Trade and Environmental Policies with Special Interest Politics: A case of Asymmetric Information

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Abstract

This paper presents a simple model on the political economy of trade and environmental policies in the presence of asymmetric information. Information asymmetries stem from the preference of the incumbent government towards welfare of the average voter and political contributions made by special interest groups. Special interest groups are owners of sector-specific factors of production used to produce traded goods and there exist negative production externalities. The politically motivated government uses trade and environmental policies to regulate trade flows and environmental quality, respectively. Results show that information asymmetries work in favour of special interest groups as they guarantee laxer environmental policy in comparison to the baseline scenario of complete information. Trade policy, on the other hand, is invariant of the information on the incumbent's preference over aggregate social welfare and reflect terms of trade effects and effects associated with production externalities. The downward distortion in environmental policy worsens environmental quality.

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1 Introduction

The recent episodes of tariff wars between countries like the United States (US), China and India predicate the role of global political economy in shaping up international trade policies. Trade policies, hitherto chosen through negotiations at international fora like the World Trade Organisation (WTO), seem to be driven by a wave of anti-globalisation, non-cooperation and retaliation. Although there has been a vast array of disputes relating to the violation of clauses of the WTO, the present scenario is unprecedented in terms of its severity and overtness. For instance, in early 2018, the US imposed import tariffs of 25 per cent on steel and 10 per cent on aluminium. This was followed by the US pursuing India at the WTO for unfair trade practices in the form of export subsidies in sectors like steel, pharmaceuticals, information technology, chemicals and textiles. Such actions triggered retaliation by China and India in due course of time. India announced a hike in tariffs on 29 US items including almonds, apples and phosphoric acid in June 2018. Around the same time, China slapped additional duties on 659 American products including agricultural products, vehicles, aquatic products, chemicals, medical equipment and energy products (CWS, 2018).

What drives the paradox is that these nations are, apparently, members of the WTO that emphasises free and fair trade. Consequently, the objectives of trade negotiations directed at gradual movement towards free flow of goods and services across borders become increasingly difficult to attain. In defence of such protectionist policies lies the argument of safeguarding global competitiveness of domestic industries. However, alternate speculations suggest that such tariff wars are driven by threats to the gradual shift in economic order from the west to the Asian nations like China, India, Vietnam, Indonesia and Singapore. What is more worrisome is that such threat is triggered by the scepticism associated with global warming and climate change in the west, especially in the US. Many are of the view that the narrative of human activities impinging on climate change is unfounded and misleading. With the US taking the lead, there are misgivings that environmentalists and climate scientists have twisted facts and science to support and promote hysteria about climate change in order to protect their research funding and ideology. For example, the US did not ratify the Kyoto Protocol (1997) and has withdrawn from the Paris Agreement (2016). On the whole, radical environmentalism has been regarded as anti-industry and affects competitiveness of the manufacturing sector adversely. Such protectionist policies may invite counter action of retaliation from trading partners, thus leading to a tariff war of sorts. Else, there could be more relaxed environmental regulation in Home that counters the impact of higher import tariffs in Foreign. Consequently, protectionist trade policies compounded with environmental regulations influence domestic economic activity coupled with resonating effects in the foreign market in a globalised world. Hence, these policies cannot be studied in isolation.

Accordingly, when national governments interact through trade and environment policies in order to augment their competitive edge in the international market, any rewards or losses from such policies get tied to the welfare of economic agents at the micro level, viz. consumers, producers, environmentalists via the general equilibrium effects. Any change in policies at the sectoral level set by the government would alter domestic as well as world prices (in case of a large open economy) of the associated output. While producers would

benefit from higher domestic prices, consumers would lose their surplus to the producers. Environmentalists, on the other hand, are advocates of improved environmental quality. Their motive lies in control or reduction of pollution activities related to production or consumption. Environmental compliance costs or pollution charges escalate production costs and producers shift the burden to consumers, who now face higher prices. This would, however, depend on the elasticities of demand and supply curves. Hence, each group may have 'special interests' attached to trade or environmental policies or both. The social welfare effects, however, remain ambiguous in general.

The literature based on the interaction between governments and interest groups revolves around the inter-linkages between politics and economics. Incumbent governments, with the motive of being elected to power, announce an extensive array of policies in order to sway voters. In other words, opposing candidates engage in electoral competition in order to maximise the probability of getting elected. Apart from electoral competition, incumbent governments may also act semi-benevolent with an objective to maximise political support. Special interest groups offer campaign contributions to the incumbent government which is contingent upon policies set. The incumbent government, then, maximises the political support function which is a weighted sum of pure social welfare and campaign contributions. Resultantly, policies chosen by the incumbent would not be at the first-best level. The political equilibrium reflects optimal policies which are necessary to sway voters (especially the lobby groups) in favour of the incumbent. In the words of Dixit et al. (1997), this phenomenon is described as common agency where a set of principals (political action groups) overcome the free-rider problem and simultaneously and non-cooperatively offer contributions to the agent (a legislator) to influence political processes that determine economic policies. While only a subset of the population succeeds in overcoming the free rider problem, and lobby for policies in their favour, the legislator cares about the welfare of every individual irrespective of him/her being a part of any political action group or not. Apart from welfare of individuals in general, the legislator also cares for campaign contributions. Equilibrium policies are chosen by maximising a weighted welfare function[1] and revenues generated thereof are redistributed to the public in the form of undistorted lump sum transfers.

One of the seminal works attributed to special interest politics and endogenous trade policy is by Grossman and Helpman (1994). In a multi-sector model with homogeneous labour input and sector specific inputs, it emphasises on the role of organised lobby groups in the determination of trade policy. Owners of sector specific inputs whose incomes are tied to the domestic price of the output of the corresponding sector, have a direct stake in trade policies affecting the domestic price of the sector specific output. If this fraction of the population consumes only non-traded goods, then there is a greater likelihood of pushing for trade policies which raise domestic prices of traded goods. Accordingly, results suggest that only organised lobby groups enjoy protection in terms of tariff while unorganised ones lose protection. Such incongruity in protection levels is attributed to the contributions made by organised lobbies. Incumbent governments peddle their policy stance for campaign contributions and this serves the interests of lobbies with the aim of increasing the chances of being re-elected. For an organised sector, protection level rises with a rise in the level of output per unit of imports. This is due to higher stakes of the owners of the sector specific input. The social cost of protection, reflected by import

demand or export supply elasticities, has a negative impact on the level of protection.

Following Grossman and Helpman (1994), Maggi and Rodriguez-Clare (1998) went a step further by introducing the element of time in their model. The assumption that sectors producing traded goods use sector specific inputs would hold only in the short run. In the long run, inputs tend to be mobile across sectors. Therefore, governments may not always choose protection over commitment to free trade. Mobility of inputs across sectors would generate conflict of interests, thereby, precluding the likelihood for lobby formation and hence campaign funding. In that case, the incumbent has no incentive to adopt protectionist policies. The dynamic aspect of trade policy making has also been studied by Celik et al. (2013) by incorporating non-cooperative congressional bargaining. Other related studies on legislative bargaining include Grossman and Helpman (2005) and Willmann (2005). Unlike interactions between the incumbent and special interest groups, Celik et al. (2013) model interactions between legislative assemblies. Legislators from each constituency are only concerned with the welfare of their own constituency. As a result, equilibrium outcomes show that a legislator demands import tariff (or export subsidy) for a good that is produced in his/her constituency and an import subsidy (or export tax) on goods produced in the other constituency. The sequential bargaining game may be welfare-worsening for all participants. Moreover, identical industries are subject to different tariff levels. Models on legislative bargaining do not incorporate the political support function approach as in case of Grossman and Helpman (1994).

