q_x} = \beta, \tag{7}$$

the share of the natural resource. These relationships will be utilized later in the analysis.

The use of the natural resource in the import-competing sector X generates pollution that is proportional to its use. Hence, the magnitude of N_x measures the magnitude of pollution. Pollution is local.[6]

All workers have an identical utility function. One part of it is quasi-linear with respect to goods X and Y. Further, it is quadratic with respect to the consumption of good X. Another part captures disutility from pollution.[7] It is given by

$$U^f = c_y + \nu_x c_x - \frac{c_x^2}{2} - \tilde{\gamma} N_x, \quad \nu_x,\ \tilde{\gamma} > 0. \tag{8}$$

A consumer maximizes this subject to his budget constraint, $c_y + pc_x = I$, where I denotes consumer spending. Utility maximization problem yields a linear demand function for good X as $c_x = \nu_x - p$. The consumer surplus from the consumption of good X equals $u(c_x(p)) - pc_x(p) = c_x^2(p)/2$.

2.2 The political structure

Industrialists being the specific factor owners have a common interest in the reward to this factor, $\pi(\cdot)$. Assume that there is no free riding amongst them and they are able to organize themselves for the purpose of lobbying (Olson 1965). Call them lobby-x. On the other hand, the workers are not organized and they do not lobby. As expected, the industrial lobby's welfare is increasing in import tariff and decreasing in pollution tax (see eq. 5).

The government's objective function is a weighted sum of social welfare and campaign contributions. On the one hand, contributions from lobby-x are used toward campaign spending and to sway voters in its favour. On the other, an increase in social welfare increases the probability of re-election, given that the voters' population takes this into account in casting their vote for a candidate. Electoral outcomes are only implicit.

Unlike G-H (1994, 1995), in our model government wields bargaining power vis-á-vis the lobby, as does the lobby vis-á-vis the government. As in Binmore, Rubenstein and Wolinsky (1986), Qiu (1999) and Goldberg and Maggi (1999) we apply Nash-bargaining to characterize the interaction between the government and the lobby-x. Let $\lambda \in (0, 1)$ and $(1-\lambda)$ represent the government's and lobby-x's bargaining power, respectively.

[6] Since our focus is on policy determination in the home country alone (rather than on policy interaction between countries), whether pollution is local or global does not have any qualitative bearing on the results.

[7] Utility functions that are linear in environmental pollution are also assumed in Copeland and Taylor (1995b) and McAusland (2003).

In the absence of campaign contributions, the pay-offs of lobby-x and the government can be defined as,

$$
\begin{aligned}
U^i &= \pi(\tau, p(t)); && (9)\\
U^{sw} &= \bar{L} + \bar{L}\frac{c_x(p(t))^2}{2} + \pi(\tau, p(t)) + tp^w M_x(\tau, p(t)) + \tau N_x(\tau, p(t)) \\
&\quad -\gamma N_x(\tau, p(t)), && (10)
\end{aligned}
$$

where 'sw' stands for aggregate social welfare, $\bar{L}$ is the total wage income, $\bar{L}c_x^2(\cdot)/2$ and $\pi(\cdot)$ are aggregate consumer and producer surplus, $tp^w M_x(\cdot) + \tau N_x(\cdot)$ are the total tax/tariff revenues ploughed back to the economy, and $\gamma(\equiv \bar{L}\tilde{\gamma}) > 0$ is the economy-wide marginal pollution damage parameter.

In the presence of lobbying and campaign contributions, the pay-off function of the government is a weighted average of social welfare (as defined in (10)) and lobby-x's contributions, O_x:

$$U^g = U^{sw} + aO_x, \quad (11)$$

where $a > 0$ is the weight that government assigns to political contributions relative to that on social welfare. Define $\rho \equiv a/(1+a)$, which is the relative weight the politician attaches to the campaign contribution; ρ can be treated as the 'politicization' parameter. The net payoff of lobby-x is given by $U^i - O_x$.

2.3 The stages of the game

There are three stages in the game played between the incumbent government and lobby-x. In the first stage the government and lobby jointly decide the contribution schedule, $O_x(p(t), \tau)$ through a process of Nash-bargaining.

In the second stage, the government chooses a pair (t^*, τ^*) on the contribution schedule $O_x(\cdot)$ that maximizes U^g. Having announced the policies, it receives from lobby-x the monetary contribution $O_x(t^*, \tau^*)$ associated with the chosen policy pair. Although the political game takes place in one-shot, it is assumed that the interest group does not renege on its promise to make monetary contributions in the second stage of the game.

In the third stage, production and consumption take place and the labour market clears.

3 The Analysis

3.1 Social optimum

As a benchmark suppose that there is no politics and the government is a benevolent maximizer of aggregate social welfare. Then, clearly, a free trade policy ($t = 0$) and a Pigouvian tax on pollution input constitute the first-best policy package for this small open economy. The latter is the solution to the problem:

$$\underset{\tau}{\text{Max}} \quad U^{sw} \equiv \bar{L} + \bar{L}\frac{c_x^2(p^w)}{2} + \pi(\tau, p^w) + (\tau - \gamma)N_x(\tau, p^w),$$

which yields

$$\tau^o = \gamma, \tag{12}$$

where superscript 'o' denotes socially optimal solutions. Thus, in the absence of lobbying, pollution tax is set at the level of social marginal damage, γ, and there is full internalization of the environmental externality by the government.

We next bring in the presence of interest group politics. A description of the bargaining process follows.

3.2 The bargaining process

Nash-bargaining over $O_x(\tau, t)$ is represented by

$$\begin{aligned} &\underset{O_x}{\text{Max}} \quad (\Delta U^{sw}(\tau, t) + aO_x)^{\lambda}\left(\Delta U^i(\tau, t) - O_x\right)^{1-\lambda} \\ &\text{s.t.} \qquad\qquad O_x > 0, \end{aligned} \tag{13}$$

where ΔU^{sw} and ΔU^i represent the change in the pay-off of the government and lobby-x respectively (excluding campaign offers from lobby to the government) in moving from the social optimum to a politically determined equilibrium. This yields

$$O_x = \lambda \Delta U^i(\cdot) - \frac{(1-\lambda)}{a}\Delta U^{sw}(\cdot) \tag{14}$$

$$\begin{aligned} &= \lambda\left[\pi(\cdot) - \pi^o\right] - \frac{(1-\lambda)}{a}\left[\bar{L}\left(\frac{c_x^2(\cdot)}{2} - \frac{c_x^{o\,2}}{2}\right) + (\pi(\cdot) - \pi^o)\right. \\ &\left. + (\tau N_x(\cdot) - \tau^o N_x^o) + tp^w M_x(\cdot) - \gamma(N_x(\cdot) - N_x^o)\right] \equiv O_x(\tau, t). \end{aligned} \tag{15}$$

It is the solution to the first-stage bargaining game. As long as $\Delta U^i > 0$ and $\Delta U^{sw} < 0$ the contribution $O_x(\cdot) > 0$ for all λ and a.[8]

[8] We have $\Delta U^{sw} = U^{sw}(\tau, t) - U^{sw}(\gamma, 0) < 0$ since U^{sw} is maximized at $t = 0$ and $\tau = \gamma$. Moreover, it is easy to see that $\pi = \pi(\underset{(-)}{\tau}, \underset{(+)}{t})$. Thus, $\Delta U^i (\equiv \Delta\pi) = U^i(\tau, t) - U^i(\gamma, 0) > 0$ as long as $\tau \leq \gamma$ and $t > 0$. By continuity, it follows that $\Delta U^i > 0$

In (14) it is implicit that both τ and t are politically set. One could, however, consider special cases where only one policy instrument is political, either the pollution tax or the tariff rate, whilst the other is set to maximize social welfare. In such cases, the contribution functions will respectively be of the form: $O_x(\tau, 0)$ and $O_x(\gamma, t)$.

