Southern Export of Dirty "Variety" and Optimality of

Environmental Standards: Case of Consumption Pollution

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Abstract

This paper examines the optimality of environmental standards that are often observed to be imposed by the importing North on exporting South. In the context of goods di¤erentiated in terms of environmental quality and the degree of consumption pollution they generate, consumers' willingness-to-pay varying with such quality and being di¤erent across di¤erent income groups, we show that : (1) competitive environmental qualities are sub-optimal; (2) environmental-quality dependent consumption tax is the ...rst-best policy; and (3) when South has a cost advantage in dirty varieties, the second-best policy for North is to lower minimum environmental standard from the autarchic level of minimum standard.

Key Words : Environmental quality choice; consumption pollution; environmental standard.

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1 Introduction

With the growing concern over environmental impacts of production and trading activities, the North-South trade relation has got renewed attention from the economists, environmentalists as well as from men-in-practice. Spatial separation of dirty and clean industries across the South and the North, on the one hand, and comparative advantage of Southern countries in dirty goods and ecological dumping, on the other hand, are at the core of such concerns. These concerns have motivated the importing countries to impose environmental standards on such exports coming from the developing countries. The ISO 14000 series certi...cates are typical examples.

With the proliferation of such environmental standards, one might wonder whether these physical regulations on product standards are optimal for the importing country under consideration. After all, these standards restrict trade and accordingly robs o¤ the gains to be had from consuming the good from a cheaper source. Indeed there are gains from such regulations as it may entail less environmental damages (that of course depends upon the particular approach to de...ne such damages), but it is not clear a priori whether these are su¢ cient to outweigh the losses from restricted trade thereby making the regime Pareto-superior to free trade. Thus, the use of environmental standards against export of dirty goods (or varieties) by South

is not a self-enforcing proposition as it may entail larger welfare losses for the importing North.

One might argue, however, that production of dirty goods is distortionary and thus free trade is not necessarily welfare improving under such circumstances. Moreover, such activities may have an adverse impact of dirty goods on the productivity of other sectors [Copeland and Taylor (1999)]. But these arguments are valid when we look at the production and welfare of the exporting South. To use the production externality argument, that holds the centre-stage in the large body of literature on trade and environment, to justify imposition of environmental standards by the North where the dirty good is imported and consumed, we need a much broader perspective. For example, if exports of dirty goods by India increases production and hence environmental degradation there, one might wonder why the importing country, say US, should be concerned with such imports from India and would like to impose environmental standards?

There may be two plausible answers. First is the concern for the global environment itself. That is, to quote Maler (1992), "there are non-physical relations that arise because individuals in importing country may be concerned with environmental resources in the exporting country". Second, and more important, is the transboundary pollution e¤ects exempli…ed by upstream polluting countries and downstream su¤ering countries. But when

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such non-physical relations are absent and transnational damages are negligible either due to the nature of the emission or due to the fact that the exporting and importing countries in question are geographically far apart, concerns against import of dirty goods are hard to justify in terms of production externality[1]. The US imposition of ISO 14000 series regulations on Indian exports is one such example that needs a more plausible explanation.

Such concerns are, however, immediate once we focus on environmental degradation through consumption rather than production. Examples of such damages through consumption and the related issue of consumption externality are overwhelming. Cigarette smoking, auto-emissions are typical examples. This calls for shifting the focus from production-pollution to the consumption-pollution and the relative demand for goods having more and less pollution emissions through consumption. That is, the environmental-quality of the goods is what we have to take into account instead of the conventional approach of pollution-intensity of goods from the production side if we wish to examine optimality of environmental regulation by the importing North concerned primarily with its own national welfare

This is the primary concern of this paper. We examine the welfare im-

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[1]Certainly the countries can be hurt by such trade [Copeland and Taylor (1999)], but essentially this amounts to non-convexities of the production set as a consequence of environmental degradation. There are cases, however, when both trading partners gain and the use of environmental standards by one country in such cases is even harder to justify.

