

Corruption, Environmental Resources, and International Trade

Priya Ranjan¹ and Baishali Bakshi

University of California, Irvine

Abstract

It is shown how corruption in the management of environmental resources can give rise to a comparative advantage in the environment intensive industries. International trade, in this setting, is not necessarily welfare improving. Welfare implications of an export tax and an import tariff on the environment intensive goods are derived. Import tariffs have the potential of improving the welfare of both the exporter and the importer of the environment intensive good in the presence of corruption. An export tax, on the other hand, increases the world welfare and the welfare of the exporting country, but necessarily reduces the welfare of the importing country.

Keywords: corruption, environment, trade

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¹ Corresponding author, Department of Economics, University of California, Irvine, CA 92697. Phone: (949) 824 1926, Fax: (949) 824 2182. E-mail: pranjan@uci.edu.

1. Introduction

With the increased pace of globalization in the recent decades, the concern about its effects on environment has attracted the interests of environmentalists, economists, and policymakers alike. This has given rise to a burgeoning literature exploring the link between trade and environment². However, this literature has largely ignored the implications of corruption for the link between trade and environment, which is the subject of this paper.

A large number of environmental resources are state property resources³, which means that the governments are responsible for enforcing the access and conservation rules for these resources. However, even when *de jure* property rights are well defined, as in the case of state property resources, *de facto* property rights may not be. The problems arise due to either the inability or the unwillingness of the governments to enforce socially optimal rules for the access and conservation of these resources. For example, many tropical forests are state property, but are over-exploited because encroachment, settlement and illegal logging go unchecked. In many other cases, the governments willingly charge a sub-optimal access fee for the use of resources leading to over-exploitation. There are ample real world examples of corruption in the management of environmental resources⁴. Even though these examples are about the exploitation of forest resources, it is conceivable that similar forces are at play in the

² e.g. Markusen (1976), Pethig (1976), Siebert et al. (1980), McGuire (1982), Chichilnisky (1994), Barbier and Rauscher (1994), Barbier et al. (1995), Copeland and Taylor (1994,1995, 1999), Brander and Taylor (1997a, 1997b, 1998), Hotte, Long, and Tian (2000), Antweiler, Copeland, and Taylor (2001).

³ As opposed to common access and common property resources, which suffer from the standard 'tragedy of commons' problem leading to over-exploitation of resources. See Heltberg (2002) for a nice survey of different property rights regimes regarding natural resources and their consequences.

⁴ According to World Bank (1999) "In many countries, illegal logging is similar in size to legal production. In others, it exceeds legal logging by a substantial margin.... [P]oor governance, corruption and political alliances between parts of the private sector and ruling elites combined with minimal enforcement capacity at regional and local levels, all played a part". According to Bengwayan (1999), "estimates from Indonesia suggest that over 70% of logging in the country is illegal in some way. The Philippines' once sprawling 16 million hectares of virgin forests dominated by hardwoods is now down to only 700,000 hectares. The blame is falling on governments that over the years have passed laws favorable to logging concessions and implemented forest protection poorly. The logging firms circumvented government forestry laws and corrupt local officials enriched themselves." (Source: Michael Bengwayan, Environment News Service, <http://www.ens.lycos.com>). According to the Royal Institute for International Affairs website "It seems likely that at least half of all the logging activities in particularly vulnerable regions- the Amazon basin, Central Africa, Southeast Asia and the Russian Federation- is illegal" (Source: <http://www.illegal-logging.info/Scale.htm>).

management of other environmental resource such as clean air, fresh water etc. which, by their very nature, are state property resources⁵.

Despite the abundance of anecdotal evidence of corruption in the management of environmental resources, a formal analysis of the consequences of corruption for the link between environmental resources and trade has been lacking. This paper constructs a theoretical model to study the implications of corruption in the management of environmental resources for international trade. The model that is developed is particularly applicable to state property resources such as forests or some other government managed environmental resources such as clean air or fresh water.

We embed a model of corruption in a general equilibrium framework with two goods, X and Y , where good X is labor intensive and good Y is environment intensive. Environmental resources can enter as input in the production of good Y in two alternative ways. They can enter as a material input such as forests in the production of lumber. Since forests are a state owned natural resource, the government determines the access fee for using forests. Alternatively, the production of Y can affect an environmental resource such as clean air or water by jointly producing pollution. We model this as pollution entering the production of Y as input and the firms having to pay the government determined pollution tax to use this input.

Corruption as a phenomenon is complex and it is plausible for it to exist and be manifested in more than one form⁶. We provide two alternative models of corruption that we believe capture a wide range of phenomena related to corruption in the management of environmental resources, but by no means are exhaustive. The first type attempts to capture the enforcement problems at regional and local levels even if the top-level government is corruption free. In this case, the top-level government wants to maximize the aggregate social welfare, but lacks the ability (inefficient monitoring) to perfectly enforce socially optimal environmental regulation due to corruption at the lower administrative level. To be precise, the top-level government fixes a socially optimal price for accessing the environmental resource, but the corrupt official at the lower administrative level allows access to environmental resources in

⁵Here is an example of corruption in the management of pollution. In an assessment of India's Pollution Under Control (PUC) system to reduce urban air pollution, a World Bank sponsored study found the system to be ineffectual. It was easy to evade inspection and the risk of being fined for not possessing a PUC sticker was small. Source: http://www.worldbank.org/wbi/cleanair/caiasia/topics/topic_documents/puc_execsum.pdf

⁶ See Bardhan (1997) for an excellent survey of different types of corruption and their implication for development.

exchange for a bribe lower than the official price. The bribe itself is determined by a process of Nash bargaining between the official and the producer who wants access to the environmental resource in question. This way of modeling corruption is similar in spirit to Shleifer and Vishny's (1993) portrayal of the case of 'corruption with theft' where an official extracts a bribe lower than the government price and hides the transaction. As pointed out by Bardhan (1997), this type of corruption is more insidious, difficult to detect, and therefore more persistent than some other forms of corruption because the transaction is mutually beneficial to the official and the producer.

In the second model of corruption, the top-level government itself is prone to bribery from the producers, and formulates sub-optimal environmental regulation, for example, sets a lower than optimal logging fee or pollution tax⁷. Among other things, this also captures the nexus between the ruling elite and the private sector working to the detriment of environment as pointed out in several case studies. The modeling approach that we adopt for this latter type of corruption is similar to the political support function (e.g. Hillman 1989, Van Long and Vousden (1991)) approach in the political economy literature, where governments give higher weight to the welfare of organized interest groups in choosing policies⁸.