The Grossman and Helpman (1994) framework has been used in several studies focusing on trade-environment linkages. Damania et al. (2003) suggest that trade liberalisation leads to increase in pollution tax in the protected sector if the level of corruption is high. Although trade policy is assumed to be exogenous, they show that as trade liberalisation reduces output of the polluting good, the bribe offer from the lobby declines and pollution tax rises. In addition to this, the decline in the domestic production of the polluting good also reduces the policy maker's incentive to address the distortion that originates from the negative externality in production. This results in a reduction in pollution tax. When the level of corruption is high, the bribery effect dominates the latter effect and causes pollution tax to rise. Apart from industry lobbies, environmental lobbies too influence policies. With exogenous trade policy, a reduction in protection would result in lower pollution taxes if the lobbying effort by the environmental lobby group declines faster than the lobbying effort by the industry lobby group (Fredriksson, 1999). The endogeneity of both the policies may also result in the policy maker facing a trade-off between lower protection and less stringent environmental regulation versus higher tariffs and higher environmental regulations (Mehra, 2010). A common characteristic shared by these studies is the assumption that trading nations are too small to influence international prices. It is Grossman and Helpman (1995) and Conconi (2003) who attempt to examine policy interactions for large open economies. The former only discusses the implications of domestic politics in determination of trade policies under cooperation as well as non-cooperation by large open economies, in the absence of environmental regulations. An extension of the analysis in Grossman and Helpman (1994), it provides an exposition of the motives for trade protection in large open economies. Apart from the gains from political support, trade protection in the context of large open economies is also driven by terms of trade gains. For a sector producing importables (export goods),

protection is inversely related to the elasticity of foreign export supply (foreign import demand). Potential social gains from trade protection rise as the elasticity of foreign export supply (foreign import demand) falls, which reflects the standard Ramsey pricing rule. Employing a similar approach, Conconi (2003) examines the role of green lobbies in shaping environmental policies in the presence of emissions leakage to other countries. Furthermore, this study also incorporates trade policies and concludes that the impact of green lobbying on environmental policy is contingent upon the existing trade policy regime. When trading nations are not constrained by international trade rules, green lobbies have a bias in favour of higher pollution taxes. Under a free trade regime, emissions leakage alters the preference of green lobbies towards lower pollution taxes. Since the focal point of this study revolves around environmental policy, instances of trade-environment linkages have not been addressed in an explicit manner but some pointers are provided. An interesting result of the study that green lobbies favour pollution taxes lower than the optimal level in the presence of transboundary pollution, is based on the premise of a free trade regime. In a similar but more comprehensive study by Schleich and Orden (2000), the trade-environment linkage has been explored in order to compare the impact of each of these policies (trade policy and domestic policy) on environmental quality.

One of the common links across these existing studies is the assumption that the incumbent government or the legislator's preferences over social welfare are common knowledge. However, we cannot rule out instances where special interest groups that makes monetary transfers to the policy maker in order to swerve economic policies in its favour, have incomplete information about the legislator's preference over social welfare. Such a situation typically arises when the policy maker is newly elected and the political pressure groups are unfamiliar with its agent's preferences. It may also arise with in case of a renewed mandate if political and administrative uncertainties loom large. For instance, investors in Angola, Africa are imperilled by the impending elections on account of uncertainties in the policies to be adopted by the elected government (Cabeça, 2022). Incumbent governments make ambitious pledges in terms of welfare programmes to woo voters. These pledges, however, may not necessarily align with the interests of the investors. Moreover, it is extremely difficult to make predictions on the incumbent's policy stance. The present regime in India had to revoke its Farm Laws amid nationwide protests. Such actions heighten uncertainties and risks associated with the incumbent's preferences. Until recently, the federal government of West Bengal, India that has been ruling for more than a decade and was lauded for ousting the Left Front government for *Poriborton* (change), has been fraught with rampant corruption (Datta, 2022). The recruitment scam in public institutions in the state throws light on how the incumbent's preferences over social welfare vis-á-vis political contributions are not common knowledge. While goodwill of the incumbent government signals its commitment towards announced policies, there exists scope for extracting information rents from interests groups by hiding its true preference type. As a result, unlike the case of complete information, campaign contributions by political action groups serve more that one purpose: (a) to meet the political objectives of interest groups; (b) to induce the agent to reveal its true type.

In the specific context of asymmetric information, Montanari (2008) develops an explicit principal-agent model where an interest group has incomplete information about the degree of benevolence of the neo-elected government. Results suggest that incomplete information aggravates the level of policy distortion as compared

to the benchmark scenario of complete information. Utilising this approach in our model, we introduce the role of information asymmetries on equilibrium trade and environmental policies and compare the results with the case where the policy maker's preference over social welfare is common knowledge.

The benchmark model for a common-agency framework under incomplete information suggests that the equilibrium trade policy coincides with that obtained under complete information. This is primarily due to policy targeting where trade policy is used to exploit market power and address the negative externality from foreign production. This result is similar to that of Schleich and Orden (2000). The equilibrium environmental policy, measured through an environmental tax, is lower than that of complete information except for the scenario where the incumbent government is purely benevolent. Therefore, political action groups benefit from information asymmetries by paying lower taxes for generating pollution. The incumbent government, on the other hand, enjoys positive information rent regardless of its preference over aggregate social welfare. Therefore, incomplete information over the policy maker's preferences worsens environmental quality. Equilibrium trade policy, and hence trade flows are unaffected by information asymmetries.

The sequence of the paper is as follows. Section 2 develops the analytical model followed by the key conclusions in Section 3.

The following section develops the formal analysis.

2 Model structure

The world comprises two large open economies, namely, home and foreign. The political and economic structures are assumed to be identical across the nations. However, tastes and preferences, factor endowments and political scenarios may differ. In what follows is an exposition of the structure of the home country. An '*' is appended to each of the notations in the formal model for denoting the foreign counterparts.

2.1 Consumers

There are K consumers at home, $k = 1, 2, 3, ..., K$, who face identical and additively separable preferences which are assumed to be quasi-linear. Each resident k maximises a utility function given as

$$U_k = c_Z + \Sigma_{i=1}^{n} u_i(c_{X_i}) - \xi; \tag{1}$$

where c_Z denotes consumption of numeraire good Z whose price is unity in the domestic as well as the foreign market and c_{X_i} is consumption of non-numeraire good X_i $(i = 1, 2, ..., n)$. The function $u_i(.)$ is differentiable, increasing and concave in each of its arguments. The term ξ indicates environmental damage from production of non-numeraire goods, which depends on both domestic and foreign emissions. Emissions, in turn, are increasing in the level of production of the non-numeraire good.

Environmental damage is given by

$$\xi(\mathbf{p}, \mathbf{p}^*) = \Sigma_{i=1}^{n}[(1-\theta_i)E_i(p_i) + \theta_i E_i^*(p^*{}_i)]; \tag{2}$$

where $\mathbf{p}$ and $\mathbf{p}^*$ are vectors of producer prices in the domestic and the foreign country, respectively. θ_i and $(1-\theta_i)$ are the relative weights placed on domestic and foreign emissions, E_i and E_i^* of sector i, respectively. When pollution is global in nature, $\theta_i = \frac{1}{2}$. For local pollution, $\theta_i = 0$. For $0 < \theta < \frac{1}{2}$, there exists regional environmental problems.

The damage function obeys standard properties. It affects the utility of a representative consumer adversely through production of non-numeraire goods that generates emissions and has perverse effects on utility.