3.3 The political equilibria

We begin by considering situations where only one policy instrument - pollution tax or tariff - is political.[9]

3.3.1 Bargaining over environment policy

Let the government be committed to free trade (i.e. $t = 0$) whilst the pollution tax is political. It will be shown, as one would expect, that the pollution tax in the political equilibrium is always less than the Pigouvian tax.

Given $O_x = O_x(\tau, 0)$, the government solves the maximization problem:

$$\begin{aligned}
\underset{\tau}{Max} \quad U^g &\equiv U^{sw}(\cdot) + aO_x(\cdot) \\
&= \bar{L} + \bar{L}\frac{c_x^2(\cdot)}{2} + \pi(\cdot) + (\tau - \gamma)N_x(\cdot) \\
&\quad + a\lambda[\pi(\cdot) - \pi^o] - (1-\lambda)\Bigg[\bar{L}\left(\frac{c_x^2(\cdot)}{2} - \frac{c_x^{o\,2}}{2}\right) \\
&\quad + \pi(\cdot) - \pi^o + (\tau - \gamma)N_x(\cdot) - (\tau^o - \gamma)N_x^o\Bigg].
\end{aligned} \tag{16}$$

The first-order condition is: $a\frac{\partial \pi}{\partial \tau} + \left(\frac{\partial \pi}{\partial \tau} + (\tau - \gamma)\frac{\partial N_x}{\partial \tau} + N_x\right) = 0$. Notice that it is independent of λ. Using the Hotelling's lemma in (6) this is equivalent to

$$-\left(\frac{1-\alpha}{1-\alpha-\beta}\right)\left(\frac{\tau-\gamma}{\tau}\right)N_x - aN_x \quad = \quad 0. \tag{17}$$

This leads to the solution

$$\tau^e \quad = \quad \frac{(1-\alpha)\gamma}{1-\alpha+a(1-\alpha-\beta)} < \gamma, \tag{18}$$

where superscript 'e' represents that there is bargaining over environment policy alone. Hence, the politically set environmental tax is below the socially optimal level. Making substitutions from the first-order

even when $\tau > \gamma$ as long as $|\tau - \gamma|$ is sufficiently small.

[9]However, the centrepiece of our analysis is the characterization of the full political equilibrium, where bargaining happens over both the policy instruments.

condition in (17), it is easy to derive that $\frac{\partial U^2}{\partial^2 \tau} = -\left(\frac{1-\alpha}{1-\alpha-\beta}\right)\gamma\lambda\frac{N_x}{\tau^{e2}} < 0$, and the second-order conditions are met.

3.3.2 Bargaining over import tariffs

Suppose that the government is committed to optimally regulating the state of the environment, i.e., it sets $\tau = \tau^o \equiv \gamma$, the Pigouvian tax. But trade policy is 'politically negotiable'. It then solves

$$\begin{aligned}\underset{t}{\text{Max}} \quad U^g \quad &= \quad \bar{L} + \bar{L}\frac{c_x^2(\cdot)}{2} + \pi(\cdot) + tp^w M_x(\cdot) + a\lambda[\pi(\cdot) - \pi^o] \\ & \quad -(1-\lambda)\left[\bar{L}\left(\frac{c_x^2(\cdot)}{2} - \frac{c_x^{o\,2}}{2}\right) + \pi(\cdot) - \pi^o + tp^w M_x(\cdot)\right].\end{aligned} \tag{19}$$

The first-order condition is: $aQ_x - t\left(\bar{L}p^w + \frac{\partial Q_x}{\partial t}\right) = 0$, which is equivalent to

$$aQ_x(\tau, t) - \frac{t}{1+t}\left[\bar{L}p(t) + \frac{\alpha+\beta}{1-\alpha-\beta}Q_x(\tau,t)\right] \quad = \quad 0. \tag{20}$$

Again, the bargaining power does not influence the choice of policy. The last expression is obtained by utilizing the Hotelling's lemma in (6), using definitions, $M_x = C_x - Q_x$, $C_x = \bar{L}c_x$, canceling out terms and inserting the value of the partial $\partial Q_x/\partial t$ from the solution in (2). Note that at $t = 0$, $\partial U^g/\partial t = aQ_x > 0$. This is because the deadweight loss from tariff is of second-order in magnitude whereas the marginal gain from campaign contributions is of first-order magnitude. This implies that $t > 0$ at the political equilibrium. (This is dealt with in greater detail later.)

By substituting for Q_x from (2) factoring out $((\alpha+\beta)/\kappa_x)^{\frac{\alpha+\beta}{1-\alpha-\beta}}\bar{L}p^{w\frac{\alpha+\beta}{1-\alpha-\beta}}\tau^{\frac{-\beta}{1-\alpha-\beta}}(1+t)^{\frac{\alpha+\beta}{1-\alpha-\beta}}$, the first-order condition in (20) can be restated as

$$m(t^f) \equiv -t^f\frac{\bar{L}p^{w\frac{1-2(\alpha+\beta)}{1-\alpha-\beta}}\gamma^{\frac{\beta}{1-\alpha-\beta}}}{\Gamma(1+t^f)^{\frac{\alpha+\beta}{1-\alpha-\beta}}} - \frac{\alpha+\beta}{1-\alpha-\beta}\frac{t^f}{1+t^f} + a \quad = \quad 0, \tag{21}$$

where 'f' denotes the situation where lobbies influence trade policies alone, $\tau^f = \gamma$ by assumption and $\Gamma \equiv [(\alpha+\beta)/\kappa_x]^{\frac{\alpha+\beta}{1-\alpha-\beta}}$. In view of (21), we get

Proposition 1:

$$\frac{t^f}{1+t^f} < \frac{a(1-\alpha-\beta)}{\alpha+\beta}.$$

That is, there is an upper bound on the tariff rate.

Appendix A proves that the solution to $t^f \in (0,1)$ exists, the 'true' solution of t^f is unique and the second-order condition is met if

$$\text{either } \ (i)\ \alpha+\beta \leq \frac{1}{2}; \text{ or } \ (ii)\ \rho \leq \frac{1}{2} \Leftrightarrow a < 1, \tag{R1}$$

where recall that $\rho \equiv a/(1+a)$ is the politician's weight on campaign contribution in his objective function. This condition may be viewed as a 'regularity' condition. Intuitively, this says that the price elasticity of output of the importable good be less than one, or that the elasticity be high *and* the degree of politicization be *not* high enough. We assume that (R1) holds.

The equilibrium outcomes under the single-instrument cases are summed up in Proposition 2.

Proposition 2: *(i) When only the pollution tax is politically determined, the government sets it below the social optimum. Alternatively, if only the import tariff is political, a positive level of protection is provided to the importable sector. (ii) The larger is the weight on campaign contributions, more distorted are environment and trade policies from the socially desirable perspective. On the other hand, the larger is the worker population, closer is the pollution tax to the Pigouvian level and the lower is the level of tariff protection.*

It is intuitive that, since government cares for political contributions, the policy stance of the government reflects a compromise in terms of social welfare. If the lobby influences environment policy only, the government is induced to set an environmental standard that is lower than the socially desirable level. If there is bargaining over trade policy alone, the government concedes through providing a positive level of tariff protection.

Moreover, the higher the government's concern for contributions from the lobby, represented by a higher value of a, the more favourable are the equilibrium policies toward lobby-x: $d\tau^e/da < 0$ and $dt^f/da > 0$.[10] These depict a larger deviation from the social optimum.