In both cases of corruption discussed above, the end result is a sub-optimal effective price of environmental resources, which may take the form of a lower logging fee or pollution tax. This leads to an over-exploitation of environmental resources. It also confers a comparative advantage in the environment intensive products on countries with a greater degree of corruption. This comparative advantage is not based on any differences in preferences, factor endowments or technology. It should be mentioned at the outset that we are not denying the importance of these

⁷ Here is a *possible* real world example of this phenomenon. In 2001, U.S. lumber firms complained against their Canadian rivals that the latter benefited from a hidden subsidy because the Canadian government did not charge enough fees for logging on government lands. The U.S. Commerce Department concluded that the low fees was a subsidy of 19% and hence imposed a Countervailing duty to offset this. The reason why we think this is a *possible* example is because we do not know if the logging fee was sub-optimal. It was the claim of the US lumber lobby, which was vindicated by the US commerce department.

⁸ In a seminal contribution to the political economy literature Grossman and Helpman (1994) formalized what is known as the 'influence driven contributions approach'. In this setting governments care about general welfare as well as contributions (same as bribes in our set up), and the organized interests make political contributions (bribes) in exchange for favorable policies. The policy outcome in this setting is the same as when the objective function that the government maximizes gives higher weight to the welfare of organized interest groups. Therefore, political support function approach can be interpreted as a reduced form of the 'influence driven contributions approach'. For our purposes the details of the 'influence driven contributions approach' are not needed, and therefore, we use the reduced form political support functions approach.

other determinants of trade. Our goal is to neutralize these other determinants to focus on the new issues arising from the consideration of corruption in the management of environmental resources.

International trade in this setting implies that the country having a greater degree of corruption specializes in the environment intensive products. This worsens the problem of over-exploitation of environmental resources in these countries, and therefore, free trade does not guarantee welfare gains. In a North-South context, if corruption exists in both but the degree is higher in the South than in the North, then the gains from trade for the North are higher than the usual gains because trade alleviates the existing distortion in the North by reducing the production of environment intensive products. Looking at trade policy in this context, we show that some types of trade interventions can increase the welfare of both. For example, an import tariff by the North can improve the welfare of both the North and the South. An export tax by the South, on the other hand, increases the world welfare and the welfare of the South, but necessarily reduces the welfare of the North. However, note that any intervention in trade is of a second-best kind because the source of distortion is the corruption in environmental regulation. The first-best policy is to deal with the issue of corruption directly through better institutional design.

From the substantial literature on the relationship between trade and environment referred to earlier, we discuss only those which are more relevant to the subject of our paper. Pethig (1976), Siebert et al. (1980), and McGuire (1982) investigate the effects of pollution policy on the pattern of trade. However, pollution policy in all these models is exogenous. In Copeland and Taylor (1994) pollution policy is endogenous, and the differences in policies arise due to differences in national incomes which in turn derive from differences in the endowment of human capital. We also endogenize pollution policy, but identify corruption as an alternative source of differences in policies across countries. In addition, corruption, in our framework, confers a comparative advantage in the pollution intensive industries on countries with a higher degree of corruption. Since the pollution taxes in Copeland and Taylor (1994) are socially

optimal in both countries, trade is always welfare improving. However, pollution taxes are sub-optimal in our model due to corruption, and hence trade interventions can be welfare improving⁹.

The papers in the literature on trade and natural resources most closely related to our work are Chichilnisky (1994), Brander and Taylor (1997a, 1997b, 1998). In Chichilnisky (1994) the over-exploitation problem arises because natural resource is owned as unregulated common property in the South, and as private property in the North, while in Brander and Taylor (1997b, 1998) it is an open access resource (open access denotes the lack of ownership and control). Open access and common property resources are jointly referred to as the *commons* (or common pool resources), and, therefore, suffer from the 'tragedy of commons' problem alluded to earlier. In contrast, in our paper natural resources are state property, and the problem arises due to corruption. In Brander and Taylor (1997a), resources are nationally owned, but lax resource management in a "consumer" country leads to open access, while strict resource management in a "conservationist" country yields the socially optimal outcome. Therefore, they look at the polar cases of open access and perfectly regulated resources. The interpretation of open access as arising from lax resource management is similar in spirit to the corruption problem in our paper. The valued added in our framework is that we model corruption explicitly, and it is the differences in the degree of corruption (measured by a single parameter) that forms the basis of comparative advantage in our model¹⁰. However, at a deeper level our paper shows the robustness of the insights of Chichilnisky (1994) and Brander and Taylor (1997a, 1997b, 1998) regarding the over-exploitation of common pool resources and their implications for trade to state property resources in the presence of corruption. Therefore, we regard our work as complementary to these earlier papers.

To sum up, our main contribution lies in constructing a theoretical model to bring corruption issues to the forefront of the analysis of environmental resource management and exploring its deeper implications, particularly with respect to international trade.

⁹ See Markusen (1975) for an early discussion of the welfare implications of alternative trade and environmental policies in an economy which produces a pollution intensive good.

¹⁰ It should also be pointed out that unlike the papers by Brander and Taylor which use a dynamic framework, we use a static framework like Chichilnisky (1994). This is done mainly for analytical tractability since we are embedding a model of corruption in a general equilibrium framework. This also allows a dual interpretation of our framework as a model of pollution regulation as well as natural resource regulation.

The rest of the paper is organized as follows. In section 2 we set up the baseline model and derive the autarky equilibrium in the first-best case of no corruption. In section 3 we embed the two alternative models of corruption in the baseline model and show how a higher degree of corruption can give rise to comparative advantage in the environment intensive goods. In section 4 we discuss the welfare implications of international trade, and various trade policy instruments. Section 5 presents concluding remarks.

2. The Model

We assume that each country produces two final goods, X and Y . X is also chosen as the numeraire in the model implying that the price of X , denoted by p_X equals 1. The relative price of Y is denoted by p_Y . The utility function of each agent from the consumption of the two goods is given by

$$U(X, Y) = BX^{1-h}Y^h, B > 0, 0 < h < 1, U_X, U_Y > 0, U_{XX}, U_{YY} < 0 \quad (1)$$

Denote the income of an agent by I_i . Now the budget constraint of each agent is given by

$$I_i = p_Y Y + X \quad (2)$$

The utility maximization of individuals yields the following relative demand function for Y .

$$(Y^D / X^D) = \frac{h}{(1-h)p_Y} \quad (3)$$

The indirect utility function of an agent can be written as

$$V(p_Y, I_i) = Bh^h(1-h)^{1-h} \frac{I_i}{p_Y^h} \quad (4)$$

The above implies that for a given p_Y the utility of each agent is linear in income.

Good X is produced using labor only. The total amount of labor available in the economy is \bar{L} . We assume a constant returns to scale production function for X given by

$$X = cL_X, c > 0 \quad (5)$$

where L_X is the amount of labor employed to produce X . This also implies that the wage rate, w , equals c as long as some X is produced in the economy.

The number of entrepreneurs with the technology to produce good Y is N . Good Y is produced using labor and an environmental input. If the environmental input is a state owned natural resource such as forest, then the producers of good Y need to procure a license for a certain tract of forest. Alternatively, if the environmental input is pollution, then the producers

of good Y need to obtain pollution permits from the government¹¹. Denote the price of license for a tract of forest or of pollution permit by p_L . With the pollution permit interpretation, p_L is same as a pollution tax. Denote the number of licenses or the number of pollution permits procured by an individual producer by n .