The domestic producer and consumer prices of the non-numeraire good i are given by p_i and q_i, respectively. ω_i denotes the offshore/world price of the good, which is endogenous.

Given these prices and income I, a consumer maximises his/her utility subject to the budget constraint

$$c_Z + \mathbf{q}\mathbf{c_X} = I; \tag{3}$$

where $\mathbf{q} = (q_1\ q_2\ q_3.....q_n)$ and $\mathbf{c_X} = (c_{X_1}\ c_{X_2}\ c_{X_3}.....c_{X_n})$ denote the vector of home consumer prices and home consumption, respectively.

The first-order condition for utility maximisation yields

$$q_i = \frac{\partial u_i}{\partial c_{X_i}}; \tag{4}$$

which gives the demand function $d_i(q_i)$ as the inverse of $\frac{\partial u_i}{\partial c_{X_i}}$. Total demand for good i in the home country is given by $D_i(q_i) = Kd_i(q_i)$ and $\frac{\partial D_i(q_i)}{\partial q_i} = D_q^i < 0$.

Net consumer surplus from consumption of non-numeraire goods is given by

$$S(\mathbf{q}) = \mathbf{ju} - \mathbf{qd}; \tag{5}$$

where $\mathbf{j} = (1\ 1\ 1....1)$, $\mathbf{u} = (u_1\ u_2\ u_3.....u_n)'$; and $\mathbf{d} = (d_1(q_1)\ d_2(q_2)\ d_3(q_3).....d_n(q_n))'$. Here, $\mathbf{u}$ denotes the vector of gross consumer surplus and $\mathbf{d}$ is the vector home demand respectively. Since, a consumer spends the remaining income on consumption of the numeraire good, indirect utility function is given as

$$V(\mathbf{q}, I) = I - \mathbf{qd} + \mathbf{ju} = I + S(\mathbf{q}). \tag{6}$$

2.2 Producers

The production technology associated with the numeraire good Z exhibits constant returns to scale (CRS). By choice of units appropriately, the labour-output coefficient is assumed to be unity, i.e., one unit of labour produces one unit of output. Under the assumption of perfect competition, wage rate equals unity in the sector producing the numeraire good. The aggregate supply of labour l is sufficiently large to maintain a positive level

of output of good Z in equilibrium. Each of the other n sectors, characterised by perfect competition, uses CRS technology to produce X_i using labour, sector specific capital. The supply of sector specific capital is inelastic. Labour is assumed to be mobile across sectors and there is no inter-sectoral mobility of sector specific inputs. Production of non-numeraire goods generates environmental pollution. For simplicity, we assume that there is no pollution abatement and one unit of output translates into one unit of emission.

Given this Ricardo-Viner framework, the owners of the sector specific input derive residual rents from this production sector. For each sector producing the non-numeraire good, Hotelling's lemma ensures that the slope of the profit function with respect to home prices would give the supply function, i.e.,

$$X_i(p_i) = \frac{\partial \Pi_i}{\partial p_i}. \tag{7}$$

2.3 Government

The government has a set of policies that it can implement, namely, trade policies and environment policies, both of which act as potential tools for redistribution of income. Trade flows of the non-numeraire goods are regulated through trade taxes or subsidies. Similarly, the government may regulate environmental damage from production of these goods with an environmental tax on emissions. Hence, price based instruments are employed for regulation of both trade flows and environmental damage. Revenues generated from such policies are distributed to the public in a lump sum fashion.

While trade policies drive a wedge between domestic prices and international prices, environmental policies result in a deviation between domestic consumer prices and producer prices. Assuming a specific tariff, t_i and an environmental tax, τ_i, domestic producer price and consumer price are, respectively, given by

$$p_i = \omega_i + t_i - \tau_i; \tag{8}$$

and

$$q_i = \omega_i + t_i \tag{9}$$

where t_i is greater than zero in case of an import tariff or an export subsidy and less than zero for an import subsidy or an export tax. τ_i is positive when an environmental tax is in place and negative in case of an environmental subsidy.

Per capita government revenue generated from trade policy is given as

$$r(\mathbf{t}, \boldsymbol{\omega}; \boldsymbol{\tau}) = \frac{1}{K} \Sigma_{i=1}^{n} t_i M_i(p_i, q_i); \tag{10}$$

where $M_i = D_i(q_i) - X_i(p_i)$.

$\mathbf{t} = (t_1\ t_2\ t_3.....t_n)$, $\boldsymbol{\omega} = (\omega_1\ \omega_2\ \omega_3.....\omega_n)$ and $\boldsymbol{\tau} = (\tau_1 \tau_2 ....\tau_n)$ denote trade policy vector, international price vector and environmental tax vector, respectively.

Similarly, per capita revenue from environmental tax is given as

$$e(\boldsymbol{\tau}, \boldsymbol{\omega}; \boldsymbol{t}) = \frac{1}{K}\Sigma_{i=1}^{n}\tau_i X_i(p_i); \tag{11}$$

where τ_i is the environmental tax imposed on the production externality in sector i.

2.4 Complete Information

2.4.1 The political structure

The aspect of politics in the model of trade policy determination is driven by the production process in each sector. Immobility and indivisibility of certain sector specific inputs ensure that their owners have direct claims in the rent accruing to that sector. Returns to the factors of production in sector i are directly linked to the price of X_i prevailing at home. Since, advalorem trade taxes or subsidies would have a direct impact on domestic prices of goods, and the associated rents emerging there, stakes of the owners of specific inputs get tied to trade policies. The owners of specific inputs, also being consumers, have their welfare attached to all policies that affect domestic prices.

Trade policies which drive up domestic prices have a favourable impact on the welfare of owners of the specific input. Consequently, a subset of such groups may jointly pursue their common interest to the incumbent government. The inherent assumption made here is that members of such groups overcome the free rider problem. Further, the set of organised industries is assumed to be exogenously given. These groups, referred to as lobbies, finance campaign funding for the incumbent government in exchange of policies (trade and environmental ones) set in their favour. The incumbent, on the other hand, aims to maximise the probability of getting re-elected. Higher welfare generated by policies set by the incumbent would increase the chance of being re-elected. However, there are general voters including consumers, workers and unorganised specific factor owners who fail to make campaign contributions, can by no means influence the incumbent. As a result, the incumbent government weighs both campaign contributions and pure social welfare while choosing policies.

The lobby in industry i offers a contribution schedule $C(\boldsymbol{t}, \boldsymbol{\tau};\ \boldsymbol{t^*}, \boldsymbol{\tau^*})$ that maximises its joint welfare given as

$$v_i = W_i(\boldsymbol{t}, \boldsymbol{\tau};\ \boldsymbol{t^*}, \boldsymbol{\tau^*}) - C_i(\boldsymbol{t}, \boldsymbol{\tau};\ \boldsymbol{t^*}, \boldsymbol{\tau^*}); \tag{12}$$

where

$$W_i(\boldsymbol{t}, \boldsymbol{\tau};\ \boldsymbol{t^*}, \boldsymbol{\tau^*}) \equiv l_i + \Pi_i(p_i) + \alpha_i K\big[S(\boldsymbol{t}, \boldsymbol{\tau}) + r(\boldsymbol{t}, \boldsymbol{\tau}) + e(\boldsymbol{t}, \boldsymbol{\tau}) - \xi(\boldsymbol{t}, \boldsymbol{\tau})\big]. \tag{13}$$

Welfare (gross of contributions) of lobby in sector i is a sum of labour income of the factor owners, profits/rents earned, consumer surplus from consumption of non-numeraire goods and transfers from the government. Transfers include revenues generated from trade policy and environmental regulations. α_i refers to the proportion of the population that owns the specific input used in sector i.