Besides political contributions, government also cares for consumers' welfare. We find that the effect of an increase in consumer (worker) population, $\bar{L}$, works in a manner which is just the opposite of change in the weight parameter, a. Since a larger population implies greater aggregate damage from exposure to pollution (from $\gamma \equiv \bar{L}\tilde{\gamma}$), the pollution tax is found to be increasing in it: $d\tau^e/d\bar{L} > 0$. Similarly, tariffs lead to a higher domestic price for the importable good, a source of loss in consumer surplus. Therefore, the larger is the population of workers and, hence, the overall loss in consumer surplus, the lower is the

[10]Differentiating (18) and (21) respectively with respect to a, we get

$$\frac{d\tau^e}{da} = -\frac{(1-\alpha)(1-\alpha-\beta)\gamma}{[(1-\alpha)+a(1-\alpha-\beta)]^2} < 0; \quad \frac{dt^f}{da} = -\frac{\partial m/\partial a}{\partial m/\partial t^f} > 0,$$

where we recall that $m(\cdot)$ defines the l.h.s. of the first-order condition (21). The sign of dt^f/da follows $\partial m/\partial t^f < 0$ from second-order conditions (see Appendix B) and $\partial m/\partial a > 0$.

equilibrium tariff rate, namely $dt^f/d\bar{L} < 0$.[11] Having made these points, we henceforth normalize $\bar{L}$ to one for ease of exposition of the results.

3.3.3 Trade and environment policies: Both political

This is our central case. Let lobby-x bargain with the government over both policy instruments: pollution tax and import tariff. The government solves the maximization problem

$$\begin{aligned}\operatorname*{Max}_{\tau,t} U^g &= 1 + \frac{c_x^2(\cdot)}{2} + \pi(\cdot) + \tau N_x(\cdot) + tp^w M_x(\cdot) - \gamma N_x(\cdot) + a\lambda[\pi(\cdot) - \pi^o] \\ &\quad -(1-\lambda)\left[\left(\frac{c_x^2(\cdot)}{2} - \frac{c_x^{o\,2}}{2}\right) + \pi(\cdot) - \pi^o + (\tau - \gamma)N_x(\cdot) \right. \\ &\quad \left. -(\tau^o - \gamma)N_x^o + tp^w M_x(\cdot)\right], \end{aligned} \tag{22}$$

where $c_x = \bar{L}c_x = C_x$, the aggregate economy-wide demand for good X. (Recall that $\bar{L}$ is normalized to one.)

By collecting terms and utilizing the Hotelling's lemma (in 6), the first-order condition with respect to pollution tax is $\frac{\partial U^g}{\partial \tau} = 0 \Leftrightarrow (\tau - \gamma)\frac{\partial N_x}{\partial \tau} - tp^w\lambda\frac{\partial Q_x}{\partial \tau} - aN_x = 0$. Making substitutions for the partials from the expressions in (2) and (3) and using the relationship in (7) this is equivalent to,

$$f(\tau^l, t^l) \equiv -(1-\alpha)\left(\frac{\tau^l - \gamma}{\tau^l}\right) + \frac{t^l}{1+t^l} - a(1-\alpha-\beta) = 0 \tag{23}$$

$$\Leftrightarrow \tau^l = \frac{(1-\alpha)\gamma}{1-\alpha+a(1-\alpha-\beta) - \frac{t^l}{1+t^l}}. \tag{24}$$

The superscript 'l' stands for full-lobbying or full-political equilibrium. This is the extension of (18) where only the pollution tax is political.

With respect to import tariff the first-order condition is: $\frac{\partial U^g}{\partial t} = 0 \Leftrightarrow (\tau - \gamma)\frac{\partial N_x}{\partial t} + tp^w\left[\frac{\partial C_x}{\partial t} - \frac{\partial Q_x}{\partial t}\right] + ap^w Q_x = 0$, after utilizing Hotelling's lemma in (6), $C_x = c_x$ (with $\bar{L}$ is normalized to unity) and $M_x = C_x - Q_x$. Substituting for the partials from the solutions in (2) and (3), this equation is equivalent to

$$g(\tau^l, t^l) \equiv \frac{\beta}{1-\alpha-\beta}\left(\frac{\tau^l - \gamma}{\tau^l}\right) - t^l\left[\frac{p^{w\,\frac{1-2(\alpha+\beta)}{1-\alpha-\beta}}\tau^{l\,\frac{\beta}{1-\alpha-\beta}}}{\Gamma(1+t^l)^{\frac{\alpha+\beta}{1-\alpha-\beta}}} + \frac{\alpha+\beta}{(1-\alpha-\beta)(1+t^l)}\right] + a = 0, \tag{25}$$

[11] Taking the two equations again, differentiating with respect to $\bar{L}$ gives

$$\frac{d\tau^e}{d\bar{L}} = \frac{(1-\alpha)\tilde{\gamma}}{(1-\alpha)+a(1-\alpha-\beta)} > 0; \quad \frac{dt^f}{d\bar{L}} = -\frac{\partial m/\partial\bar{L}}{\partial m/\partial t^f} < 0.$$

Again, the sign $dt^f/d\bar{L}$ follows from the second-order conditions being met and $\partial m/\partial\bar{L} < 0$.

where recall $\Gamma \equiv [(\alpha+\beta)/\kappa_x]^{\frac{\alpha+\beta}{1-\alpha-\beta}}$. Note that this is an extension of (21) in the one-instrument case. In most of what follows, we use eqs. (23), and eq. (26) below.

$$h(\tau^l, t^l) \equiv a(1-\alpha-\beta) - \frac{\alpha t^l}{1+t^l} - \frac{(1-\alpha)t^l p^{w\frac{1-2(\alpha+\beta)}{1-\alpha-\beta}} \tau^{l\frac{\beta}{1-\alpha-\beta}}}{\Gamma(1+t^l)^{\frac{\alpha+\beta}{1-\alpha-\beta}}} = 0. \tag{26}$$

This is derived by substituting (23) into (25) and eliminating $(\tau^l - \gamma)/\tau^l$.

We first prove that a solution of $(\tau^l,\, t^l)$ in the positive quadrant exists. This is straightforward. Turning to (24), we see that it generates τ as a function of t as shown by the upward sloping U_τ^g curve in Figure 1. Consider now the first-order condition (26), which can be rewritten as:

$$\tau^l = (1+t^l)^{\frac{\alpha+\beta}{\beta}} \left[\frac{a(1-\alpha-\beta) - \alpha\frac{t^l}{1+t^l}}{(1-\alpha)t^l}\right]^{\frac{1-\alpha-\beta}{\beta}} \equiv n(t), \tag{27}$$

where, for notational simplicity, we have normalized $p^{w\frac{1-2(\alpha+\beta)}{1-\alpha-\beta}}/\Gamma = 1$. This function has the properties that as $t \to 0$, $n(t) \to \infty$ and as t is equal to that positive number such that $a(1-\alpha-\beta) - \alpha\frac{t^l}{1+t^l} = 0$, say $\bar{t}$, $n(\bar{t}) = 0$. Hence the U_τ^g curve the $n(t)$ function *must* intersect in the positive quadrant, proving that a solution of $(\tau,\, t)$ in this quadrant exists. In particular, $0 < t^l < \bar{t}$, i.e.,

Proposition 3:

$$\frac{t^l}{1+t^l} < \frac{a(1-\alpha-\beta)}{\alpha} \qquad \text{from (26).} \tag{28}$$

This is the upper limit on tariff rate.