plications of environmental regulations for the Northern country that is imposing the regulation in a situation where goods generate pollution when they are consumed. Given the consumption pollution and consequent consumption externality, an appeal to the theory of distortion pioneered by Bhagwati and Srinivasan (1963) and Johnson (1965) indicates that a consumption tax is an optimal intervention. We then show that no uniform equivalent minimum environmental standard on the Northern producers exists. That is, uniform environmental standards are only second-best under autarchy and the particular level of such minimum standard depends on the income distribution pattern. But the optimum rate of consumption tax and its equivalent level of second-best environmental standard di¤er under free trade from those under autarchy. Consequently, the physical environmental regulation that was in force before trade liberalization is not even the second-best. Moreover, depending on the extent of cost advantage of South in producing dirty varieties, this may even be Pareto-inferior to free trade. The second-best environmental regulation in such a case calls for a lower minimum environmental standard on Southern exports of dirty varieties.

At this point, it is instructive to distinguish our analyses from the earlier analyses of Krutilla (1991) and Ulph (1992). Krutilla compares optimal consumption (production) tax with standard Pigouvian tax when the regulatory country is a net exporter and when it is net importer of the good generating

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the negative consumption (production) externality. His focus has been on the terms-of-trade e¤ect of the environmental taxes. On the other hand, primary concern of Ulph is to examine the choice between environmental standards and taxes as policy instruments of the two national governments who use these instruments strategically to their respective national advantages. But with production as the source of pollution, he shows that countries when acting strategically will prefer to use standards rather than taxes for same level of pollution. This falls short of an analysis that compares optimal policies.

Whereas our concern of Pareto-superiority of environmental standards to free trade is quite di¤erent, the analytical structure that we use to address this issue further di¤erentiates our analyses from those existing in the literature on trade and environment. The good under consideration is assumed to have di¤erent environmental quality levels permissible by the present state of technology with the degree of consumption of pollution varying with such quality levels. Thus, even with constant level of consumption (or production), environmental damages may be higher when environmental quality is lower. The good is then called to be of dirtier variety. The particular variety of the good, i.e., its environmental quality level, at equilibrium is, however, a choice variable for the ...rms. Consumers' willingness to pay varies with the particular environmental quality of the good and this in‡uences the ...rms' choice of the quality level from amongst the technologically feasible set. How-

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ever, given the consumer heterogeneity that reflects income disparity within the North, in equilibrium both dirty and clean varieties may be offered. This provides the basis for environmental-quality dependent taxes and standards to attain Pareto-optimal outcome.

The rest of the paper is organized as follows. In section 2 we develop a model of choice of environmental quality in North under autarchy given income disparities and consequent consumer heterogeneity. The modeling of the demand side draws heavily from models of vertical product differentiation [Acharyya (1998), Shaked and Sutton (1982) and Tirole (1989)]. We show that market outcome is sub-optimal due to the consumption-pollution and optimal environmental quality can be achieved through quality-dependent consumption tax or equivalent environmental-quality regulation. Section 3 examines welfare implications of trade liberalization by the North when Southern ...rms have (comparative) cost advantage in dirty varieties. It also derives the main results regarding (sub-) optimality of environmental regulation. Finally, we provide some concluding remarks in section 4.

2   A Model of North

We use the demand-approach developed elsewhere [Acharyya (2000)] to model the North. Consider a good X that has different environmental quality levels

indexed by $A \in [0, \overline{A}]$: The environmental quality is measured by the environmental damages through consumption of the good in terms of pollution emission, say. A higher value of A means that the good inflicts upon the society a smaller amount of pollution emission. There is, however, a limit to the highest environmental quality permissible by the present state of technology that is indicated by $\overline{A}$. The characterization of preference and cost structures are as follows.