The incumbent government is politically motivated and, hence, values campaign contributions. However,

he/she also cares for the general voter whose voting preference in future would depend on the welfare generated in the present. If the general voter is content with the policies chosen, the probability of the incumbent getting re-elected rises. Resultantly, the incumbent maximises a political support function given as

$$G = \Sigma_{i \in L} C_i(\boldsymbol{t}, \boldsymbol{\tau};\ \boldsymbol{t^*}, \boldsymbol{\tau^*}) + aW(\boldsymbol{t}, \boldsymbol{\tau};\ \boldsymbol{t^*}, \boldsymbol{\tau^*}); \quad a \geq 0; \tag{14}$$

where L denotes the set of organised sectors which make campaign contributions to the government and

$$W(\boldsymbol{t}, \boldsymbol{\tau};\ \boldsymbol{t^*}, \boldsymbol{\tau^*}) \equiv l + \Sigma_{i=1}^{n} \Pi_i(p_i) + K\big[S(\boldsymbol{t}, \boldsymbol{\tau}) + r(\boldsymbol{t}, \boldsymbol{\tau}) + e(\boldsymbol{t}, \boldsymbol{\tau}) - \xi(\boldsymbol{t}, \boldsymbol{\tau})\big]. \tag{15}$$

Here, $l = \Sigma_{i=1}^{n} l_i$ denotes total labour income (recall that the wage rate is normalised to unity) and a is the weight attached to pure social welfare.

Analogously, similar expressions can be derived for the foreign country. The most interesting aspect of the model is the interdependence in trade and environmental policies between the two nations. Since both trading partners are large open economies, any change in domestic prices of traded goods would have a significant impact on the world prices. Thus, our model internalises these terms of trade effects.

The international trade equilibrium is given as

$$M_i(t_i, \tau_i, \omega_i) + M_i^*(t_i^*, \tau_i^*, \omega_i) = 0 \quad \forall\ i; \tag{16}$$

where $M_i(p_i, q_i) = D_i(q_i) - X_i(p_i)$ and $M_i^*(p_i^*, q_i^*) = D_i^*(q_i^*) - X_i^*(p_i^*)$ denote net imports of good i by the home and foreign country, respectively. The world market equilibrium for a particular good is reached when exports by one country equal imports by the other. The market clearing international price of the good is obtained thereof and is denoted by

$$\omega_i^o = \omega(t_i, \tau_i, t_i^*, \tau_i^*) \quad \forall\ i.$$

At this price, export supply of good i equals import demand.

2.5 Stages of the game

The game takes place in three stages. In the first stage, a non-cooperative menu auction takes place among political action groups or lobbies in each country, i.e., they choose contribution schedules contingent upon an array of policy outcomes which maximise their welfare. Each lobby acts simultaneously and non-cooperatively, taking the contribution schedules of all other lobbies at home and in the foreign country as given. Faced with the contribution schedules of the set of organised industries, the government sets policies in the second stage. Neither the lobbies nor the government renege on their commitments. Observing the set of policies announced, lobbies make contribution to the government. In the final stage, labour and world markets clear and production and consumption take place.

2.6 Non-cooperative equilibrium

Following Grossman and Helpman (1995), the Nash equilibrium for a policy vector, $\boldsymbol{T = (t, \tau)}$ at home and $\boldsymbol{T = (t^*, \tau^*)}$ in the foreign country can be defined as follows:

Proposition 1: *For any arbitrary policy vector* $\mathbf{T}^*$ *of the foreign country,* $\mathbf{T^0}$ *and* $\{C_i^0\}_{i\in L}$ *are the equilibrium responses in policy* $\boldsymbol{T}$ *and contribution schedules contingent upon policy* $\boldsymbol{T}$ *if*

(a) $\mathbf{T^0} = \underset{\mathbf{T}}{\arg\max}\, \mathbf{\Sigma_{i\in L} C_i^0}(\mathbf{T};\mathbf{T}^*) + \mathbf{aW}(\mathbf{T},\mathbf{T}^*)$, *and*

(b) there does not exist any feasible contribution function $C_i(\mathbf{T};\mathbf{T}^*)$ *and a policy vector* $\mathbf{T^i}$ *for every organised interest group* $i \in L$ *such that*

(i) $\mathbf{T^i} = \underset{\mathbf{T}}{\arg\max}\, \mathbf{C_i}(\mathbf{T};\mathbf{T}^*) + \mathbf{\Sigma_{j\neq i, j\in L} C_j^0}(\mathbf{T};\mathbf{T}^*) + \mathbf{aW}(\mathbf{T},\mathbf{T}^*)$, *and*

(ii) $W_i(\mathbf{T^i},\mathbf{T}^*) - \mathbf{C_i}(\mathbf{T^i};\mathbf{T}^*) > \mathbf{W_i}(\mathbf{T^0},\mathbf{T}^*) - \mathbf{C_i}(\mathbf{T^0};\mathbf{T}^*)$.

While (a) shows that the policy vector chosen by the government maximises its objective function, (b) states that any lobby group i is unable to raise its welfare by unilaterally deviating and revising its contribution schedule from $C_i^0(\mathbf{T^0};\mathbf{T}^*)$, given the contribution schedules of all other groups. Taken together, (a) and (b) imply

$$\mathbf{T^0} = \underset{\mathbf{T}}{\arg\max}\, \mathbf{W_i}(\mathbf{T},\mathbf{T}^*) - \mathbf{C_i^0}(\mathbf{T};\mathbf{T}^*) + \mathbf{\Sigma_{j\neq i, j\in L} C_j^0}(\mathbf{T};\mathbf{T}^*) + \mathbf{aW}(\mathbf{T},\mathbf{T}^*)\ \forall\ \mathbf{i}\in\mathbf{L}. \tag{17}$$

Broadly speaking, an equilibrium response by the home government to any arbitrary policy chosen by the foreign government should maximise the joint welfare of each lobby as well as the objective function of the government, assuming that the contribution schedules of all other lobbies are given. The same holds true for the foreign country.

Assuming that the contribution schedules as well as the pure social welfare functions are differentiable around the point of equilibrium, we have the following first-order conditions

$$\nabla_{\mathbf{T}} W_i(\mathbf{T^0},\mathbf{T}^*) - \nabla_{\mathbf{T}}\mathbf{C_i^0}(\mathbf{T^0};\mathbf{T}^*) + \mathbf{\Sigma_{j\neq i, j\in L}}\nabla_{\mathbf{T}}\mathbf{C_j^0}(\mathbf{T^0};\mathbf{T}^*) + \mathbf{a}\nabla_{\mathbf{T}}\mathbf{W}(\mathbf{T^0},\mathbf{T}^*) = \mathbf{0}\ \forall\ \mathbf{i}\in\mathbf{L}; \tag{18}$$

and

$$\Sigma_{j\neq i, j\in L}\nabla_{\mathbf{T}} C_j^0(\mathbf{T^0};\mathbf{T}^*) + \mathbf{a}\nabla_{\mathbf{T}}\mathbf{W}(\mathbf{T^0},\mathbf{T}^*) = \mathbf{0}. \tag{19}$$

Using (19) in (18), we have

$$\nabla_{\mathbf{T}} C_i^0(\mathbf{T^0};\mathbf{T}^*) = \nabla_{\mathbf{T}}\mathbf{W_i}(\mathbf{T^0},\mathbf{T}^*)\ \forall\ \mathbf{i}\in\mathbf{L}. \tag{20}$$

Expression (20) shows that each lobby group sets its contribution schedule in such a manner that a marginal change in campaign contributions (or marginal cost for it) due to a change in home policy for any given foreign policy equals the change in gross welfare of the lobby due to the policy change, which is akin to the arbitrage condition for each lobby. This has been referred to as the local truthfulness property of equilibrium contribution schedules (Grossman and Helpman, 1994).