In Appendix B it is derived that the second-order conditions are met under a regularity condition, which is more restrictive than (R1) in the one-instrument case. This is the condition (R2) below. That is, either

$$\alpha+\beta \leq \frac{1}{2}, \text{ or (ii) } \rho < \frac{\alpha}{2\alpha+\beta} < \frac{1}{2} \Leftrightarrow a < \frac{\alpha}{\alpha+\beta}. \tag{R2}$$

Intuitively, (R2) is similar to (R1): it requires that either the price elasticity of the output of the importable be less than one, or that it be higher than one *and* the politicization parameter be low enough. Comparing with (R1), however, there is only one difference, that is, according to (R2), for all values of α and β such that $\alpha+\beta > 1/2$, ρ needs to be less than $\alpha/(2\alpha+\beta)$, which is less than $1/2$. We assume that (R2) is met. Given the second-order conditions are met, the solutions are unique.

We now characterize τ^l, which is particularly interesting. Observe that, unlike the case when only the pollution tax is political, the equilibrium pollution tax in our two-instrument case can *exceed* the

Pigouvian level, i.e. it is possible that $\tau^l > \gamma$! This is because, as seen in (23), both the marginal gain and the marginal loss to the government's objective function from an increase in τ are first-order in magnitude. Since the possibility of $\tau^l > \gamma$ is interesting and 'paradoxical' in the context of political economy, it would have been most desirable if a sufficient condition on the parametric configuration could be found under which it arises. However, it does not seem possible to obtain one. Hence, instead, a simulation exercise was undertaken to confirm this possibility as well as to obtain an understanding of conditions under which this possibility arises. Various combinations of parameter values were assigned. The only restriction used here is that the regularity condition (R2) be met. The results of a representative sample are compiled in Table 1.

In general, it is indicated that when the government has more than one policy instrument, it may, under some parametric configuration, 'give in' to the lobby demand in respect of one policy instrument and not in respect of the other. This is amongst the most interesting results of this analysis. Intuitively, since the government is politically inclined, it would like to transfer income to the lobbying industry. The most efficient way to do this would be through direct (lump sum) transfers. But recall that direct transfers are, by assumption, absent in this model. So, the issue is - what is the most efficient way to transfer income to the industry, while minimizing the harm to the consumers.

Recall that from (5), both a high tariff and a weaker (lower) pollution tax would subsidize the industry. However, a marginal rise in tariff offers a second-order loss in aggregate welfare in the form of deadweight loss but a first-order marginal gain in campaign contributions, as compared to a marginal increase in pollution tax that entails a first-order aggregate welfare gain from improved environmental quality and a first-order welfare loss due to marginal decline in campaign contributions. Therefore, following the efficiency property, government uses tariff protection to satisfy the lobbying industry in the import competing sector. At the same time, it applies pollution tax to counterbalance the distortion arising from use of trade policy as well as to address the externality caused by pollution. Whether equilibrium pollution policy entails a tax higher or lower than the Pigouvian tax depends on how political the government is, meaning as to how much weight it assigns to the welfare of the lobby in the utility function, which is denoted by a. For this, one could consider the following two cases.

First, consider the case when $\alpha + \beta \leq 1/2$ (i.e. the price elasticity of output of the importable good, X, is less than one) as in Runs 1 and 2 in Table 1. If this is associated with a high enough weight, a, on political contributions, and a high world price of the importable good, p^w, the increase in the marginal cost in terms of loss in political contributions due to marginal increase in τ in government's objective function exceeds its marginal benefits associated with improved environment quality. This entails $\tau^l < \gamma$ as in Run 2. Conversely, if the less than one price elasticity of output of X is associated with a relatively low value of a, and a low p^w, the rise in marginal cost of an increase in τ is offset by the increase in marginal benefits due to improved environment quality. Thus, in equilibrium, the government sets the pollution tax above the Pigouvian tax. This is the case in Run 1.

Next, consider the case when the price elasticity of output is greater than one: $\alpha + \beta > 1/2$. The results are enumerated in Runs 3 and 4 in Table 1. Even in this case, the pollution tax will exceed the Pigouvian tax if the government is not much politically inclined: the parameter, a, is relatively small, and the world price, p^w, is higher, as indicated by the results in Run 3 (compared to Run 4). Thus, for low enough value of the politicization parameter, a, $\tau^l > \gamma$.

This confirms the result derived by Aidt (1998), but in a somewhat different context of multiple – producer and environmental – lobbies that are functionally specialized, and advocate, respectively, their profit and environmental interests. The producer lobbies accept the higher than Pigouvian adjustment of environmental tax only in exchange for a production subsidy. By comparison, we derive a stronger result. In our model there is only one functionally specialized interest group, the producer lobby. Despite the absence of the environmental lobby, we get that the government may trade-off a protective trade policy with an environment policy which is more stringent than the socially optimal one, to maximize its politically motivated objective function.[12]

(Further, observe that in all the four cases in Table 1 (as well as in all the simulations runs), the lobby's surplus at the political equilibrium compared to the social optimum, i.e. $\Delta U^i (\equiv U^i(\tau, t) - U^o(\gamma, 0) \equiv \Delta\pi^i$, is higher, irrespective of $\tau^l \gtreqless \gamma$.)

The government's policy stance in the political equilibrium is now summarized in Proposition 4.

Proposition 4: *(i) The government always concedes by offering a positive tariff protection to the domestic import-competing industry. (ii) However, in setting the environment policy, it may or may not concede in that it may set the pollution tax higher than the Pigouvian tax.*

[12] Schleich (1999) also derives the possibility that environmental quality in the political optimum could exceed the socially optimum level. However, as a rejoinder to it, Dijkstra (2002) refutes this possibility by showing that in this specific case, the second-order conditions for maximization of the political objective function are violated.

Intuitively, a marginal increase in t from $t = 0$ imparts only a second-order aggregate welfare loss (or deadweight loss) but a first-order gain in political contribution. Thus, $\partial U^g/\partial t > 0$, and the political equilibrium entails a positive tariff unambiguously. On the other hand, a marginal increase in pollution tax from the Pigouvian level, γ, has *a first-order welfare gain and a first-order loss* in terms of political contribution; this implies $\tau^l \gtreqless \gamma$.

Even though τ^l may exceed γ, one would expect that there be an upper limit on τ^l, based on the magnitude of tariff protection granted. This is true. By multiplying the first-order condition (25) by $(1-\alpha-\beta)$ and adding up with the other (i.e., eq. (23) to eliminate $a(1-\alpha-\beta)$, we get the proposition below.

Proposition 5:

$$\tau^l < (1+t^l)\gamma \tag{29}$$

This is the upper limit on τ^l, which is positively related to the equilibrium tariff, t^l.

We can now compare the pollution at the political equilibrium (N_x^l) to that at the social optimum (N_x^o).

Recall that at the social optimum, $\tau = \gamma$ and $t = 0$. Then, from (3),

$$\begin{aligned}\frac{N_x^l}{N_x^o} = \frac{(1+t^l)^{\frac{1}{1-\alpha-\beta}}}{(\tau^l/\gamma)^{\frac{1-\alpha}{1-\alpha-\beta}}} &> \frac{(1+t^l)^{\frac{1}{1-\alpha-\beta}}}{(1+t^l)^{\frac{1-\alpha}{1-\alpha-\beta}}}, \text{by using (29)} \\ &= (1+t^l)^{\frac{\alpha}{1-\alpha-\beta}} > 1. \end{aligned} \tag{30}$$

Hence,

Proposition 6: *Irrespective of $\tau^l \gtreqless \gamma$, pollution is more at the political equilibrium than at the social optimum.*

Having characterized the political equilibrium, the comparative statics of policy levels with respect to key parameters of the model are carried out in the next section. We use the first-order conditions (23) and (26) for this purpose. Utilizing these, we first characterize the *interdependencies* between the two policy instruments at the political equilibrium.

Totally differentiating eq. (23) or (24), we get

$$\frac{d\tau^l}{dt^l} = \frac{(1-\alpha)\gamma}{\left((1-\alpha) + a(1-\alpha-\beta) - \frac{t^l}{1+t^l}\right)^2} \cdot \frac{1}{(1+t^l)^2} > 0. \tag{31}$$

Hence, if there is an increase in tariff, the government is induced to increase the pollution tax, i.e., it 'offsets' a higher import tariff by raising the level of the pollution tax. This can be explained as follows.