2.1 Preference Structure

Consider two types of Northern consumers de...ned by their income levels $\mu_L < \mu_H$. Let n_i be the number of consumers with income μ_i. Each consumer buys, if at all, only one unit of the good. Note that by this assumption we rule out any congestion e¤ect which is of course for analytical convenience. Total demand for the good is, therefore, zero (when none buys the good), n_i (when only income-group i buys) or $n_L + n_H$ (when all buy the good).

Let $\circledR$ denote the taste parameter and without any loss of generality we assume,

$$\circledR = \circledR(\mu) \; ; \; \circledR_\mu > 0 \qquad (1)$$

The building bloc of this demand-approach is that consumers must care for the environmental quality and accordingly must be willing to pay di¤erent

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prices for goods of di¤erent environmental qualities. We also assume that consumers can judge the environmental quality of the good (i.e., the degree of environmental damages it causes) before actual consumption. Otherwise there would arise the problem of informational externality such as in markets for lemons. Of course, consumers might still fail to fully internalize the social cost of consuming the good and consequently we have the standard consumption externality problem where private and social willingness to pay di¤er.

The net utility that a typical μ_i-consumer enjoys from consuming the good of environmental quality A is[2],

$$U = u\,[^{®}\,(\mu_i)\,;A]\;\text{i}\;p;\quad u\,(^{®};0) > 0;\; u_A > 0;\; u_{AA}\quad 0;\; u_{A®} > 0 \qquad (2)$$

This is assumed to be continuous in A and p. The partial derivatives imply that the marginal utility of or marginal willingness to pay for the good of quality A (which in this case is also the marginal rate of substitution between price and quality) is positive and non-decreasing in A. Note that $u_{A®}$ captures the change in the marginal willingness to pay as taste ($^{®}$) changes and this

[2]This preference structure is commonly speci...ed in models of vertical product di¤er-entiation. See Acharyya (1998) and Tirole (1989), for example.

relationship is expected to be positive.

In addition, the preference function is assumed to have the following desirable properties for all $A \in [0, \bar{A}]$:

$$u\left[\theta(\mu_H) ; A\right] > u\left[\theta(\mu_L) ; A\right] \tag{2a}$$

$$u_A\left[\theta(\mu_H) ; A\right] > u_A\left[\theta(\mu_L) ; A\right] \tag{2b}$$

These essentially imply a positive association between total and marginal utilities of quality across the income groups in North. That is, the high-income consumers of North derive greater total as well as marginal utility and accordingly are willing to pay higher price than the low-income consumers.

A typical consumer with income μ_i buys the good only if it derives non-negative (net) utility from it,

$$u\left[\theta(\mu_i) ; A\right] \geq p \qquad \forall A \in [0, \bar{A}] \tag{3}$$

This is the individual-rationality (IR) constraint or the market-participation rule. Of course, we assume that the consumer derives zero utility from holding his money income and in case he is indifferent between buying and not buying (when strict equality in (3) holds), the tie-breaking rule is that he buys the good.

On the other hand, μ_i-consumers purchase the good of any environmental quality A_i at price p_i instead of A_j at price p_j if it satis...es their self-selection (SS) constraint :

$$u\,[^{\circledR}(\mu_i);A_i] \; ¡ \; p_i \; \lrcorner \; u\,[^{\circledR}(\mu_i);A_j] \; ¡ \; p_j \tag{4}$$

Tie-breaking rule is that in case of equality in (4), A_i is purchased if $A_i > A_j$:

In addition we assume that,

$$\mu_i \; \lrcorner \; u^{\pounds \circledR}(\mu_i);\overline{A}^{\natural} \quad 8\,i \tag{5}$$

That is, (all) consumers can a¤ord to pay for the good of highest environmental quality[3]. There is, thus, no purchasing power constraint. This is the standard practice in the existing literature on choice of quality of conventional goods.