Summing (20) over all i and using (19), we get

$$\Sigma_{i\in L}\nabla_{\mathbf{T}}W_i(\mathbf{T^0},\mathbf{T}^*)+\mathbf{a}\nabla_{\mathbf{T}}\mathbf{W}(\mathbf{T^0},\mathbf{T}^*)=\mathbf{0}\;\forall\;\mathbf{i}\in\mathbf{L}. \tag{21}$$

In case of the foreign country, we have

$$\Sigma_{i\in L^*}\nabla_{\mathbf{T}^*}W_i^*(\mathbf{T}^{*\mathbf{0}},\mathbf{T})+\mathbf{a}^*\nabla_{\mathbf{T}^*}\mathbf{W}^*(\mathbf{T}^{*\mathbf{0}},\mathbf{T})=\mathbf{0}\;\forall\;\mathbf{i}\in\mathbf{L}^*. \tag{22}$$

Conditions (20) and (21) give us equilibrium policy responses $\mathbf{T^0}$ and $\mathbf{T}^{*\mathbf{0}}$ and hence $\{C^0_{i\;i\in L}\}$ and $\{C^{*0}_{i\;i\in L^*}\}$ such that $\{C^0_{i\;i\in L},\mathbf{T^0}\}$ is the equilibrium response to $\mathbf{T}^{*\mathbf{0}}$ and $\{C^{*0}_{i\;i\in L^*},\mathbf{T}^{*\mathbf{0}}\}$ is the equilibrium response to $\mathbf{T^0}$.

Now, let us solve for the Nash equilibrium for sector i.[2]

The best response functions for trade and environmental policies for the home country are given by

$$t=-\frac{X_p}{Kd_q-X_p}\tau-\frac{I_L-\alpha_L}{a+\alpha_L}\frac{X}{Kd_q-X_p}-\frac{M}{Kd_q-X_p}\frac{\phi}{1-\phi}+\frac{K}{Kd_q-X_p}\left\{(1-\theta)E_XX_p-\theta E^*_{X^*}X^*_{p^*}\frac{\phi}{1-\phi}\right\}; \tag{23}$$

and

$$\tau=-\frac{X^*_{p^*}-Kd^*_{q^*}}{X_p}\frac{\sigma}{\sigma-1}t-\frac{I_L-\alpha_L}{a+\alpha_L}\frac{X}{X_p}+\frac{M}{X_p}\frac{\sigma}{\sigma-1}+K\left\{(1-\theta)E_X+\theta\frac{E^*_{X^*}X^*_{p^*}}{X_p}\frac{\sigma}{1-\sigma}\right\}; \tag{24}$$

where $\phi=-\frac{\partial\omega}{\partial t}$ and $\sigma=\frac{\partial\omega}{\partial\tau}$.

Solving for the Nash equilibrium trade and environmental policies in case of complete information [see detailed proof in Appendix A], we get

$$t^o=\frac{1}{\eta^*}-\frac{K\theta E^*_{X^*}X^*_{p^*}}{K^*d^*_{q^*}-X^*_{p^*}}; \tag{25}$$

and

$$\tau^o=-\frac{I_L-\alpha_L}{a+\alpha_L}\frac{X}{X_p}+K(1-\theta)E_X; \tag{26}$$

where $I_L=\begin{cases}0, & \text{if the sector is unorganised}\\ 1, & \text{otherwise;}\end{cases}$

and $\alpha_L=\Sigma_{i\in L}\alpha_i$ denotes the fraction of voters who are members of a lobby group. $\eta^*\equiv\frac{K^*d^*_{q^*}-X^*_{p^*}}{K^*d^*-X^*}$ is the proportional rate of change in foreign imports demand or export supply. $X_p\equiv\frac{\partial X}{\partial p}$ and $X^*_{p^*}\equiv\frac{\partial X^*}{\partial p^*}$capture the price sensitivity of domestic supply and foreign supply, respectively. Notations with an '*' sign represent the foreign counterparts.

Without loss of generality, if the home country is an importer, equilibrium import tariff is inversely related to the proportional rate of change in foreign export supply. This term also relates to the elasticity of foreign export supply. Import tariff is higher when the proportional rate of change of foreign export supply is lower. Import tariff also depends on the change in foreign production and hence, emissions owing to a change in foreign price from an import tariff. Higher levels of global pollution induces domestic governments to raise protection.

Higher levels of import tariff corrects for the negative externality generated by production abroad. This is given by expression (25).

Equilibrium pollution tax, given by expression (26) comprises two components, namely, effects of political support and effects of environmental damage. Organised sectors enjoy an environmental subsidy by peddling political support to the incumbent. The incumbent, however, places weight to general welfare of voters and hence taxes domestic production that reflects total marginal damage. These results mirror the ones obtained by Schleich and Orden (2000) and arrive at the following proposition:

Proposition 2: *The government uses trade policy to exploit the international market power and address the negative externality generated by foreign production. Environmental policies cater to the demand of industry lobbies in exchange of political support and address the negative externality generated by domestic production.*

In the next section, we introduce information asymmetry between the incumbent and lobbies with respect to the benevolence parameter.

2.7 Asymmetric Information

In this section, we consider a situation where political action groups cannot observe the preference of the incumbent government over aggregate social welfare, i.e., the lobby groups do not know precisely how politically inclined the incumbent government is. Such information asymmetries typically arise when the incumbent is newly elected. With its public welfare preferences being private information, the incumbent has an incentive to extract information rents from the lobbies while maximising political welfare. Lobbies, on the other hand, have direct stakes in the public policy (import tariffs/export subsidies) which goes to determine domestic prices and hence rewards to the specific inputs. Unaware of the relative weight attached to aggregate social welfare (benevolence) by the incumbent, lobbies should design offers for campaign funds in such a manner that they ensure truthful revelation of preference by the incumbent. This scenario encapsulates a simple principal-agent problem, where the incumbent government is an agent characterised by hidden type owing to the exclusive private information, and lobbies are principals who find it difficult to comprehend the agent's preference towards social welfare before making campaign contributions. Therefore, it is an adverse selection problem. Notwithstanding the hidden information, lobbies are acquainted with the probability distribution of the type of the incumbent government (in terms of the degree of benevolence). Thus, the probability distribution of the parameter denoting the weight on social welfare is common knowledge which enables them to independently design some incentive schemes or contract for the agent (here the incumbent) and manipulate its behaviour to set trade and environmental policies in a manner consistent with their preferences. The optimal contract design must satisfy two constraints, namely, individual rationality and incentive compatibility. Individual rationality represents the participation constraint for the incumbent government which ensures that it receives at least the reservation utility, i.e., the utility if it did not receive any contribution. In contrast, incentive compatibility ensures that the incumbent government always prefers a contract designed for its true type among the menu of contribution schedules.

2.7.1 A formal analysis

To begin with, we assume that there are $n+1$ perfectly competitive sectors in each country, one being the clean numeraire sector and n polluting non-numeraire sectors that produce traded goods.

Principal-agent problem

Producers in the non-numeraire sector are owners of specific factors and see their income tied to both trade and environmental policies since both the policies directly affect the domestic price of the good. The politically motivated government maximises the following political welfare function

$$G(T(a)) = \Sigma_{i=1}^{n} C_i(T(a)) + aW(T(a)); \tag{27}$$

where $T(a) = (t(a), \tau(a))$ denotes the policy vector.

This is exactly similar to expression (12).