The increase in pollution tax lowers pollution and offers a marginal benefit to the government in terms of improved environment quality. At the same time, increase in tax reduces lobby rents, thus reducing political contributions. From Hotelling's lemma the loss in campaign contributions is proportional to the loss in lobby rent. This is the marginal cost of pollution tax to the government. *Ceteris paribus*, a higher tariff *offsets (reduces)* the marginal cost through positive impacts on lobby rents. At the same time, it *lowers* the marginal benefit from tax by encouraging the output of the polluting importable good. However, as the effect of tariff on the marginal costs of tax dominates its effect on the marginal benefits, government is induced to raise the pollution tax to offset the negative environmental effect of higher tariffs. This relationship between τ^l and t^l is shown by the positively sloped schedule U_τ^g in Figure 1.

Now turn to eq. (26). Totally differentiating we obtain,

$$\frac{dt^l}{d\tau^l} = -\frac{\beta}{\tau^l(1-\alpha-\beta)} \cdot \frac{t^l {p^w}^{\frac{1-2(\alpha+\beta)}{1-\alpha-\beta}} {\tau^l}^{\frac{\beta}{1-\alpha-\beta}}}{\Gamma(1+t^l)^{\frac{\alpha+\beta}{1-\alpha-\beta}}} \cdot \frac{1}{Z} < 0, \tag{32}$$

where Z is defined and proven to be positive in Appendix B. The negative sign of $dt^l/d\tau^l$ says that if there is an increase in τ, there is a decrease in tariff protection granted by the government. This may appear 'surprising' in the sense that the politically motivated government responds to higher pollution tax – which harms the lobby – by lowering tariff protection, which also harms the lobby. But, it can be explained as follows. The marginal benefit to the government from tariff is proportional to the marginal effect of tariff on the benefit to the lobbyists, who supply campaign funds, which, by the envelope theorem, is equal to the output. An increase in the pollution tax lowers output, and from the policy maker's perspective, *lowers* the marginal benefit to it from tariff. Hence, the policy maker is induced to reduce tariff. This relationship generates the locus U_t^g in Fig. 1. The intersection of the two schedules, U_τ^g and U_t^g defines the political equilibrium.

We now examine the exogenous changes in three basic parameters: pollution disutility, γ, world price of the importable good, p^w, and government's weight on contributions, a. Each of these comparative statics is addressed separately in the three sub-sections below.[13]

[13]There is another important parameter, namely the bargaining power index, λ. However, λ does not appear in either of the first-order conditions (23) or (25). Hence, equilibrium τ^l and t^l are independent of λ. But a change in λ affects the allocation of surplus between the government and the lobby.

4 Comparative statics of equilibrium policy

4.1 Disutility of pollution

Suppose the society becomes more environmentally conscious and attaches a higher weight to disutility from pollution. That is, γ increases.

In (24) we see that $\partial\tau^l/\partial\gamma > 0$, as one would expect. This implies that in Fig. 1, the U_τ^g curve shifts up. The U_t^g curve does not shift since γ does not appear in (25) or (26). As a result, $\frac{d\tau^l}{d\gamma} > 0$ and $\frac{dt}{d\gamma} < 0$. Intuitively, an increase in γ leads to a higher pollution tax. Since trade protection is a strategic substitute of pollution tax, the former falls.

The effect on pollution is clear: it decreases on both accounts. Thus,

Proposition 7: *If the marginal disutility from pollution increases, pollution tax increases, tariff protection falls and the amount of pollution decreases.*

4.2 World price of importable good

Suppose p^w increases. Eq. (24) is not affected, since p^w does not appear in it. The U_τ^g curve does not shift. But eq. (26) is affected. Partially differentiating (26), we have $\partial h/\partial p^w \lesseqgtr 0$, i.e., the U_t^g curve shifts in or out as $\alpha + \beta \lesseqgtr 1/2$. Hence, $\frac{d\tau^l}{dp^w}$ and $\frac{dt^l}{dp^w} \lesseqgtr 0$ as $\alpha + \beta \lesseqgtr \frac{1}{2}$. Recall that $\alpha + \beta \gtrless 1/2$ respectively refers to output of importable good X being elastic or inelastic. Hence,

Proposition 8: *As the world price of the importable good increases, the pollution tax increases or decreases according as the price elasticity of supply of the importable good exceeds or falls short of one.*

However, tariff protection can be seen in terms of the absolute difference between the domestic price and the world price, i.e., by $T \equiv p^w t$, rather than by the 'ad valorem' tariff t. When t^l increases, it is obvious that T increases too. When t falls, the effect on T is not clear by simple inspection. But it is shown below that T rises unambiguously regardless of the sign of $\alpha + \beta - 1/2$. Hence,

Proposition 9: *As world price of the importable good increases, tariff protection measured by the absolute difference between the domestic price and the world price rises.*

The proof of this proposition is as follows. Using $T^l = p^w t^l$, eqs. (23) and (26) can be restated as

$$\tilde{f}(\tau^l, T^l) \;=\; -(1-\alpha)\left(\frac{\tau^l-\gamma}{\tau^l}\right) + \frac{T^l}{p^w + T^l} - a(1-\alpha-\beta) = 0; \tag{33}$$

$$\tilde{h}(\tau^l, T^l) \;=\; a(1-\alpha-\beta) - \alpha\frac{T^l}{p^w + T^l} - (1-\alpha)\frac{T^l {\tau^l}^{\frac{\alpha+\beta}{1-\alpha-\beta}}}{(p^w + T^l)^{\frac{\alpha+\beta}{1-\alpha-\beta}}}. \tag{34}$$

These two equations respectively define a positively and a negatively sloped locus between τ^l and T^l, which are analogous to U^g_τ and U^g_t curves. In Fig. 2, these are respectively, denoted as $\tilde{U}^g_\tau$ and $\tilde{U}^g_{T^l}$ curves. It is straightforward to check that as p^w increases, both these curves shift to the right, to $\tilde{U}^{g1}_\tau$ and $\tilde{U}^{g1}_{T^l}$. This implies that T^l increases unambiguously.

Proposition 9 should not be surprising. It ties in with the issue of protection to declining industries in the presence of political economy, as analyzed, for example, by Hillman (1982, 1989). Hillman finds that, as the world price facing a small, importing-competing industry falls, the government is inclined to grant less protection in terms of the discrepancy between the domestic price and the world price. Proposition 9 says the same, and for the same reason. That is, at the original level of protection, a decrease in world price tends to reduce the profit-gain to the firm owners from protection. There is less political support at the margin. Hence, the policy maker is induced to reduce protection.

Why pollution tax may increase or decrease can now be explained. An increase in T^l implies that the domestic price increases unambiguously. This tends to increase the demand for the polluting input and hence increase pollution. If the price elasticity of output exceeds 1, the increase in pollution from the increase in domestic price is very large. This entails a very high marginal welfare cost. The government then 'contains' the pollution increase by increasing the pollution tax. If the price elasticity of output is less than 1, the marginal welfare loss from pollution is not high, and the government further supports the lobbyist by lowering the tax on pollution.

How does an increase in p^w affect pollution? Note that since T^l rises, the domestic price unambiguously increases. This tends to increase the demand for the pollucite input and hence increase pollution. If τ^l falls, it also tends to increase pollution. Therefore, pollution rises unambiguously. However, if τ^l rises (when $\alpha+\beta > 1/2$), the effects of changes in domestic price and τ^l on pollution are opposite of each other, leaving the overall impact on pollution unclear.