The preference structure de...ned in (2) and the IR constraint (3) imply that the indi¤erence curves between price and environmental quality is positively sloped and concave in $(A;p)$-space with lower curve indicating higher (net) utility. An important property of this preference structure is that the

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[3] It need not be assumed that this is the only good that the individuals consume. There may be other conventional goods. All we need is the additively independent utility functions with constant proportion of money income being spent by each individual on this conventional goods and the non-conventional, quality-di¤erentiated good. This is the standard assumption used in the literature on vertically-di¤erentiated (conventional) goods.

corresponding indifference curves are vertically parallel, i.e., have same slope

for any given environmental quality, A :

$$\mu \frac{dp}{dA} \P_{\overline{U}} = u_A[\circledR(\mu_i);A] \tag{6}$$

This has far reaching implications as we will see later.

2.2 Cost structure

Suppose there is no ...xed cost of production and the marginal cost of the

good is invariant with respect to output level (x) but varies positively with

the environmental quality :

$$C^N (x;A) = c^N (A) x; \quad c_A^N > 0; \; c_{AA}^N > 0 \tag{7}$$

However, convexity of the cost curve, $c_{AA}^N > 0$, is not su¢cient to ensure

an interior solution, i.e., $A < \overline{A}$ in a perfectly competitive (or monopolistic)

market. Given the restrictions on u_A and c_A, the necessary condition for this

is,

$$c_A^N(\overline{A}) > u_A \pounds \circledR(\mu_H);\overline{A}^{\pi} \tag{7a}$$

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Thus the cost curve must be sufficiently convex. Given $c_A^N (0) < u_A [\circledR (\mu_i) ; 0]$[4];

$c_{AA}^N > 0$ as defined in (6), and (2a), this condition ensures that,

$$c_A^N (A_i) = u_A [\circledR (\mu_i) ; A_i] \quad \text{for some } A_i < \overline{A} \qquad (8)$$

2.3 Choice of environmental quality in North : Autarchy

2.3.1 Unregulated Competitive Choices

Consider perfectly competitive ...rms choosing environmental quality levels given the preference and cost structures as de...ned above. Let A_{iC} be the quality level o=ered to the $\mu_i$consumers. Such competitive solution must satisfy following two marginal conditions :

$$p_{iC} = c^N(A_{iC}) \qquad (9)$$

$$u_A [\circledR (\mu_i) ; A_{iC}] = c_A^N(A_{iC}) \qquad (10)$$

The ...rst condition is the standard zero-pro...t condition that requires marginal cost (MC) of production equals the price of the good for any given environmental quality. The second condition is the marginal-quality condition requiring the MC of quality is equal to the marginal revenue (MR) from

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[4]With c_{AA} ˳ 0; to ensure that producing any environmental quality is feasible, we need to assume $c_A (0) < u_A [\circledR (\mu) ; A]$.

quality variation. Given (2a) and the restrictions on the cost function, it is immediate that,

$$A_{LC} < A_{HC} < \overline{A} \tag{11}$$

The competitive solution is illustrated in Figure 1. The corresponding welfare levels attained by the Northern consumers are indicated by the indi¤erence curves l^0l^0 and h^0h^0 respectively for the representative consumers of μ_L and μ_H income groups. Formally, denoting these private gains by B;

$$B^a = n_1 fu [® (\mu_L); A_{Lc}] \text{ i } c^N (A_{Lc})g + n_2 fu [® (\mu_H); A_{HC}] \text{ i } c^N (A_{HC})g \tag{12}$$

2.3.2 Regulation and Optimality

The competitive environmental quality levels in general will not be the optimal qualities. Typical of any externality problem, the consumers will not internalize the social cost associated with the consumption pollution that the good generates and accordingly private and social valuations of the good di¤er[5]. That is, u [® (\mu_i); A] de…ned in (2) does not indicate the bene…t

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[5]This has no con‡ict with our earlier assumption that consumers correctly perceive the environmental quality of the good by which we mean that there is no misperception about the private bene…t from consuming the good.

that the society derives from consuming (one unit of) the good of quality A.