We assume a diminishing returns-to-scale production function for Y in the two inputs: labor, l_Y , and the number of licenses or pollution permits, n .

$$Y_i = Al_Y^a n^b, A > 0, a, b > 0, (a + b) < 1 \quad (6)$$

where Y_i is the output produced by the i^{th} producer. The entrepreneur undertaking Y production is the residual claimant. The reason for introducing a hidden factor of production, entrepreneur, has to do with the modeling of corruption. The entrepreneur, as a residual claimant, will have an incentive to bargain with the officials for a lower license price (or pollution permit price) in the corrupt official case, and to influence the government to charge a lower license price (or permit price) in the top-level corruption case. (To conserve space, hereafter we will talk about p_L as the license price and n as the number of licenses. It should be understood that they also stand for pollution permit price or pollution tax, and the number of permits, respectively)

The market for Y is competitive, which means that each Y producer solves the following maximization problem.

$$\mathbf{p}(p_Y, p_L) = \underset{l_Y, n}{\text{Max}} \quad p_Y Al_Y^a n^b - cl_Y - p_L n \quad (7)$$

The solution to the above problem is given by

$$n(p_Y, p_L) = \mathbf{g} p_Y^{\frac{1}{1-a-b}} p_L^{-\frac{1-a}{1-a-b}}; \quad l_Y(p_Y, p_L) = \frac{\mathbf{a}}{\mathbf{b}c} \mathbf{g} p_Y^{\frac{1}{1-a-b}} p_L^{-\frac{b}{1-a-b}} \quad (8)$$

where $\mathbf{g} \equiv \{Aa^a c^{-a} b^{1-a}\}^{\frac{1}{1-a-b}}$. Next, using the optimal values of n and l_Y from equation (8) into the profit function in (7), we get the following expression for the profit function.

¹¹ Using pollution as an input in production is not uncommon in the literature. See, for example, Pethig (1976), Siebert et al. (1980), McGuire (1982), and Copeland and Taylor (1994).

$$\mathbf{p}(p_Y, p_L) = \frac{1-a-b}{b} n(p_Y, p_L) p_L = \frac{1-a-b}{b} \mathbf{g} p_Y^{\frac{1}{1-a-b}} p_L^{-\frac{b}{1-a-b}} \quad (9)$$

Denote the supply of Y by an individual producer by Y_i^S . Next, using Hotelling's lemma we obtain the following results.

$$\frac{\partial \mathbf{p}(p_Y, p_L)}{\partial p_Y} \equiv Y_i^S(p_Y, p_L) = \frac{\mathbf{g}}{b} p_Y^{\frac{a+b}{1-a-b}} p_L^{-\frac{b}{1-a-b}}; \quad \frac{\partial \mathbf{p}(p_Y, p_L)}{\partial p_L} = -n(p_Y, p_L) \quad (10)$$

Since there are N identical Y producers, the total supply of Y , denoted by Y^S , can be written as:

$$Y^S = N Y_i^S(p_Y, p_L) = N \frac{\mathbf{g}}{b} p_Y^{\frac{a+b}{1-a-b}} p_L^{-\frac{b}{1-a-b}} \quad (11)$$

2.1 Autarky equilibrium in the first-best case

We assume that the government maximizes social welfare comprising the aggregated indirect utility of individuals in the economy and a quadratic disutility from depleting environmental resources. Therefore, the aggregate social welfare can be written as

$$SWF = \frac{T}{p_Y^h} \{c\bar{L} + N\mathbf{p}(p_Y, p_L) + N p_L n(p_Y, p_L)\} - c_1 \{N n(p_Y, p_L)\}^2 \quad (12)$$

where $T = B\mathbf{h}^h(1-\mathbf{h})^{1-h}$, $0 < \mathbf{h} < 1$. $I \equiv c\bar{L} + N\mathbf{p}(p_Y, p_L) + N p_L n(p_Y, p_L)$, is the national income, where $N p_L n(p_Y, p_L)$ is the revenue generated from the sale of forest licenses, which is given back to the consumers in a lump sum fashion. The last term in (12) is the disutility from the depletion of natural resources or pollution. In our static framework, the disutility from the depletion of environmental resources is a way to capture the conservation issue in a simplified manner¹².

Using the expression for $\mathbf{p}(p_Y, p_L)$ from equation (9) the above expression for welfare can be simplified as

$$SWF = \frac{T}{p_Y^h} \left\{ c\bar{L} + \frac{(1-a)}{1-a-b} N\mathbf{p}(p_Y, p_L) \right\} - c_1 \{N n(p_Y, p_L)\}^2 \quad (13)$$

We assume that the government treats p_Y as given while choosing p_L . In the open economy case this will imply that governments do not use environmental policy to manipulate their terms of

¹² The form of disutility from the depletion of environmental resources is similar to that used by Copeland and Taylor (1994) for disutility from pollution.

trade. Maximizing (13) with respect to the license price, p_L , and using the expression for $n(p_Y, p_L)$ derived in equation (8) we obtain the first-best optimal license price as follows.

$$p_L^* = \left\{ \frac{2Nc\mathbf{g}}{T} \right\}^{\frac{1-a-b}{2(1-a)-b}} p_Y^{\frac{1+h(1-a-b)}{2(1-a)-b}} \quad (14)$$

Define \mathbf{e}_{p_L, p_Y} as the elasticity of p_L^* with respect to p_Y . From (14) $\mathbf{e}_{p_L, p_Y} \equiv \frac{1+h(1-a-b)}{2(1-a)-b}$. Using the optimal value of p_L in equation (11) we get the following supply curve for Y .

$$Y^S = N \frac{\mathbf{g}}{\mathbf{b}} \left\{ \frac{2Nc\mathbf{g}}{T} \right\}^{\frac{-b}{2(1-a)-b}} p_Y^{\frac{(a+b)-b\mathbf{e}_{p_L, p_Y}}{1-a-b}} \quad (15)$$

Since $(a+b) - b\mathbf{e}_{p_L, p_Y} > 0$, the above implies that supply of Y is increasing in the price of Y .

As the total amount of labor available in the economy is fixed at \bar{L} , the amount of labor that can be used for X production can be determined by using (8) as

$$L_X = \bar{L} - Nl_Y = \bar{L} - N \frac{\mathbf{a}\mathbf{g}}{\mathbf{b}\mathbf{c}} \left\{ \frac{2Nc\mathbf{g}}{T} \right\}^{\frac{-b}{2(1-a)-b}} p_Y^{\frac{1-b\mathbf{e}_{p_L, p_Y}}{1-a-b}} \quad (16)$$

Since $1 - b\mathbf{e}_{p_L, p_Y} > 0$, an increase in p_Y implies an increase in the amount of labor used in Y production, and hence L_X must fall, which implies a fall in X^S . Therefore, the relative supply of Y with respect to X , (Y^S / X^S) , is increasing in p_Y . Since we have already established that the relative demand for Y is decreasing in p_Y , we get a unique equilibrium in autarky.