Numerical simulations were undertaken to evaluate the effect of an increase in p^w on pollution, when $\alpha + \beta > 1/2$. Interestingly, it was found that for all the permissible values of the parameters, the effect on pollution was positive, i.e., pollution rose unambiguously as p^w increased. Table 2 contains a sample of different values of p^w and the associated levels of pollution when other parameters were chosen values, $\alpha = 0.47,\ \beta = 0.10,\ a = 0.80$ and $\gamma = 0.5$.

4.3 Weight on political contributions

Suppose the government becomes more political in the sense that it attaches a higher weight on the welfare of the lobby in its utility function. That is, there is an increase in a. From (24), we observe that, at given τ, an increase in a implies an increase in t. Thus, the U_τ^g curve in Fig. 2 shifts out. Similarly, from (26), $\partial t/\partial a > 0$. Hence the U_t^g curve shifts out also. Since both the first-order conditions imply that, at given τ, t increases, we have $dt/da > 0$. However, $d\tau/da \gtreqless 0$. An interesting possibility emerges to the effect that as a government becomes more politically inclined, it may not relent with respect to pollution tax. Thus,

Proposition 10: *As the government gets more political it offers higher protection to the importable sector. However, the effect on the environment policy is ambiguous.*

Appendix C contains the detailed derivations.

Simulation exercises do confirm the above. Runs 3, 4 and 5 in Table 3 indicate parametric configurations under which $d\tau/da < 0$, whereas the others illustrate examples where $d\tau/da > 0$. In particular, it turns out that $d\tau/da > 0$ when the world price, p^w, is high enough (as in simulation Runs 6, 7 and 8).

However, the impact of an increase in the politicization of the government is always detrimental to the environment, as is depicted in the last column of Table 3.

5 Conclusions

The paper analyzes the political-economy interaction between trade and environment policies in the context of a small import-competing industry. Two alternative cases are studied. Under the first, we let only one policy instrument (either pollution tax or import tariff) be politically determined, whilst in the second, both trade and environment are political. For the first, it is shown that the government is induced to choose the policy that entails a compromise in social welfare: environmental tax is set lower than the Pigouvian tax and a positive tariff protection provided to the importable sector. Clearly, in either case the effect on environment is negative.

In the second scenario, both the trade and environment policies are influenced by political pressure.

Bargaining over more than one policy instrument allows the government to trade-off one policy with another. We find that whilst the government always 'concedes' by providing positive tariff protection to the import-competing sector at home, it may or may *not* give in to the lobby's demand for lower pollution tax. In situations when the government is not very much politically inclined, it is possible that it would offset a higher tariff with a pollution tax that is *higher* than the Pigouvian tax. There is, however, an upper limit on the magnitude by which the equilibrium pollution tax could exceed the socially optimal tax. Nevertheless, at the political equilibrium the pollution is always worsened as compared to the social optimum.

An exogenous increase in the preference for 'cleaner' environment induces the government to raise the pollution tax and lower tariff protection. As expected, the pollution decreases unambiguously.

As the world market price of the importable good rises, it is interesting that the absolute level of tariff protection, measured by the difference between the domestic and world price of the importable good, *rises*, which ties up well the existing literature on the political economy of protection to declining industries. The effect on the pollution tax is more predictable. It is conditional on whether the elasticity of output of the importable good exceeds one or falls short of one; in the first case the tax rises and in the second, it falls as the price of the world importable good rises. The effect on the environment is always negative, however.

As the government becomes more political, i.e., it weighs the political contribution relatively more in its utility function, it grants higher tariff protection. But it may *not* lower the pollution tax. It is surprising that it may trade-off higher import tariff with a stricter environmental regulation. The environment quality is always adversely affected.

In sum, the analysis in this paper provides useful insights into how, under the influence of special-interest politics, the trade and environment policies interact with each other.

Appendix A

It is shown here that, when only import tariff is politically determined, the regularity condition (R1) ensures that $t^f \in R_+$ and the second-order condition of 'political-utility' maximization is met. For notational simplicity superscript 'f' has been ignored in this appendix.

Recall that first-order condition (20) can be expressed as:

$$m(t) \equiv -t \left[\frac{\bar{L}p^{w\frac{1-2(\alpha+\beta)}{1-\alpha-\beta}} \gamma^{\frac{\beta}{1-\alpha-\beta}}}{\Gamma(1+t)^{\frac{\alpha+\beta}{1-\alpha-\beta}}} + \frac{\alpha+\beta}{(1-\alpha-\beta)(1+t)} \right] + a = 0, \tag{A1}$$

where $\tau = \gamma$ (by assumption) and $\Gamma \equiv [(\alpha+\beta)/\kappa_x]^{\frac{\alpha+\beta}{1-\alpha-\beta}}$.

Note that $m(0) > 0$. When $t \to \infty$, by applying L'Hospital's rule,

$$\lim_{t\to\infty} m(t) = \left(a - \frac{\alpha+\beta}{1-\alpha-\beta} \right) - \frac{1-\alpha-\beta}{\alpha+\beta} \left. \frac{\bar{L}p^{w\frac{1-2(\alpha+\beta)}{1-\alpha-\beta}} \gamma^{\frac{\beta}{1-\alpha-\beta}}}{\Gamma(1+t)^{\frac{2(\alpha+\beta)-1}{1-\alpha-\beta}}} \right|_{t\to\infty} < 0,$$

if either $\alpha + \beta < 1/2$ or $a \leq 1 < (\alpha+\beta)/(1-\alpha-\beta)$ ($\Leftrightarrow \rho \leq 1/2$); this is the regularity condition (R1). Hence $m(t)|_{t\to\infty} < 0$ and thus a solution $t^f \in (0, \infty)$ exists if (R1) is met.

Next, differentiating $m(t)$,

$$m'(t) = -\frac{\bar{L}p^{w\frac{1-2(\alpha+\beta)}{1-\alpha-\beta}} \gamma^{\frac{\beta}{1-\alpha-\beta}}}{\Gamma(1+t)^{\frac{\alpha+\beta}{1-\alpha-\beta}}} \left(1 - \frac{\alpha+\beta}{1-\alpha-\beta} \frac{t}{1+t} \right) \tag{A2}$$

In view of (A2), $m'(t) < 0$ if the coefficient of $\bar{L}$ is negative, i.e., $\left(\frac{\alpha+\beta}{1-\alpha-\beta}\right) < \left(\frac{1+t}{t}\right)$. This is satisfied in $\alpha+\beta \leq 1/2$. Suppose $\alpha+\beta > 1/2$. Then also, in view of Proposition 1, we have $\left(1 - \frac{\alpha+\beta}{1-\alpha-\beta} \frac{t}{1+t}\right) > (1-a)$, which is positive if $a \leq 1$ ($\Leftrightarrow \rho \leq 1/2$). Hence the condition (R1) also ensures that $m'(t) < 0$ and the second-order condition is met.

Appendix B

In this appendix it is shown that, when both tariff and tax are politically determined, the regularity condition (R2) ensures that the second-order conditions relating to (23) and (25) hold, which, in turn, implies that the solutions τ^l and t^l are unique. For notational ease, let us here ignore the superscript 'l' on τ or t.

The second-order conditions require that,

$$f_\tau \quad < \quad 0, \tag{B1}$$

$$g_t \quad < \quad 0, \tag{B2}$$

$$f_\tau g_t - f_t g_\tau \quad > \quad 0, \tag{B3}$$

where $f(\cdot) = 0$ and $g(\cdot) = 0$ are the first-order conditions (23) and (25), respectively.

We begin with the proof for (B1). By differentiating $f(\cdot)$ with respect to τ, we have

$$f_\tau = -\frac{(1-\alpha)\gamma}{\tau^2} < 0. \tag{B4}$$

This proves (B1).