Since there is no a priori reason to believe why the high-income Northern con-

sumers will internalize the social cost partially or fully even though they may

have entirely di¤erent valuation of private bene...t they derive as indicated in

(2b), we can expect divergence between social and private bene...ts from (or

willingness-to-pay for) the good to be same across di¤erent income levels[6].

However, it is reasonable to assume that such divergence is smaller higher is

the environmental quality of the good. Formally, if $^-$ denotes the social cost

due to consumption pollution that is not internalized by the consumers, the

following speci...cation seems reasonable :

$$^- = {^-}(A) \; ; \quad {^-}_A(A) < 0; \quad {^-}_{AA}(A) < 0 \tag{13a}$$

$$^- {}^{i}\!\!\frac{^c}{A} = 0; \quad {^-}(A) > 0 \quad 8 \, 0 < A < \overline{A} \tag{13b}$$

In Figure 2, $a_i^a a_i$ re‡ects society's maximum willingness to pay for di¤er-

ent environmental qualities for income level μ_i. $^-(A)$ measures the vertical

di¤erence between this curve and the IR constraint of the typical consumer.

Given such de...nitions, we can write the following proposition :

Proposition 1 :

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[6]Our results will hold even if such divergences vary with the income levels. But the algebra will become a bit cumbersome.

Competitive environmental qualities are : i) sub-optimal, ii) lower than the optimum.

Proof :

For the ...rst part we note that the socially optimum menu $(p_i^\pi; A_i^\pi)$ is the one along the cost curve for which the total surplus from catering the μ_i-consumers $W_i = (u [^\circledR (\mu_i); A] \; ¡ \; c(A) \; ¡ \; ^-(A))$ is maximum: That is,

$$u_A [^\circledR (\mu_i); A_i^\pi] \; ¡ \; ^-_A (A_i^\pi) = c_A(A_i^\pi) \tag{14a}$$

$$p_i^\pi = c(A_i^\pi) \tag{14b}$$

Suppose, the competitive quality maximizes W_i, i.e., $A_{iC} = A_i^\pi$: Thus, $c_A(A_{iC}) = c_A(A_i^\pi)$ and $u_A [^\circledR (\mu_i); A_{iC}] = u_A [^\circledR (\mu_i); A_i^\pi]$: Consequently, by (10) and (14a) this should mean, $^-_A(A_i^\pi) = 0$: But this contradicts (13a). Hence, $A_{iC} = A_i^\pi$; i.e., competitive quality is sub-optimal.

On the other hand, for the second part, evaluating the change in social welfare (W_i) at A_{iC} we observe,

$$\mu \frac{dW_i}{dA} \P_{A=A_{iC}} = u_A [^\circledR (\mu_i); A_{iC}] \; ¡ \; c_A(A_{iC}) \; ¡ \; ^-_A(A_{iC})$$
$$= \; ¡ \; ^-_A(A_{iC}) > 0 \quad \text{[using (10) and (13a)]}$$

Therefore, $A_i^c > A_{iC}$. ¤

Corollary 1 : A (per unit) quality-dependent consumption tax, z, designed to make private bene...ts (net of taxes) equal to social bene...t,

$$z = {}^-(A) \quad 8 A 2 \; \frac{\textsterling}{0;} \; \overline{A}^{\text{¤}} \tag{15}$$

is the optimal policy.