Next we show how corruption can give rise to comparative advantage in Y .

3. Autarky Equilibrium in the Corruption Case

3.1 Corruption at lower administrative level

In this case, the Y producers obtain the licenses from local government officials. These officials are opportunistic and they try to maximize their utility. The officials can make money by selling the licenses at a lower than the government administered price and hiding the transaction from the top-level government. However, they run the risk of getting caught with some probability q , which depends on the monitoring efficiency of the government. The officials bargain with Y producers to transact at a bribe, b , strictly less than the government determined license fee, p_L . If the official transacts at p_L , he earns no surplus. However, if the official is caught taking a bribe, the official has to pay the correct license fee, p_L , to the

government¹³. Hence the bargaining surplus of the official from transacting at the bribe price, b , given that he sells n_i licenses to the i^{th} Y producer, is

$$(b - \mathbf{q} p_L) n_i \quad (17)$$

The official's participation in the bargaining process, requires this surplus to be positive, implying $b > \mathbf{q} p_L$. Denote the profit of the Y producer by \mathbf{p}_{p_L} if he buys licenses at p_L , and by \mathbf{p}_b , if he buys them at b . We assume that the producer can always get the license at the official price, and therefore \mathbf{p}_{p_L} becomes his reservation payoff. Now, to participate in the bargaining, the Y producer needs a positive bargaining surplus, i.e., $\mathbf{p}_b - \mathbf{p}_{p_L} > 0$.

Assume that the Y producer and the official engage in Nash bargaining. Also, for simplicity, assume that the bargaining situation is symmetric with Y producers and officials having equal bargaining power. In this case the Nash bargaining solution requires splitting the surplus from bargaining equally between the two parties, which implies the following¹⁴.

$$\mathbf{p}_b - \mathbf{p}_{p_L} = (b - \mathbf{q} p_L) n_i \quad (18)$$

Equation (18) determines the value of the bribe b , which, in turn, depends on \mathbf{q} and p_L . Using equation (9) the bargaining surplus of the forest producer in equation (18) becomes

$$\mathbf{p}_b - \mathbf{p}_{p_L} = \frac{1 - \mathbf{a} - \mathbf{b}}{\mathbf{b}} \mathbf{g} p_Y^{\frac{1}{1 - \mathbf{a} - \mathbf{b}}} \left(b^{-\frac{\mathbf{b}}{1 - \mathbf{a} - \mathbf{b}}} - p_L^{-\frac{\mathbf{b}}{1 - \mathbf{a} - \mathbf{b}}} \right) \quad (19)$$

The corresponding surplus for the official becomes

$$\mathbf{g} (b - \mathbf{q} p_L) \left(\frac{p_Y}{b^{1 - \mathbf{a}}} \right)^{\frac{1}{1 - \mathbf{a} - \mathbf{b}}} \quad (20)$$

Equating the Nash bargaining surpluses (19) and (20), we obtain

$$b^{\frac{1 - \mathbf{a}}{1 - \mathbf{a} - \mathbf{b}}} + \left(\frac{\mathbf{a} + 2\mathbf{b} - 1}{1 - \mathbf{a} - \mathbf{b}} \right) p_L^{\frac{\mathbf{b}}{1 - \mathbf{a} - \mathbf{b}}} b - \frac{\mathbf{b}}{1 - \mathbf{a} - \mathbf{b}} \mathbf{q} p_L^{\frac{1 - \mathbf{a}}{1 - \mathbf{a} - \mathbf{b}}} = 0 \quad (21)$$

Equation (21) determines the optimal value of b as a function of p_L and \mathbf{q} . We can write the solution to (21) as the following implicit function.

¹³ To make it more realistic, we can introduce a penalty of $F > 0$, if the official is caught taking a bribe. We have normalized F to zero for algebraic simplicity. $F > 0$ does not change the qualitative results in the paper.

$$b = g(\mathbf{q}, p_L) \quad (22)$$

It can be shown from (21) that $\frac{\partial b}{\partial \mathbf{q}} > 0$ and $\frac{\partial b}{\partial p_L} > 0$. Therefore, the greater the monitoring efficiency, \mathbf{q} , the higher the effective license fee, b , for a given p_L . Since \mathbf{q} captures the degree of corruption in our model, we have established that the effective license fee is closer to the administered license fee the less the corruption.

In the special case when $\mathbf{a} + 2\mathbf{b} = 1$, the solution to (21) can be written as

$$b = \mathbf{q}^{\frac{1-\mathbf{a}-\mathbf{b}}{1-\mathbf{a}}} p_L \quad (23)$$

Since $\mathbf{q} < 1$, the above implies that $b < p_L$. Moreover, $\mathbf{a} + \mathbf{b} < 1$ also implies $b > \mathbf{q} p_L$.

So far we have established that in the presence of corruption, the effective license fee is going to be less than the actual license fee determined by the government. However, this does not automatically yield an inefficient outcome. In principle, if the top-level government has perfect information about the workings of corruption at the lower level and the effective license price evolving from it, it can adjust the chosen license price to negate the effect of corruption. Thus, instead of setting the administered license fee at p_L^* , it would set it at some p_L^C , such that the resulting effective license fee, b , equals the first-best license fee.

$$b = g(\mathbf{q}, p_L^C) = p_L^* \quad (24)$$

It is obvious that the social welfare in this case is equivalent to that resulting in the first-best case of no corruption, and there is no effective distortion in the economy. Corruption only has a redistributive effect in that some of the revenue from the licenses goes to corrupt officials instead of the government. We will rule out this possibility by simply assuming that the top-level government does not have information about the workings of corruption downstream. This is not completely unrealistic because in most developing countries, often the flow of information is limited between different levels of government. More realistically, governments may be either unwilling or unable to do anything about the corruption downstream for any number of reasons.

¹⁴ Strictly speaking, given the indirect utility function in equation (4), the utility of each agent will be their income multiplied by a constant which is a function of p_Y . Since the same constant appears on both sides of the equation below, we do not write it explicitly.