Next, turn to (B2). Differentiating $g(\cdot)$ with respect to t,

$$g_t = -\left[\frac{p^{w^{\frac{1-2(\alpha+\beta)}{1-\alpha-\beta}}}\tau^{\frac{\beta}{1-\alpha-\beta}}}{\Gamma(1+t)^{\frac{\alpha+\beta}{1-\alpha-\beta}}}\left(1-\frac{\alpha+\beta}{1-\alpha-\beta}\cdot\frac{t}{1+t}\right)+\frac{\alpha+\beta}{(1-\alpha-\beta)(1+t)^2}\right] \tag{B5}$$

$$= -\left[Z + \frac{\beta}{(1-\alpha)(1-\alpha-\beta)(1+t)^2}\right], \tag{B6}$$

$$\text{where } Z \equiv \frac{p^{w^{\frac{1-2(\alpha+\beta)}{1-\alpha-\beta}}}\tau^{\frac{\beta}{1-\alpha-\beta}}}{\Gamma(1+t)^{\frac{\alpha+\beta}{1-\alpha-\beta}}}\left(1-\frac{\alpha+\beta}{1-\alpha-\beta}\cdot\frac{t}{1+t}\right)+\frac{\alpha}{(1-\alpha)(1+t)^2}. \tag{B7}$$

From (B5) note that when $\alpha+\beta \leq 1/2$, $g_t < 0$. Now suppose $\alpha+\beta > 1/2$, then turn to (B6). The following Lemma proves that under our regularity condition (R2), $Z > 0$. This would imply that $g_t < 0$.

Lemma 1: *Given (R2),* $Z > 0$.

Proof: Observe that $Z > 0$ if $\alpha+\beta \leq 1/2$. Suppose $\alpha+\beta > 1/2$. Then,

$$\begin{aligned}
Z &= \frac{1}{t}\left[\left(\frac{\beta}{1-\alpha-\beta}\right)\left(\frac{\tau^l-\gamma}{\gamma}\right)+a-\left(\frac{\alpha+\beta}{1-\alpha-\beta}\right)\frac{t}{1+t}\right] \\
&\quad\cdot\left(1-\left(\frac{\alpha+\beta}{1-\alpha-\beta}\right)\frac{t}{1+t}\right)+\frac{\alpha}{(1-\alpha)(1+t)^2} \qquad \text{(using (25))} \\
&= \frac{1}{t}\left[\frac{\beta}{(1-\alpha-\beta)(1-\alpha)}\left(\frac{t}{1+t}-a(1-\alpha-\beta)\right)+a-\left(\frac{\alpha+\beta}{1-\alpha-\beta}\right)\frac{t}{1+t}\right] \\
&\quad\left(1-\left(\frac{\alpha+\beta}{1-\alpha-\beta}\right)\frac{t}{1+t}\right)+\frac{\alpha}{(1-\alpha)(1+t)^2} \qquad \text{(using (23))}. \qquad \text{(B8)} \\
&= \frac{1}{t}\left[\frac{a(1-\alpha-\beta)}{1-\alpha}-\frac{\alpha}{(1-\alpha)}\frac{t}{(1+t)}\right]\left(1-\left(\frac{\alpha+\beta}{1-\alpha-\beta}\right)\frac{t}{1+t}\right)+\frac{\alpha}{(1-\alpha)(1+t)^2} \\
&= \frac{1}{(1-\alpha)t}\left[a(1-\alpha-\beta)+\frac{\alpha(\alpha+\beta)}{1-\alpha-\beta}\left(\frac{t}{1+t}\right)^2-a(\alpha+\beta)\frac{t}{1+t}\right]-\frac{\alpha}{1-\alpha}\frac{t}{(1+t)^2}. \qquad \text{(B9)}
\end{aligned}$$

By collecting terms, this will be

$$= \quad \frac{\alpha t}{(1-\alpha)(1+t)^2}\left(\frac{\alpha+\beta}{1-\alpha-\beta}-1\right)+\frac{a}{t(1-\alpha)}\left[(1-\alpha-\beta)-(\alpha+\beta)\frac{t}{1+t}\right] \tag{B10}$$

The first term in the r.h.s. is positive since $\alpha+\beta>1/2$. The second term is positive if $(1-\alpha-\beta)-(\alpha+\beta)(t/(1+t))>0$, for which it is sufficient that $(1-\alpha-\beta)-(\alpha+\beta)\frac{a(1-\alpha-\beta)}{\alpha}>0$, which follows from Proposition 3. This is equivalent to,

$$a \quad < \quad \frac{\alpha}{\alpha+\beta}, \tag{B11}$$

which is (iib) of the regularity condition (R2). This completes the proof of (B2).

Next, turn to (B3). Differentiating $f(\cdot)$ with respect to t,

$$f_t = \frac{1}{(1+t)^2}. \tag{B12}$$

Similarly, differentiating $g(\cdot)$ with respect to τ, we have,

$$g_\tau = -\frac{\beta}{(1-\alpha-\beta)\tau}\left[\frac{tp^{w\,\frac{1-2(\alpha+\beta)}{1-\alpha-\beta}}\tau^{\frac{\beta}{1-\alpha-\beta}}}{\Gamma(1+t)^{\frac{\alpha+\beta}{1-\alpha-\beta}}}-\frac{\gamma}{\tau}\right].$$

Using (25) to eliminate $\frac{tp^{w\,\frac{1-2(\alpha+\beta)}{1-\alpha-\beta}}\tau^{\frac{\beta}{1-\alpha-\beta}}}{\Gamma(1+t)^{\frac{\alpha+\beta}{1-\alpha-\beta}}}$, the r.h.s. is,

$$\begin{aligned}
&= \quad -\frac{\beta}{(1-\alpha-\beta)\tau}\left[\frac{\beta}{1-\alpha-\beta}\left(\frac{\tau-\gamma}{\tau}\right)+a-\frac{\alpha+\beta}{1-\alpha-\beta}\,\frac{t}{1+t}-\frac{\gamma}{\tau}\right]\\
&= \quad -\frac{\beta}{(1-\alpha-\beta)\tau}\left[\left(\frac{-\alpha+1}{1-\alpha}\right)\frac{t}{1+t}-1\right]=-\frac{\beta}{(1-\alpha-\beta)\tau(1+t)},
\end{aligned}$$

which is obtained by using (23) to eliminate $(\tau-\gamma)/\tau$.

Collecting the partials $f_\tau,\ g_t,\ f_t$ and g_τ, we have,

$$\begin{aligned}
f_\tau g_t - f_t g_\tau \quad &= \quad \frac{(1-\alpha)\gamma}{\tau^2}\left[Z+\frac{\beta}{(1-\alpha-\beta)(1-\alpha)(1+t)^2}\right]\\
&\quad\; -\frac{1}{(1+t)^2}\frac{\beta}{(1-\alpha-\beta)\tau(1+t)}\\
&= \quad \frac{(1-\alpha)\gamma}{\tau^2}Z+\frac{\beta}{(1-\alpha-\beta)\tau(1+t)^2}\left[\frac{\gamma}{\tau}-\frac{1}{(1+t)}\right]>0
\end{aligned} \tag{B13}$$

since, given $Z>0$ (see Lemma 1), the first term is positive, and the second is also positive because $[\gamma/\tau-1/(1+t)]>0$ in view of Proposition 5. Hence, (B3) is also proven.

The results in (B1)-(B3) imply that the second-order conditions corresponding to (23) and (25) are met and the equilibrium is unique.

Appendix C

When both tariff and tax are political, the effect of an increase in the politicization parameter, a, on τ is discussed. Again, for notational brevity, the superscript 'l' has been ignored in this appendix.