The optimal policy is one that helps attain the social optimum and from the celebrated works of Bhagwati and Srinivasan (1963) and Johnson (1965) on the theory of distortion it is immediate that a consumption tax will be the ...rst-best policy to correct for the consumption distortion (pollution). In terms of Figure 2, the consumption tax de...ned in (15) makes $a_i^{\text{¤}} a_i$ the IR constraint (net of taxes) for the typical consumer because now he purchases the good only if,

$$u[{}^{\circledR}(\mu_i); A] \; {}_i \; {}^-(A) \; {}_, \; p$$

Accordingly, the ...rms raise the environmental quality o¤ering $A_i^{\text{¤}}$. The marginal condition (10) now should be rewritten as,

$$u_A[{}^{\circledR}(\mu_i); A_i^{\text{¤}}] = c_A^N(A_i^{\text{¤}}) + {}^-_A(A_i^{\text{¤}}) \tag{16}$$

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If instead of this price restriction a physical restriction such as environmental standard is imposed, will it be Pareto-optimal? The answer is affirmative only if we can construct consumption-tax equivalent environmental standards. Since $A_L^n = A_{HC}$, this requires consumption-tax equivalent discriminatory minimum environmental standards. But uniform minimum environmental standard is what we typically observe in most countries imposing such standards. Unfortunately, no such uniform standard exists that is ...rst-best. In particular,

Proposition 2 :

There is no (uniform) environmental standard that is Pareto-optimal.

Proof. Let us denote the minimum environmental standard as $\bar{A}$. We ...rst consider the set of consumption-tax equivalent standards. Suppose the environmental quality that producers would oøer to the μ_L-consumers under the consumption tax, A_L^n, is alternatively set as the minimum standard. Thus the producers must now choose A from the set $\bar{A} = \left[A_L^n ; \bar{A} \right]$.

Consider ...rst the μ_L-consumers. Let $A_E \in \left[A_L^n ; \bar{A} \right]$ be the environmental quality oøered to them. Thus, the (total) private bene...t derived is,

$$B_L^E = n_L f u^{\left[\circledR (\mu_L) ; A_L^{E^n} \right]} i \, c^N \, i \, A_L^{E^{\circledcirc}} g$$

Social bene...t is, however, smaller :

$$W_L^E = n_L f u^{\mathbf{£}}{}_{\circledR} (\mu_L) ; A_L^{E^{\text{π}}} \text{ } i \text{ } c^N \text{ } {}^i A_L^{E^{\mathbf{¢}}} \text{ } i \text{ } - {}^i A_L^{E^{\mathbf{¢}}} g \qquad (17)$$

But competitive forces ensure that at equilibrium the minimum standard, $A_L^{\text{π}}$, will be o¤ered :

$$A_L^E = A_L^{\text{π}} \qquad (18)$$

Because since $A_L^{\text{π}} > A_{LC}$ where A_{LC} is the solution of (10), given the curvature properties in (7) and (7a) it is immediate that,

$$u [{}_{\circledR} (\mu_L) ; A] \text{ } i \text{ } c^N (A) < u [{}_{\circledR} (\mu_L) ; A_L^{\text{π}}] \text{ } i \text{ } c^N (A_L^{\text{π}}) \quad 8 A > A_L^{\text{π}}$$

Note, given the marginal cost pricing, this inequality states that consumers will purchase $A_L^{\text{π}}$ even if $A > A_L^{\text{π}}$ is available. Thus, any ...rm o¤ering an environmental quality higher than the minimum standard will have zero demand for its good. All these imply that W_L^E in (17) is what we achieve for the μ_L-consumers under Pareto-optimal consumption tax.

On the other hand, since the minimum environmental standard $Å = A_L^{\text{π}} < A_H^{\text{π}}$, it is sub-optimal for the high-income μ_H-consumers. Hence, the environmental standard requiring $A > A_L^{\text{π}}$ is not ...rst-best.

Similar logic shows that the minimum environmental standard requiring

$A > A_H^n$ is also not optimal. It is needless to check for other environmental standards simply because those cannot help us attain the maximum welfare level even for one set of consumers unlike these two consumption-tax equivalent standards.

Hence the claim. ∎

Note that the above result does not depend on whether A_L^n is greater than or less than A_{HC}. However, for analytical simplicity, we will assume hereafter that $A_L^n = A_{HC}$. Relaxing this assumption does not alter our results derived below qualitatively.