Therefore, we assume that the government maximizes the social welfare given by equation (13) to choose the first-best license price p_L^* given by (14). However, due to corruption, the effective license fee in the economy is

$$b = g(\mathbf{q}, p_L^*) \quad (25)$$

Therefore, the supply of Y in this case is

$$Y^S = N \frac{\mathbf{g}}{\mathbf{b}} p_Y^{\frac{\mathbf{a}+\mathbf{b}}{1-\mathbf{a}-\mathbf{b}}} b^{\frac{\mathbf{b}}{1-\mathbf{a}-\mathbf{b}}} \quad (26)$$

Denote the elasticity of b with respect to p_L by \mathbf{e}_{b,p_L} . Now, (26) implies that the sign of

$\frac{dY^S}{dp_Y}$ depends on the sign of $\mathbf{a} + \mathbf{b}(1 - \mathbf{e}_{b,p_L} \mathbf{e}_{p_L,p_Y})$. As noted in the first-best case,

$\mathbf{a} + \mathbf{b}(1 - \mathbf{e}_{p_L,p_Y}) > 0$, therefore, a sufficient condition for $\frac{dY^S}{dp_Y} > 0$ is $\mathbf{e}_{b,p_L} \leq 1$. This is always true

when $\mathbf{a} + 2\mathbf{b} = 1$, because as discussed earlier, in this case $b = \mathbf{q}^{\frac{1-\mathbf{a}-\mathbf{b}}{1-\mathbf{a}}} p_L \Rightarrow \mathbf{e}_{b,p_L} = 1$. In the more general case we assume that parameters satisfy¹⁵

Assumption 1 : $\mathbf{a} + \mathbf{b}(1 - \mathbf{e}_{b,p_L} \mathbf{e}_{p_L,p_Y}) > 0$.

Next, going through the same steps as in the first-best case it can be shown that the relative supply of Y is increasing in p_Y in this case as well.

To see how a lower \mathbf{q} can give rise to a comparative advantage in Y production, note that for each p_Y the government chosen license fee, p_L^* , given in (14) is independent of \mathbf{q} . The corresponding b is given by (25) above. Since b is increasing in \mathbf{q} , for each p_Y a lower \mathbf{q} implies a lower b and hence a greater relative supply of Y . Therefore, the country with a lower \mathbf{q} has a comparative advantage in good Y , which is the environment intensive product.

3.2 Corruption at top level

Now we discuss the case when the Y producers can bribe the top-level government itself into charging a sub-optimal license fee. The bribe may take the form of gift-giving by lobbyists to politicians, campaign contributions to Political Action Committees, or post-retirement jobs in

¹⁵ Numerical simulations confirm that this condition is easily satisfied for reasonable values of $\mathbf{a}, \mathbf{b}, \mathbf{q}$.

private firms to bureaucrats of agencies dealing with the management of environmental resources. To formalize this in our context, we assume, following the political support function approach, that the government attaches a weight of $(1 + \mathbf{d})$ to the welfare of the Y producers and a weight of one for other members, where $\mathbf{d} > 0$. Thus, while choosing the license fee, p_L , the government maximizes the following welfare function.

$$SWF = \frac{T}{p_Y^h} \left\{ c\bar{L} + (1 + \mathbf{d})N\mathbf{p}(p_Y, p_L) + Np_L n(p_Y, p_L) \right\} - c_1 \{ Nn(p_Y, p_L) \}^2 \quad (27)$$

Using the expression for $\mathbf{p}(p_Y, p_L)$ from equation (9), the above can be written as

$$SWF = \frac{T}{p_Y^h} \left\{ c\bar{L} + \frac{(1 - \mathbf{a}) + \mathbf{d}(1 - \mathbf{a} - \mathbf{b})}{1 - \mathbf{a} - \mathbf{b}} N\mathbf{p}(p_Y, p_L) \right\} - c_1 \{ Nn(p_Y, p_L) \}^2 \quad (28)$$

Setting the partial derivative of the above with respect to p_L to zero we obtain the optimal license price in the top-level corruption case as follows.

$$p_L^l = \left\{ \frac{2Nc_1 \mathbf{g}}{TE} \right\}^{\frac{1 - \mathbf{a} - \mathbf{b}}{2(1 - \mathbf{a}) - \mathbf{b}}} p_Y^{\frac{1 + \mathbf{h}(1 - \mathbf{a} - \mathbf{b})}{2(1 - \mathbf{a}) - \mathbf{b}}}; \text{ where } E = 1 + \mathbf{d} \left(\frac{1 - \mathbf{a} - \mathbf{b}}{1 - \mathbf{a}} \right) \quad (29)$$

Comparing the above license price with the first-best (no corruption) license price, it is easy to see that $p_L^l < p_L^*$, since $\mathbf{d} > 0$.

To see how greater corruption of this form can give rise to a comparative advantage in the production of Y , assume that $\mathbf{d}_S > \mathbf{d}_N$, that is the government in the South is more prone to influence by the organized interest groups. Now, it is easy to see from (29) that $\frac{\partial p_L^l}{\partial \mathbf{d}} < 0$, which along with $\mathbf{d}_S > \mathbf{d}_N$ implies that for each p_Y the licensing fee in the South is going to be lower than the licensing fee in the North. Thus, at each p_Y the relative supply of Y will be higher in the South, implying a comparative advantage for the South in the environment intensive product.

Therefore, we have established that both types of corruption lead to under-pricing of environmental resources. Furthermore, corruption of either type can give rise to comparative advantage in the production of environment intensive products. Next, we next analyze the welfare implications of trade based on corruption.

4. Implications of International Trade

4.1 Welfare impact of trade

Since the comparative advantage in our model is based on corruption, which is a kind of distortion, and not on the differences in preferences, endowments, or technology, the standard gains from trade results do not hold in this case. To see the impact of trade on welfare in the case of lower administrative level corruption, write the true social welfare as follows.

$$SWF_A = \frac{T}{p_Y^h} \left\{ c\bar{L} + \frac{(1-\mathbf{a})}{1-\mathbf{a}-\mathbf{b}} N\mathbf{p}(p_Y, b) \right\} - c_1 \{Nn(p_Y, b)\}^2 \quad (30)$$

where $b = g(\mathbf{q}, p_L^*)$ as given in (25)¹⁶. The impact of trade on welfare can be captured by a change in p_Y as follows.

$$\frac{d(SWF_A)}{dp_Y} = \frac{\partial(SWF_A)}{\partial p_Y} + \frac{\partial(SWF_A)}{\partial b} \frac{db}{dp_L^*} \frac{dp_L^*}{dp_Y} \quad (31)$$

It is shown in the appendix that

$$\frac{d(SWF_A)}{dp_Y} = \frac{T}{p_Y^h} (Y^S - Y^D) - \left[\frac{2c_1 N \mathbf{b} Y^S}{(1-\mathbf{a}-\mathbf{b})} \right] \left[1 - (1-\mathbf{a}) \mathbf{e}_{b, p_L} \mathbf{e}_{p_L, p_Y} \right] \left[\frac{n(p_Y, b)}{b} - \frac{n(p_Y, p_L^*)}{p_L^*} \right] \quad (32)$$

where Y^S is the supply of Y and Y^D is the demand for Y . For an exporter of Y international trade causes an increase in p_Y . Since $Y^S > Y^D$ for an exporter, the first term above captures the standard gains from trade. The sign of the second term on the r.h.s of (32), which consists of 3 bracketed terms is determined as follows. The first bracketed term is always positive. The second bracketed term captures the feedback effect of a change in p_Y on the domestic distortion. It can be easily verified $(1-\mathbf{a}) \mathbf{e}_{p_L, p_Y} < 1$, which implies that a sufficient condition for the second bracketed term to be positive is $\mathbf{e}_{b, p_L} \leq 1$. Even if $\mathbf{e}_{b, p_L} > 1$, under the parametric restriction summarized in assumption1, which is a sufficient condition for the relative supply curve to be upward sloping, the second bracketed term is positive. The third bracketed term captures the interaction of trade with the existing distortion in the economy due to corruption. Since $p_L > b$ in