Pure social welfare is compromised as the level of equilibrium tariff rises, which implies that

$$\frac{\partial W(t(a))}{\partial t(a)} < 0; \tag{28}$$

and welfare improves as equilibrium environmental tax rises, i.e.,

$$\frac{\partial W(\tau(a))}{\partial \tau(a)} > 0. \tag{29}$$

Unlike the incumbent government (agent) who has private information about the *benevolence* parameter, a of its payoff function, lobbies (principal) do not possess any such information. Lobbies, however, have a prior knowledge about the distribution of a, which is drawn from $\Upsilon = [0, a^M] \subset \mathbb{R}$ with a cumulative distribution function $F(a)$ and a density function $f(a) > 0$ on $[0, a^M]$, where a^M denotes the strictly positive upper bound of the support of the random variable a. Further, the distribution of a is common knowledge and both parties are risk-neutral. The utility function of the lobby is given by

$$L(T(a)) = V(T(a)) - C(T(a)); \tag{30}$$

where

$$V(T(a)) = l + \Pi(T(a)) + \alpha K[S(\mathbf{T(a)}) + r(\mathbf{T(a)}) + e(\mathbf{T(a)}) - \xi(\mathbf{T(a)})]; \tag{31}$$

and $\mathbf{T(a)}$ is a policy vector for n sectors.

Here, lobbies enjoy only a fraction of the surplus from consumption of non-numeraire goods and government transfers comprising tariff revenue and pollution tax revenue net of environmental damage redistributed in a lumpsum fashion. The incumbent government has to announce its type before campaign funds are offered by the lobby. Like rational economic agents, the government tries to extract positive information rent by understating

the parameter a. Therefore, any incumbent who is less politically inclined mimic a type who is relatively more politically inclined. This ensures more contributions from political action groups. In order that the incumbent participates in the contract and reveals its true preference, the optimal contract design that would maximise the lobby's expected payoff must satisfy the individual rationality constraint and the incentive compatibility constraint of each type.

Let the optimal contract be given by

$$\Psi(a) = \{T^{**}(a), C(T^{**}(a))\}; \tag{32}$$

2.7.2 Stages of the game

The principal-agent game takes places in three stages. In the first stage, lobbies offer an incentive scheme that maps each possible value of the preference parameter, a, to trade and environmental policies, and hence, monetary transfers for electoral campaign. Following this, the incumbent announces its type and accepts the contract. In the second stage, the incumbent chooses the optimal trade and environmental policy. The incumbent does not renege but stays committed to the policy that he/she announces. In the last stage, consumption and production take place and world commodity and individual country labour markets clear.

2.7.3 Equilibrium under asymmetric information

In order to achieve the subgame perfect Bayesian Nash equilibrium, the incentive scheme must meet the participation constraint and be Bayesian incentive compatible (BIC).

The participation constraint is given by

$$G(T(a)) \geq G_0(T(a)); \tag{33}$$

where

$$G_0(T(a)) = aW(T(a)); \tag{34}$$

which implies that the the incentive scheme must guarantee at least the reservation utility, G_0 to the incumbent, i.e., the utility it would receive in case it did not accept the contract and hence earn zero contribution.

The BIC constraint ensures that an incumbent would always prefer a contract designed for its true type. The direct revelation mechanisms $(T(\hat{a}), C(\hat{a}))$ being truthful, we have

$$aW(T(a)) + C(a) \geq aW(T(\hat{a})) + C(T(\hat{a})); \text{ for any } (a, \hat{a}) \in \Upsilon^2; \tag{35}$$

Condition (35) implies

$$aW(T(a)) + C(T(a)) \geq aW(T(a')) + C(T(a')); \tag{36}$$

and

$$a'W(T(a')) + C(T(a')) \geq a'W(T(a)) + C(T(a)); \tag{37}$$

for any pair $(a, a') \in \Upsilon^2$.

Adding expressions (36) and (37), we obtain

$$aW(T(a)) + a'W(T(a')) \geq aW(T(a')) + a'W(T(a));$$

which can be simplified as

$$(a - a')[W(T(a)) - W(T(a'))] \geq 0 \tag{38}$$

Expression (38) shows incentive compatibility requires that the social welfare function $W(T(a))$ must be non-decreasing in a, i.e.,

$$\frac{\partial W(a)}{\partial T(a)} . \frac{\partial T(a)}{\partial a} \geq 0. \tag{39}$$

Using the result from (28), (38) would imply that

$$\frac{\partial t(a)}{\partial a} \leq 0; \tag{40}$$

i.e., $t(a)$ must be non-increasing.

A rise in parameter a indicates a greater weight assigned to aggregate social welfare relative to campaign contributions. This would imply a lower level of trade protection to the organised import competing/exportable sector.

Similarly, using (29) and (38), we get

$$\frac{\partial \tau(a)}{\partial a} \geq 0; \tag{41}$$

i.e., $\tau(a)$ must be non-degreasing.

If the incumbent places more weight to social welfare relative to political contributions, environmental policy becomes more stringent. Conditions (40) and (41) show that $T(a)$ is differentiable almost everywhere.

Now, suppose the incumbent of type a announces $\hat{a}$. The utility function is given by

$$G(T(a, \hat{a})) = aW(T(\hat{a})) + C(T(\hat{a})); \tag{42}$$

where

$$G^{TR}(T(a)) \equiv G(T(a, a)); \tag{43}$$

implies truthful revelation by the incumbent of type a, i.e., $a = \hat{a}$. The first-order condition for optimal response

$\hat{a}$ announced by incumbent of type a is given by

$$G(\dot{T}(a)) = a\frac{\partial W(T(\hat{a}))}{\partial T(\hat{a})}\dot{T} + \frac{\partial C(T(\hat{a}))}{\partial T(\hat{a})}\dot{T} = 0; \tag{44}$$

where, for any variable Z

$$\dot{Z} = \frac{\partial Z}{\partial a}.$$

Since the incentive compatibility constraint implies that truth telling is in the best interest for the principal, the first-order condition (44) must hold for all values of a. Differentiating the utility function of the incumbent in case of truth revelation, we get

$$G(\dot{T}(a)) = W(T(a)) + a\frac{\partial W(T(a))}{\partial T(a)}\dot{T} + \frac{\partial CT((a))}{\partial T(a)}\dot{T} = 0. \tag{45}$$

Using condition (44) for all values of a in condition (45), we obtain

$$G(\dot{T}(a)) = W(T(a)) > 0. \tag{46}$$

The above results can be summarised in the next proposition.

Proposition 3: *For $a \in [0, a^M]$, a pair of differentiable functions $T(\tilde{a})$ and $G(T(\tilde{a}))$ is incentive compatible if and only if*

$$\dot{t}(a) \leq 0;$$

$$\dot{\tau}(a) \geq 0;$$

$$G(\dot{T}(a)) = W(T(a)).$$

In what follows is the exercise of expected utility maximisation by the lobby subject to the individual rationality constraint and the incentive compatibility constraint. The lobby's problem can be stated formally as

$$\underset{\{T(a), C(T(a))\}}{Max} E[V(T(a)) - C(T(a))] \tag{47}$$

subject to

$$\dot{t}(a) \leq 0;$$

$$\dot{\tau}(a) \geq 0;$$

$$G(\dot{T}(a)) = W(T(a));$$

and

$$G(T(a)) \geq G_0(T(a)).$$

The optimisation problem in (47) can be restated by replacing the contribution schedule using the payoff function of the incumbent in expression (27). This enables us to express the lobby i's objective function in terms of the trade and environmental policy, contributions of $(L-1)$ lobbies and the incumbent's information rent.