Totally differentiating the first-order condition, (24), with respect to a, we have,

$$\frac{1}{(1+t)^2}\frac{dt}{da} - (1-\alpha)\frac{\gamma}{\tau^2}\frac{d\tau}{da} = 1-\alpha-\beta. \tag{C1}$$

Similarly, by differentiating the other first-order condition, we get,

$$\begin{aligned}&\left[\frac{\alpha}{(1+t)^2} + \frac{(1-\alpha)p^{w\frac{1-2(\alpha+\beta)}{1-\alpha-\beta}}\tau^{\frac{\beta}{1-\alpha-\beta}}}{\Gamma(1+t)^{\frac{\alpha+\beta}{1-\alpha-\beta}}}\left(1-\frac{\alpha+\beta}{1-\alpha-\beta}\,\frac{t}{1+t}\right)\right]\frac{dt}{da}\\ &\quad+\frac{(1-\alpha)\beta}{1-\alpha-\beta}\,\frac{tp^{w\frac{1-2(\alpha+\beta)}{1-\alpha-\beta}}\tau^{\frac{\beta}{1-\alpha-\beta}}}{\Gamma(1+t)^{\frac{\alpha+\beta}{1-\alpha-\beta}}}\,\frac{1}{\tau}\frac{d\tau}{da} = 1-\alpha-\beta.\end{aligned} \tag{C2}$$

Eqs. (C1) and (C2) together constitute the matrix system,

$$\begin{bmatrix} \frac{1}{(1+t)^2} & -(1-\alpha)\frac{\gamma}{\tau^2} \\ \frac{\alpha}{(1+t)^2} + \frac{(1-\alpha)p^{w\frac{1-2(\alpha+\beta)}{1-\alpha-\beta}}\tau^{\frac{\beta}{1-\alpha-\beta}}}{\Gamma(1+t)^{\frac{\alpha+\beta}{1-\alpha-\beta}}}\left(1-\frac{\alpha+\beta}{1-\alpha-\beta}\,\frac{t}{1+t}\right) & \frac{(1-\alpha)\beta}{1-\alpha-\beta}\,\frac{tp^{w\frac{1-2(\alpha+\beta)}{1-\alpha-\beta}}\tau^{\frac{\beta}{1-\alpha-\beta}}}{\Gamma(1+t)^{\frac{\alpha+\beta}{1-\alpha-\beta}}}\,\frac{1}{\tau}\end{bmatrix}\begin{bmatrix}\frac{dt}{da}\\ \frac{d\tau}{da}\end{bmatrix} = \begin{bmatrix}1-\alpha-\beta\\ 1-\alpha-\beta\end{bmatrix}$$

If Y denotes the coefficient matrix in the l.h.s., then $|Y|>0$, given that the second-order conditions hold.

Applying Cramer's Rule, we have,

$$\frac{dt}{da} = (1-\alpha-\beta)\left[\frac{(1-\alpha)\beta}{1-\alpha-\beta}\frac{tp^{w\frac{1-2(\alpha+\beta)}{1-\alpha-\beta}}\tau^{\frac{\beta}{1-\alpha-\beta}}}{\Gamma(1+t)^{\frac{\alpha+\beta}{1-\alpha-\beta}}}\,\frac{1}{\tau} + \frac{(1-\alpha)\gamma}{\tau^2}\right]\Big/|Y| > 0. \tag{C3}$$

$$\begin{aligned}\frac{d\tau}{da} &= (1-\alpha-\beta)(1-\alpha)\cdot\\ &\left[\frac{1}{((1+t)^2} - \frac{p^{w\frac{1-2(\alpha+\beta)}{1-\alpha-\beta}}\tau^{\frac{\beta}{1-\alpha-\beta}}}{\Gamma(1+t)^{\frac{\alpha+\beta}{1-\alpha-\beta}}}\left(1-\frac{\alpha+\beta}{1-\alpha-\beta}\,\frac{t}{1+t}\right)\right]\Big/|Y| \gtreqless 0.\end{aligned} \tag{C4}$$

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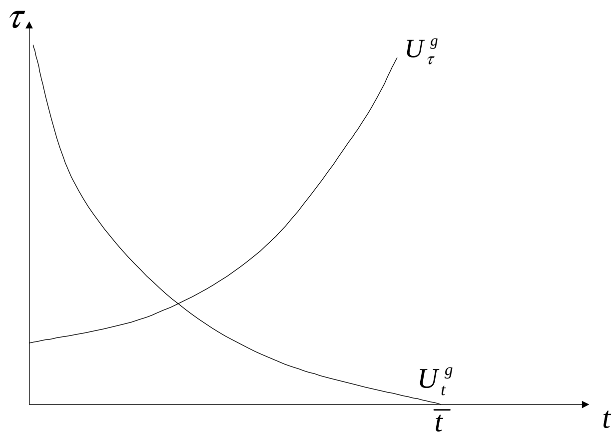

Figure 1: Determination of political equilibrium

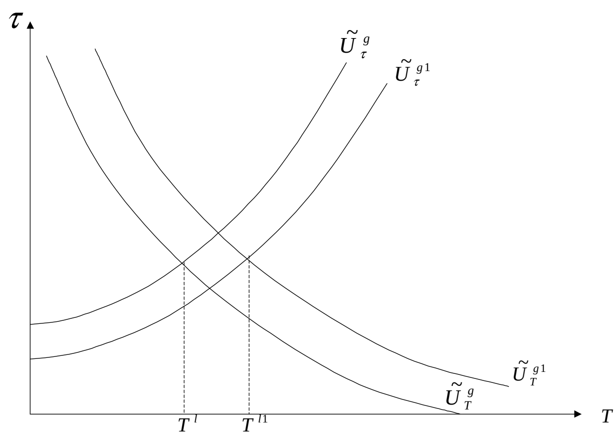

Figure 2: Comparative statics with respect to world price, p^w

Table 1: Results of numerical simulations: full political equilibrium

Parameter	α	β	p^w	γ	a	t^l	$\tau^{\mathbf{1}}$	Δ in Lobby Surplus
Run 1	0.20	0.20	0.042	**0.50**	0.30	0.25	**0.51**	0.00057
Run 2	0.20	0.20	0.21	**0.50**	0.33	0.17	**0.47**	0.00629
Run 3	0.47	0.10	32.24	**0.50**	0.75	0.49	**0.51**	646.11
Run 4	0.47	0.10	18.69	**0.50**	0.80	0.48	**0.48**	176.96

Table 2: Effect of changes in the world price on pollution: $\alpha + \beta > 1/2$

Parameter	α	β	a	γ	p^w	Pollution
Run 1	0.47	0.10	0.80	0.5	0.187	0.0025
Run 2					0.934	0.1123
Run 3					1.868	0.5822
Run 4					9.344	27.0234
Run 5					18.689	108.3255
Run 6					28.033	375.6700
Run 7					37.377	749.2474

Table 3: Comparative statics with respect to politicization parameter, a

Parameter	α	β	p^w	γ	a	t^l	τ^l	$\frac{d\tau^l}{da}$	Pollution
$\alpha + \beta < 1/2$									
Run 1	0.20	0.20	0.042	0.5	0.225	0.179	0.511	0.029	0.00111
Run 2					0.330	0.279	0.513	0.011	0.00126
Run 3	0.20	0.20	0.21	0.5	0.225	0.113	0.480	-0.091	0.01614
Run 4					0.330	0.173	0.471	-0.917	0.01810
$\alpha + \beta > 1/2$									
Run 5	0.47	0.10	18.689	0.5	0.55	0.277	0.482	-0.012	100.82
Run 6					0.80	0.479	0.482	0.011	142.08
Run 7	0.47	0.10	32.24	0.5	0.55	0.314	0.502	0.026	364.07
Run 8					0.80	0.554	0.512	0.056	525.34