¹⁶ Recall that while choosing p_L the government maximizes the social welfare given in (13). The difference in the two welfare expressions comes from the fact that the government ignores or is unaware of the corruption downstream as we assumed earlier. Therefore, while the true welfare is a function of the effective license price b , the welfare that the government maximizes is a function of the government chosen license price p_L . As well, due to corruption the government gets only $\mathbf{q}n(p_Y, b)b$ of the license revenue, while the rest ($= (1-\mathbf{q})n(p_Y, b)b$) is kept by the corrupt officials. In writing the social welfare in (30) we use $n(p_Y, b)b$ as the total revenue generated from licenses.

the case of corruption, it can be easily verified that this term is positive. This captures the fact that international trade worsens the over-exploitation problem in the country that exports the environment intensive good. Therefore, the second term on the r.h.s of (32) is positive. This implies that the impact of an increase in p_Y on the welfare of the exporter of Y is ambiguous in the presence of corruption. In a first-best world, the second bracketed term on the r.h.s of (32) is zero because $p_L = b$, and hence the gains from trade are guaranteed.

Looking at the country importing Y , note that since $Y^S < Y^D$, the first term on the r.h.s. of (32) is negative. If the importing country is distorted, then the second term is positive; otherwise the second term is zero. Therefore, for an importer of Y , $\frac{d(SWF_A)}{dp_Y} < 0$. Since p_Y decreases after opening up to trade in the country importing Y , the welfare gains from trade are guaranteed whether the importing country is distorted or not. If a country importing Y is distorted due to corruption, then in addition to the usual gains from trade, it also benefits from the alleviation of domestic distortion.

In the case of top-level corruption, a similar result obtains. The true social welfare in this case is

$$SWF_{A'} = \frac{T}{p_Y^h} \left\{ c\bar{L} + \frac{(1-\mathbf{a})}{1-\mathbf{a}-\mathbf{b}} N\mathbf{p}(p_Y, p_L^l) \right\} - c_1 \{ Nn(p_Y, p_L^l) \}^2 \quad (33)$$

where p_L^l is given by (29). It is shown in the appendix that the change in welfare in this case with respect to a change in p_Y is

$$\frac{d(SWF_{A'})}{dp_Y} = \frac{T}{p_Y^h} (Y^S - Y^D) - \frac{dT}{p_Y^h} \mathbf{b}Y^S \left[\frac{1}{1-\mathbf{a}} - \frac{1+\mathbf{h}(1-\mathbf{a}-\mathbf{b})}{2(1-\mathbf{a}-\mathbf{b})} \right] \quad (34)$$

It is easy to see that the bracketed expression on the r.h.s of (34) is positive for $\mathbf{a} + \mathbf{b} < 1$. Therefore, the impact of trade on the welfare of the country exporting Y is ambiguous, while the country importing Y unambiguously gains.

Next we show how some types of interventions in trade can increase welfare in this setting.

4.2 Impact of trade policy

We look at the implications of an export tax and an import tariff in both the small country case and the 2-country case. We assume that the South has a comparative advantage in the environment intensive good, Y , due to a higher degree of corruption. We look at two alternative

cases for the North: I) When the North is in a first-best world; II) When the North is also distorted, but less than the South (either $q_S < q_N$ or $d_S > d_N$).

Let the price of Y be p_Y^* in the North in a trading equilibrium. Now, if the South imposes an export tax of t , then the domestic price in the South is given by $p_Y = p_Y^* - t$.

Starting from a free trade situation, we want to find out the impact of an export tax, t , on welfare. The true social welfare in the South in the case of lower level corruption can be written as

$$SWF_T = \frac{T}{p_Y^h} \left\{ c\bar{L} + \frac{(1-a)}{1-a-b} Np(p_Y, b) + (p_Y^* - p_Y)EX \right\} - c_1 \{ Nn(p_Y, b) \}^2 \quad (35)$$

where EX is the amount exported. We assume that the export tax revenue is given back to the consumers in a lump sum fashion.

It is shown in the appendix that the change in welfare with respect to an export tax can be written as

$$\frac{d(SWF_T)}{dt} = \frac{T}{p_Y^h} EX \frac{dp_Y^*}{dt} - \left[\frac{2c_1 N b Y^S}{(1-a-b)} \right] \left[1 - (1-a) e_{b, p_L} e_{p_L, p_Y} \right] \left[\frac{n(p_Y, b)}{b} - \frac{n(p_Y, p_L^*)}{p_L^*} \right] \frac{dp_Y}{dt} \quad (36)$$

If the South is a small open economy, then $\frac{dp_Y^*}{dt} = 0$, by definition. Therefore, $\frac{dp_Y}{dt} = -1$, and hence an export tax is necessarily welfare improving. In the two-country case, an export tax imposed by the South is going to reduce the world price p_Y^* . But, the exact magnitude the reduction in the world price depends on the parameters. We assume that parameters are such that $\frac{dp_Y^*}{dt} < 1$, which implies that $\frac{dp_Y}{dt} < 0$ ¹⁷. Therefore, starting from a free trade situation, a small export tax unambiguously increases the welfare in the South.

A similar result obtains when corruption is present at the top level. The welfare in this case is given by

¹⁷ (If $\frac{dp_Y^*}{dt} > 1$, then we get the perverse result that an export tax raises the domestic price of the exportable good in the country imposing it.)

$$SWF_{T'} = \frac{T}{p_Y^h} \left\{ c\bar{L} + \frac{(1-a)}{1-a-b} N\mathbf{p}(p_Y, p_L') + (p_Y^* - p_Y)EX \right\} - c_1 \{ Nn(p_Y, p_L') \}^2 \quad (37)$$

It is shown in the appendix that the change in welfare with respect to an export tax is given by

$$\frac{d(SWF_{T'})}{dt} = \frac{T}{p_Y^h} EX \frac{dp_Y^*}{dt} - \frac{dT}{p_Y^h} \mathbf{b}Y^S \left[\frac{1}{1-a} - \frac{1+h(1-a-b)}{2(1-a-b)} \right] \frac{dp_Y}{dt} \quad (38)$$

Therefore, the impact of an export tax on welfare is qualitatively similar to that in the case of lower level corruption discussed above.