From (27), we get

$$C(t(a),\tau(a)) = G(t(a),\tau(a))) - \Sigma_{j\neq i, j\in L} C_j(t(a),\tau(a)) - aW(T(a)). \tag{48}$$

Using expressions (31) and (48) in the objective function of the optimisation problem (47) give us

$$\underset{\{T(a),G(T(a))\}}{Max} \int_0^{a^M} \Big[l + \Pi_i(T(a)) + \alpha K\{S(\mathbf{T}(\mathbf{a})) + r(\mathbf{T}(\mathbf{a})) + e(\mathbf{T}(\mathbf{a})) - \xi(\mathbf{T}(\mathbf{a}))\} + aW(T(a)) + \Sigma_{j\neq i, j\in L} C_j(T(a)) - G(T(a)) \Big] f(a) da \tag{49}$$

subject to

$$\dot{t}(a) \leq 0;$$

$$\dot{\tau}(a) \geq 0;$$

$$G(\dot{T}(a)) = W(T(a));$$

and

$$G(T(a)) \geq G_0(T(a)).$$

Solving for $t(a)$ and $\tau(a)$ yields

$$t^I = \frac{1}{\eta^*} - \frac{K\theta E^*_{X^*} X^*_{p^*}}{K^* d^*_{q^*} - X^*_{p^*}}; \tag{50}$$

and

$$\tau^I = -\frac{\psi - \alpha}{a + \alpha - \frac{1-F(a)}{f(a)}} \frac{X}{X_p} + K(1-\theta)E_X; \tag{51}$$

where ψ is an indicator variable that takes a value 1 if the sector is organised, and 0 otherwise.

The optimal trade policy coincides with the result obtained under complete information. The environmental policy, in contrast, has an additional term in the denominator of the first term on the right-hand side, i.e., $\left\{ - \frac{1-F(a)}{f(a)} \right\}$. This term exhibits a distortion owing to asymmetric information over the benevolence parameter a, assuming that the monotone hazard rate property, $\frac{\partial}{\partial a}\left\{ \frac{1-F(a)}{f(a)} \right\} < 0$ holds [see detailed proof in Appendix B].

Now, the ratio

$$\frac{1-F(a)}{f(a)} = \frac{1-F(\Upsilon \leq a)}{f(a)} = \frac{F(\Upsilon > a)}{f(a)}; \tag{52}$$

gives the probability of coming across a more honest politician, conditional upon having found a politician with

a certain degree of preference parameter, say, a. Therefore, the monotone hazard rate property states that this conditional probability is decreasing as the politician becomes more honest.

Expression (50) shows that the equilibrium trade policy is invariant of the distribution of benevolence parameter a. The incumbent chooses an environmental policy to cater to the demands of political action groups (expression (51)). Equilibrium environmental tax at home depends not only on a but also the distribution of a. In comparison to the equilibrium environmental policy under complete information, there seems to be an downward bias for all values of $a < a^M$. For $a = a^M$, the solution coincides with that of complete information, otherwise, there is positive information rent accruing to the policy maker irrespective of their preference over aggregate social welfare. Industry lobbies have to give up a positive information rent to the policy maker in order to induce truth-telling. The optimal contract ensures that contributions are lower for higher values of the benevolence parameter. Consequently, equilibrium environmental tax is lower for all values of the benevolence parameter except the case when $a = a^M$.

Proposition 4: *Under incomplete information:*

(a) the optimal trade policy coincides with that of complete information.

(b) the optimal environmental tax is lower than that of complete information.

Unlike the one-shot principal-agent game, there are possibilities of repeated interaction between lobbies and the policy maker. In case of repeated interactions, lobbies may offer a high powered incentive scheme to the regulator, given that they observe their true preference in the first interaction. This is known as the ratchet effect and it would add to the complexities of the incentive scheme. Such an analysis could be an immediate extension of the above model.

3 Conclusions

Information on the incumbent government's preferences over general welfare of voters may be costly. Ambitious pledges by political parties to woo voters may not necessarily translate into policies as promised. Policy stances would typically depend upon a host of factors including strength of the opposition, citizens' activism, stability of the government, institutions, change of regimes and ideologies. As a result, interest groups need to design incentive schemes to swerve policies that cater to their interests.

The present study shows that incomplete information escalates distortion in environmental policies. In fact, information asymmetries work in favour of both the incumbent government and special interest groups. On the one hand, incumbent governments enjoy positive information rents by hiding their preferences and industry lobbies pay lower environmental taxes. The equilibrium environmental policy, however, mirrors the one obtained under complete information only for the upper bound of the probability distribution of the preference parameter (i.e., the politician is least corrupt). The optimal contract ensures that a highly corrupt policy maker chooses an equilibrium environmental tax that is lower than the one obtained in the complete information model. In addition to political considerations of special interest groups, the equilibrium environmental policy also corrects

for the negative externality from domestic production.

The equilibrium trade policy is invariant of information asymmetries. The incumbent government uses trade policy to exploit world market power and to address the negative production externality from foreign production.

The present analysis can be extended by incorporating repeated interactions between special interest groups and the incumbent government. This would lead to the ratcheting problem.

In sum, the present analysis provides some telling insights on the aspect of trade and environment linkages in the presence of special interest politics and information asymmetries.

Notes

[1]A weighted welfare function for a policy maker is a weighted sum of aggregate social welfare and campaign contributions by special interest groups, where the weights are exogenous.

[2]For simplifying notations, we drop subscript i.

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Appendix A: Complete Information

Equilibrium trade and environmental policy

Proof:

Responses in domestic producer price and consumer price to domestic import tariff and domestic environmental tax are given by

$$p_t = \frac{\partial \omega}{\partial t} + 1; \tag{A1}$$

$$q_t = \frac{\partial \omega}{\partial t} + 1; \tag{A2}$$

$$p_\tau = \frac{\partial \omega}{\partial \tau} - 1; \tag{A3}$$

$$q_\tau = \frac{\partial \omega}{\partial \tau}. \tag{A4}$$

Responses in foreign producer price and consumer price to domestic import tariff and domestic environmental tax are given by

$$p_t^* = \frac{\partial \omega}{\partial t}; \tag{A5}$$

$$q_t^* = \frac{\partial \omega}{\partial t}; \tag{A6}$$

$$p_\tau^* = \frac{\partial \omega}{\partial \tau}; \tag{A7}$$

$$q_\tau^* = \frac{\partial \omega}{\partial \tau}. \tag{A8}$$

Differentiating the world market equilibrium condition with respect to home import tariff and home environmental tax yields,

$$Kd_q q_t - X_p p_t + K^* d^*_{q^*} q_t^* - X^*_{p^*} p_t^* = 0; \tag{A9}$$

and

$$Kd_q q_\tau - X_p p_\tau + K^* d^*_{q^*} q_\tau^* - X^*_{p^*} p_\tau^* = 0; \tag{A10}$$

Using results from (A1)-(A8) in (A9) and (A10) gives

$$\frac{\partial \omega}{\partial t} = -\frac{Kd_q - X_p}{(Kd_q - X_p) + (K^* d^*_{q^*} - X^*_{p^*})} \equiv -\phi; \tag{A11}$$

and

$$\frac{\partial \omega}{\partial \tau} = \frac{X_p}{(Kd_q - X_p) + (K^* d^*_{q^*} - X^*_{p^*})} \equiv \sigma. \tag{A12}$$

Expression (A11) gives the terms of trade effect of a change in domestic trade policy on international price. This effect is negative in case of an import tariff or export subsidy.