What follows from the Proposition 2 is that there does not exist any uniform consumption-tax equivalent minimum environmental standard that is Pareto-optimal. If the Northern government can discriminate between diꭣerent income groups and set separate minimum standards for producers catering them, the Pareto-optimal outcome can be attained. But that is not what we typically observe. Moreover, such discriminatory standards may require too much of information for the government. It may instead be easier to implement the consumption tax. Since uniform minimum standards are more often observed, it is important to know which of the two consumption-tax equivalent environmental standards is the second-best. This depends on the income distribution pattern as captured here by the ratio $\frac{n_L}{n_H}$: In particular,

Proposition 3 :

When the ...rst-best consumption-tax equivalent discriminatory environmental standards cannot be set, setting the smaller of the two (i.e., A_L^n) as the minimum standard for the domestic producers is second-best if,

$$\frac{n_L}{n_H} > \frac{fu[^{\circledR}(\mu_H); A_H^n] \, \dot{\imath} \, c^N (A_H^n) \, \dot{\imath}^{-}(A_H^n)g \, \dot{\imath} \, fu[^{\circledR}(\mu_H); A_{HC}] \, \dot{\imath} \, c^N (A_{HC}) \, \dot{\imath}^{-}(A_{HC})g}{fu[^{\circledR}(\mu_L); A_L^n] \, \dot{\imath} \, c^N (A_L^n) \, \dot{\imath}^{-}(A_L^n)g \, \dot{\imath} \, fu[^{\circledR}(\mu_L); A_H^n] \, \dot{\imath} \, c^N (A_H^n) \, \dot{\imath}^{-}(A_H^n)g}$$

$$(19)$$

Proof. Given our assumption that $A_L^n \quad A_{HC}$, from Proposition 2 it follows that,

$$A_L^E = A_L^n; \quad A_H^E = A_{HC}$$

when A_L^n is set as the minimum standard, whereas

$$A_L^E = A_H^E = A_H^n$$

when A_H^n is set as the minimum standard. It is now straightforward to check that,

$$W^E(A_L^n) = n_L fu[^{\circledR}(\mu_L); A_L^n] \, \dot{\imath} \, c^N (A_L^n) \, \dot{\imath}^{-}(A_L^n)g$$

$$+ n_H fu[^{\circledR}(\mu_H); A_{HC}] \, \dot{\imath} \, c^N (A_{HC}) \, \dot{\imath}^{-}(A_{HC})g \qquad (20)$$

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$$W^E(A_H^\pi) = n_L fu[\circledR(\mu_L); A_H^\pi] \, _{\displaystyle\bar{}} \, c^N(A_H^\pi) \, _{\displaystyle\bar{}} \, \bar{}(A_H^\pi)g$$

$$+n_H fu[\circledR(\mu_H); A_H^\pi] \, _{\displaystyle\bar{}} \, c^N(A_H^\pi) \, _{\displaystyle\bar{}} \, \bar{}(A_H^\pi)g \qquad (21)$$

Therefore, $W^E(A_L^\pi) > W^E(A_H^\pi)$ if (19) holds. ∎

Note that depending on the value of the parameters on the right hand side in (19), the above result is quite compatible with uniform distribution $(n_L = n_H)$.

3 Trade Liberalization in North

Suppose North liberalizes its trade regime allowing Southern ...rms to sell the good in the North. To capture the general perception that South exports dirty varieties, we assume that Southern ...rms have genuine cost advantage in dirty varieties. Suppose,

$$c^S(0) < c^N(0) \qquad (22a)$$

$$c^S(\mathcal{A}) = c^N(\mathcal{A}) \quad \text{for } A_{LC} < \mathcal{A} < A_{HC} \qquad (22c)$$

$$c_A^S(A) > c_A^N(A) \quad 8 A \qquad (22b)$$

The properties of the cost function de...ned in (7) and (7a) apply to Southern cost as well. Thus, (22a) and (22b) together with such properties imply that c^S curve lies wholly below (above) the c^N curve for all environmental quality lower (higher) than $\mathring{A}$. That the MC of quality is higher in South than in North [see (22c)] re‡ects, among others, superior quality-speci...c technology of North. On the other hand, (22a) captures the lower plant-speci...c (...xed) cost in South. This may be due to cheaper price of the inputs the intensities of which do not a¤ect the environmental quality of the good. A typical example is unskilled labour.