Using a similar analysis, we can also show that if a country with corruption in the management of environmental resources is an importer of the environment intensive good, then imposing a tariff reduces the welfare of the small importing country by exacerbating the distortion caused by corruption. This happens because the tariff raises the domestic price of the environment intensive good, leading to an increased exploitation of environmental resources, which were over-exploited to begin with. For a large importer, the impact on welfare is ambiguous because the negative effect arising from the worsening of distortion has to be balanced against the positive terms of trade effect. The algebra for the welfare implications of tariffs for an importer is very similar to that of an export tax for an exporter derived above, and hence is not reported to conserve space.

Based on the discussion above, we can summarize the possible results for the two-country case as follows, depending on whether the North is distorted or not.

Case I: Distorted South, Undistorted North

Impact of an export tax by the South

The welfare in the South increases unambiguously. The North suffers a standard terms of trade loss, and hence a decrease in welfare. The world welfare increases because of the alleviation of distortion in the South; the terms of trade effects wash out in aggregate.

Impact of an import tariff by the North

In this case, the North experiences welfare gains coming from the positive terms of trade effect. Since the world price of the environment intensive good decreases, the South experiences a terms of trade loss. However, the problem of over-exploitation of resources is reduced in the South due to a decrease in the domestic price of the environment intensive good in the South. Therefore, the net impact on the South is ambiguous. If the distortion in the South is sufficiently strong (large \mathbf{d} or small \mathbf{q}), then the welfare increases in the South. Therefore, it is possible for

an import tariff by the North to be Pareto improving. Also, as in the previous case, an increase in the world welfare is guaranteed because of the alleviation of distortion in the South.

Case II: Distorted South and distorted North

Impact of an export tax by the South

In this case the terms of trade worsens in the North as discussed earlier. In addition, an increase in the domestic price of the environment intensive good in the North worsens the distortion arising from corruption. Therefore, the welfare in the North decreases unambiguously. Since the welfare in the South increases unambiguously, the impact on the world welfare is ambiguous. Since the distortion is greater in the South, the world welfare is likely to increase.

Impact of an import tariff by the North

This improves the terms of trade in the North, however, by increasing the domestic price of the environment intensive good, it also worsens the existing distortion in the North. Therefore, the net impact on the North is ambiguous. As discussed earlier, the impact on the South is ambiguous as well.

Since the distortion in our model arises from corruption in government, it may seem preposterous to suggest another policy, like an export tax, to alleviate the problem. However, it should be recognized that in many cases local or regional governments are responsible for environmental regulation, while it is the central government that is responsible for trade policy. In this setting, an honest central government may resort to a trade policy instrument like an export tax to offset the damaging effects of corruption at lower administrative levels in the management of environmental resources. It should also be pointed out that in a two country setting the import competing sector in the importing country may rally in support of an export tax, making it politically feasible in international negotiations¹⁸.

Before ending the discussion of trade policy it should be noted that we should be very careful in deriving any policy conclusions from the above results. The trade intervention results above

¹⁸For example, in the US-Canada lumber dispute, the U.S. lumber lobby is "seriously considering" a quota system proposal by Ottawa to help end the cross-border softwood war that would see Canada collect a three-tiered export tax on shipments that exceed 17 billion board feet a year to the United States. Ottawa's offer is premised on the calculation that Canada exports about 19 billion board feet a year, and this quota lowers the bar by about 10 per cent. Source: News from the Globe and Mail, May 30, 2003, by Steven Chase and Peter http://www.globeandmail.com/servlet/ArticleNews/TPStory/LAC/20030530/RSOFT_3/Business/Idx

arise from the fact that the only source of difference between countries in our model is the degree of corruption. By design, we have neutralized all other differences (in endowments, technology, or preferences) which could be a legitimate basis for trade. In the presence of these other differences, the welfare implications of trade interventions are going to be different. As well, the reason why welfare gains from trade are not guaranteed in our setting is because of the existence of a domestic distortion. Therefore, the first-best policy is to deal with corruption directly. Any trade intervention can only be a second-best policy.

Impact of trade on environmental standards

We can use this model to study the impact of trade on environmental standards. From equation (29) it should be clear that the effective license fee is increasing in p_Y . Also, in autarky the environmental standards are higher in the North than in the South. Since trade increases p_Y in the South and decreases it in the North, it raises the environmental standards in the South and reduces it in the North. Therefore, there is a convergence in environmental standards consequent upon trade. However, as long as $d_S > d_N$ the convergence is not complete. That is, the environmental standards remain higher in the North even in the post-trade equilibrium.

4. Concluding Remarks

This paper constructs a theoretical model to formalize the link between corruption and over-exploitation of environmental resources, and explores its implications for international trade. In doing so, it puts forth corruption as an additional source of differences in environmental standards or regulations across countries, as well as a source of comparative advantage. The paper provides two alternative models of corruption with similar implications for resource use and trade. The purpose of providing two different models was to show the robustness of our results to more than one form of corruption. However, the policies required to deal with different types of corruption may be very different. The first type of corruption, where corruption lies at lower levels while the top-level government is honest, may be relatively easier to deal with. In this case, better monitoring technology or enforcement mechanism can potentially solve the problem. The second type of corruption, where the top-level government itself is prone to influence seeking by the private sector either through bribes or through political contributions, is much harder to deal with. As pointed out by Bardhan (1997), this type of

corruption may not even be illegal in most societies. Therefore, it needs better institutional design to shield the government from influence seeking by the private sector.

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Appendix: Welfare impact of trade

Corruption at Lower Level

Using (30) $\frac{\partial(SWF_A)}{\partial p_Y}$ can be written as

$$\frac{\partial(SWF_A)}{\partial p_Y} = \frac{T}{p_Y^h} \left[\frac{1-a}{1-a-b} Y^S - Y^D \right] - \frac{2c_1(Nn(p_Y, b))^2}{(1-a-b)p_Y} \quad (39)$$

where $Y^D \equiv \frac{hI}{p_Y}$. The above can be written as

$$\frac{\partial(SWF_A)}{\partial p_Y} = \frac{T}{p_Y^h} (Y^S - Y^D) + \frac{T}{p_Y^h} \frac{b}{1-a-b} Y^S - \frac{2c_1(Nn(p_Y, b))^2}{(1-a-b)p_Y} \quad (40)$$

Next, using (30) $\frac{\partial(SWF_A)}{\partial b}$ can be written as

$$\frac{\partial(SWF_A)}{\partial b} = -\frac{T}{p_Y^h} \frac{1-a}{1-a-b} Nn + \frac{2c_1(1-a)(Nn(p_Y, b))^2}{(1-a-b)b} \quad (41)$$

Using (40) and (41) and substituting Y^S for $\frac{Nn(p_Y, b)b}{b p_Y}$ we obtain

$$\frac{d(SWF_A)}{dp_Y} = \frac{T}{p_Y^h} [Y^S - Y^D] - \left[\frac{bY^S}{(1-a-b)} \right] \left[1 - (1-a) \frac{p_Y}{b} \frac{db}{dp_L^*} \frac{dp_L^*}{dp_Y} \right] \left[\frac{2c_1 Nn(p_Y, b)}{b} - \frac{T}{p_Y^h} \right] \quad (42)$$

From the analysis of autarky we know that the govt. chooses p_L to maximize the welfare in (13), which implies that p_L^* satisfies the following equation

$$\frac{T}{p_Y^h} = \frac{2c_1 Nn(p_Y, p_L^*)}{p_L^*} \quad (43)$$

Using (43) in (42) we obtain equation (32) in the text.