Expression (A12) is positive and indicates a reduction in competitiveness of the sector subject to an environmental tax. This also reflects emission leakage owing to a rise in foreign production from a rise in

international price driven by stringent environmental regulations at home.

We now begin computing the marginal effects of a change in trade policy and environmental policy for each component of the political welfare function.

Using results in (A11) in (A9) and (A12) in (A10) gives the following:

$$(Kd_q - X_p)(1-\phi) = (K^* d^*_{q^*} - X^*_{p^*})\phi; \tag{A13}$$

and

$$Kd_q\sigma - X_p(\sigma - 1) = -(K^* d^*_{q^*} - X^*_{p^*})\sigma; \tag{A14}$$

Effect on rents of industry lobbies:

$$\frac{\partial \Pi(t,\tau,\pi)}{\partial t} = X(1-\phi); \tag{A15}$$

$$\frac{\partial \Pi(t,\tau,\pi)}{\partial \tau} = X(\sigma - 1); \tag{A16}$$

Effect on consumer surplus:

$$\frac{\partial S(\boldsymbol{t},\boldsymbol{\tau},\boldsymbol{\pi})}{\partial t} = -Kd(1-\phi); \tag{A17}$$

$$\frac{\partial S(\boldsymbol{t},\boldsymbol{\tau},\boldsymbol{\pi})}{\partial \tau} = -Kd. \tag{A18}$$

Effect on revenue from trade policy:

$$\frac{\partial r(\boldsymbol{t},\boldsymbol{\tau},\boldsymbol{\pi})}{\partial t} = \frac{1}{K}\big[(Kd - X) + t(1-\phi)(Kd_q - X_p)\big]; \tag{A19}$$

$$\frac{\partial r(\boldsymbol{t},\boldsymbol{\tau},\boldsymbol{\pi})}{\partial \tau} = \frac{1}{K}\big[t(Kd_q\sigma - X_p(\sigma-1))\big]. \tag{A20}$$

Effect on revenue from environmental policy:

$$\frac{\partial e(\boldsymbol{t},\boldsymbol{\tau},\boldsymbol{\pi})}{\partial t} = \frac{1}{K}\tau X_p(1-\phi); \tag{A21}$$

$$\frac{\partial e(\boldsymbol{t},\boldsymbol{\tau},\boldsymbol{\pi})}{\partial \tau} = \frac{1}{K}\big[X + \tau X_p(\sigma-1)\big]. \tag{A22}$$

Effect on environmental damage:

$$\frac{\partial \xi(\boldsymbol{t},\boldsymbol{\tau},\boldsymbol{\pi})}{\partial t} = (1-\theta)E_X X_p(1-\phi) - \theta E^*_{X^*} X^*_{p^*}\phi; \tag{A23}$$

$$\frac{\partial \xi(\boldsymbol{t},\boldsymbol{\tau},\boldsymbol{\pi})}{\partial \tau} = (1-\theta)E_X X_p(\sigma-1) + \theta E^*_{X^*} X^*_{p^*}\sigma. \tag{A24}$$

Utilising the expressions (A15)-(A24) in the first-order condition (21) for both trade and environmental

policy yields the best response functions (23) and (24). Solving the two equations simultaneously gives the results (25) and (26).

Appendix B: Incomplete Information

Integrating both sides of expression (46), we get

$$\int_0^a \dot{G}(\tilde{a})d\tilde{a} = \int_0^a W(T(\tilde{a}))d\tilde{a};$$

$$\Rightarrow G(a) - G(0) = \int_0^a W(T(\tilde{a}))d\tilde{a};$$

$$\Rightarrow G(a) = G(0) + \int_0^a W(T(\tilde{a}))d\tilde{a}. \tag{B1}$$

Next, we compute the expected rent of the incumbent to be given up by the lobby.

Differentiating the product of the rent function of the incumbent and the distribution function of a yields

$$\frac{d}{da}\{G(a).F(a)\} = F(a).\dot{G}(a) + G(a).f(a); \quad \text{[using the product rule]} \tag{B2}$$

where

$$\frac{d}{da}F(a) = f(a).$$

Integrating both sides of (B2) over the support of a gives

$$\int_0^{a^M} \frac{d}{da}\{G(a).F(a)\}da = \int_0^{a^M} \dot{G}(a).F(a)da + \int_0^{a^M} G(a).f(a)da;$$

$$\Rightarrow \int_0^{a^M} G(a).f(a)da = G(a).F(a)\Big|_0^{a^M} - \int_0^{a^M} \dot{G}(a).F(a)da;$$

$$\Rightarrow \int_0^{a^M} G(a).f(a)da = G(a^M).F(a^M) - G(0).F(0) - \int_0^{a^M} \dot{G}(a).F(a)da.$$

Since $F(0) = 0$ and $F(a^M) = 1$, we have

$$\int_0^{a^M} G(a).f(a)da = G(a^M) - \int_0^{a^M} \dot{G}(a).F(a)da. \tag{B3}$$

Using the results from (46) and (B1) in (B3) yields

$$\int_0^{a^M} G(a).f(a)da = G(0) + \int_0^{a^M} W(T(a))da - \int_0^{a^M} W(T(a)).F(a)da; \tag{B4}$$

which gives us the expression for the expected rent of the incumbent.

Substituting the above result in (49) in the objective function yields

$$\underset{\{T(a),G(a)\}}{Max}\int_0^{a^M}\Big[\Big\{l+\Pi(T(a))+\alpha K\{S(\mathbf{T(a)})+r(\mathbf{T(a)})+e(\mathbf{T(a)})-\xi(\mathbf{T(a)})\}+aW(T(a)) \\ +\Sigma_{j\neq i,j\in L}C_j(T(a))\Big\}f(a)da-W(T(a))+W(T(a)).F(a)\Big]da-G(0) \tag{B5}$$

Now, considering the second and third terms on the right-hand side of expression (B4) and multiplying both the numerator and denominator with $f(a)$ give us

$$\int_0^{a^M}W(T(a))da-\int_0^{a^M}W(T(a)).F(a)da=\int_0^{a^M}\frac{W(T(a))}{f(a)}f(a)da-\int_0^{a^M}\frac{W(T(a)).F(a)}{f(a)}f(a)da;$$

$$\Rightarrow\int_0^{a^M}W(T(a))da-\int_0^{a^M}W(T(a)).F(a)da=\int_0^{a^M}\left\{\frac{1-F(a)}{f(a)}\right\}W(T(a))f(a)da. \tag{B6}$$

Using the result in (B6) in (B5) simplifies to

$$\underset{\{T(a),G(a)\}}{Max}\int_0^{a^M}\Bigg[\Big\{l+\Pi(T(a))+\alpha K\{S(\mathbf{T(a)})+r(\mathbf{T(a)})+e(\mathbf{T(a)})-\xi(\mathbf{T(a)})\}+aW(T(a)) \\ +\Sigma_{j\neq i,j\in L}C_j(T(a))\Big\}-\left\{\frac{1-F(a)}{f(a)}\right\}W(T(a))\Bigg]f(a)da-G(0) \tag{B7}$$

$$\Rightarrow\underset{\{T(a),G(a)\}}{Max}\int_0^{a^M}\Bigg[\Big\{l+\Pi(T(a))+\alpha K\{S(\mathbf{T(a)})+r(\mathbf{T(a)})+e(\mathbf{T(a)})-\xi(\mathbf{T(a)})\} \\ +\Sigma_{j\neq i,j\in L}C_j(T(a))\Big\}+\left\{a-\frac{1-F(a)}{f(a)}\right\}W(T(a))\Bigg]f(a)da-G(0) \tag{B8}$$

Maximising the objective function in (B8) pointwise gives the result.