Impact of export tax

We can write $\frac{\partial(SWF_A)}{\partial p_Y}$ as

$$SWF_T = SWF_A + \frac{T}{p_Y^h} (p_Y^* - p_Y) EX \quad (44)$$

Where SWF_A is as defined in (30). Now, we can write the change in welfare with respect to an export tax as follows.

$$\frac{d(SWF_T)}{dt} = \frac{\partial SWF_A}{\partial p_Y} \frac{dp_Y}{dt} + \frac{\partial SWF_A}{\partial b} \frac{db}{dp_L^*} \frac{dp_L^*}{dp_Y} \frac{dp_Y}{dt} + \frac{T}{p_Y^h} EX + t \frac{dEX}{dt} \quad (45)$$

Since $\frac{dp_Y}{dt} = \frac{dp_Y^*}{dt} - 1$, using (40) $\frac{\partial SWF_A}{\partial p_Y} \frac{dp_Y}{dt} + \frac{T}{p_Y^h} EX$ in (45) can be written as

$$\frac{T}{p_Y^h} EX \frac{dp_Y^*}{dt} + \left[\frac{T}{p_Y^h} \frac{\mathbf{b}}{1-\mathbf{a}-\mathbf{b}} Y^S - \frac{2c_1(Nn(p_Y, b))^2}{(1-\mathbf{a}-\mathbf{b})p_Y} \right] \frac{dp_Y}{dt} \quad (46)$$

Now, using (41), (43), (46) and setting $t=0$, the change in welfare with respect to an export tax can be written as

$$\frac{d(SWF)}{dt} = \frac{T}{p_Y^h} EX \frac{dp_Y^*}{dt} - \left[\frac{2c_1 N \mathbf{b} Y^S}{(1-\mathbf{a}-\mathbf{b})} \right] \left[1 - (1-\mathbf{a}) \mathbf{e}_{b, p_L} \mathbf{e}_{p_L, p_Y} \right] \left[\frac{n(p_Y, b)}{b} - \frac{n(p_Y, p_L^*)}{p_L^*} \right] \frac{dp_Y}{dt} \quad (47)$$

Corruption at top level

The change welfare with respect to a change in can be written as

$$\frac{d(SWF_{A'})}{dp_Y} = \frac{\partial(SWF_{A'})}{\partial p_Y} + \frac{\partial(SWF_{A'})}{\partial p_L^l} \frac{dp_L^l}{dp_Y} \quad (48)$$

The first term on the r.h.s. of (48) can be written as

$$\frac{\partial(SWF_{A'})}{\partial p_Y} = \frac{T}{p_Y^h} [Y^S - Y^D] + \left[\frac{T}{p_Y^h} \frac{\mathbf{b}}{1-\mathbf{a}-\mathbf{b}} Y^S - \frac{2c_1(Nn(p_Y, p_L^l))^2}{(1-\mathbf{a}-\mathbf{b})p_Y} \right] \quad (49)$$

Similarly,

$$\frac{\partial(SWF_{A'})}{\partial p_L^l} = -\frac{T}{p_Y^h} \frac{1-\mathbf{a}}{1-\mathbf{a}-\mathbf{b}} Nn + \frac{2c_1(1-\mathbf{a})(Nn(p_Y, p_L^l))^2}{(1-\mathbf{a}-\mathbf{b})p_L^l} \quad (50)$$

However, the welfare that the government maximizes, while choosing p_L is given by

$$SWF_{A'} + \mathbf{d} \frac{T}{p_Y^h} N \mathbf{p}(p_Y, p_L) \quad (51)$$

The above implies that p_L^l satisfies

$$\frac{\partial(SWF_{A'})}{\partial p_L} = \frac{T}{p_Y^h} \mathbf{d} N n(p_Y, p_L) \quad (52)$$

where $\frac{\partial(SWF_{A'})}{\partial p_L}$ is given by (50). Now, using (49), (50), and (52), the change in welfare with

respect to change in p_Y can be written as

$$\frac{d(SWF_{A'})}{dp_Y} = \frac{T}{p_Y^h} [Y^S - Y^D] - \frac{\mathbf{d} T}{p_Y^h} \mathbf{b} Y^S \left[\frac{1}{1-\mathbf{a}} - \mathbf{e}_{p_L, p_Y} \right] \quad (53)$$

Finally, from the equation determining p_L^l in the lobbying case given in (29) e_{p_L, p_Y} simply equals

$$\frac{1+h(1-a-b)}{2(1-a-b)}. \text{ Using this expression for } e_{p_L, p_Y} \text{ in (53) we obtain equation (34) in the}$$

text.

Impact of export tax

Using (33), (37) can be written as

$$SWF_{T'} = SWF_{A'} + \frac{T}{p_Y^h} (p_Y^* - p_Y) EX \quad (54)$$

The change in welfare with respect to an export tax is

$$\frac{d(SWF_{T'})}{dt} = \frac{\partial(SWF_{A'})}{\partial p_Y} \frac{dp_Y}{dt} + \frac{\partial(SWF_{A'})}{\partial p_L^l} \frac{dp_L^l}{dp_Y} \frac{dp_Y}{dt} + \frac{T}{p_Y^h} EX + t \frac{dEX}{dt} \quad (55)$$

Following the same steps as in the lower level corruption case, we can write

$$\frac{\partial(SWF_{A'})}{\partial p_Y} \frac{dp_Y}{dt} + \frac{T}{p_Y^h} EX = \frac{T}{p_Y^h} EX \frac{dp_Y^*}{dt} + \left[\frac{T}{p_Y^h} \frac{\mathbf{b}}{1-a-b} Y^S - \frac{2c_1(Nn(p_Y, p_L^l))^2}{(1-a-b)p_Y} \right] \frac{dp_Y}{dt} \quad (56)$$

While choosing optimal p_L , the government maximizes

$$SWF_{A'} + \mathbf{d} \frac{T}{p_Y^h} N\mathbf{p}(p_Y, p_L) + \frac{T}{p_Y^h} tEX \quad (57)$$

We assume that the government takes the trade policy as given, while choosing optimal p_L . Further, since we are going to evaluate welfare change at $t=0$, the maximization of (57) with respect to p_L is identical to the maximization of (51) with respect to p_L . Therefore, (50) and (52) are valid in this case as well. Using (50), (52), (56), and setting $t=0$, the r.h.s. of (55) can be written as equation (38) in the text.