3.1 Free Trade

Consider ...rst the choices of Northern and Southern ...rms in the unregulated free trade scenario. The assumed comparative cost advantage of South leads us to the following Lemma :

Lemma 1 For $\mathring{A} > A_{LC}$, "all" Northern consumers buy the Southern goods even if they are of lower environmental qualities $A_{iS} < A_{iC}$, if South has a signi...cant cost advantage in the following sense :

$$c^S(A_{HS}) \quad c^N(A_{HC}) \text{ ¡ } fu[^® (\mu_H); A_{HC}] \text{ ¡ } u[^® (\mu_H); A_{HS}]g \quad \text{for } A_{HS} < \mathring{A} < A_{HC}$$

(23)

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Proof. First of all, note that since $c_A^N(A) < c_A^S(A)$ by (22c), from the marginal quality condition (10) it follows that

$$A_{LS} < A_{LC} \qquad (24)$$

at the respective competitive equilibria.

Under autarchy the high-income μ_H-consumers purchased A_{HC} so the menu must have satis...ed their SS constraint :

$$u[^\circledR(\mu_H);A_{HC}] \ _i \ c^N(A_{HC}) > u[^\circledR(\mu_H);A] \ _i \ c^N(A) \quad 8 A \qquad (25)$$

Suppose, post-liberalization they continue to buy the Northern good despite (23). Hence we must have,

$$u[^\circledR(\mu_H);A_{HS}] \ _i \ c^S(A_{HS}) \quad u[^\circledR(\mu_H);A_{HC}] \ _i \ c^N(A_{HC}) \quad 8 \ A_{HS} < A_{HC}$$

$$(26)$$

But a little arrangement of (26) indicates that there exists some $A_{HS} < \emptyset <$ A_{HC} for which this contradicts (23). Thus high-income consumers will not buy the Northern good of higher environmental quality A_{HC}.

Proceeding in a similar fashion it can be shown that the low-income Northern consumers also buy the Southern good. ∎

This seems quite reasonable because South having signi...cant cost advantage in dirtier varieties (in this case $A_{HS} < \hbar < A_{HC}$), the lowest price it can charge is far below that charged by the Northern producers for any such qualities. What is, however, interesting is that Northern producers may not even be able to compete in cleaner varieties in which they have cost advantage.

This is illustrated in Figure 3. The cost curve c^S corresponds to the case where Southern ...rms' cost advantage for $A < \hbar$ A_{HC} is not too large in the sense de...ned in (23). Under autarchy the μ_H Northern consumers attained the net utility level $h^0 h^0$ purchasing the good of environmental quality A_{HC}. When trade is liberalized in North, c^S lying wholly above $h^0 h^0$, they can at most enjoy the utility level indicated by the indi¤erence curve tangent at S (not shown) from purchasing the Southern good of quality A_{HS}. But that utility level is strictly lower than that indicated by $h^0 h^0$. So they will not buy the Southern good. But when the Southern cost curve is c_0^S indicating signi...cant cost advantage, the low-income Northern consumers will buy the Southern good even if it is of lower environmental quality. This is simply because they now derive a higher net utility and that is what, not the environmental quality per se, in‡uences their purchase decision. We are now in a position to write down our next Proposition :

Proposition 4 :

Suppose the South has a cost advantage in dirty varieties that is "not"signi...cant in the sense de...ned in (23), and North has a cost advantage in cleaner varieties. In such a case, Northern ...rms cater the high-income Northern consumers with the "autarchic" quality A_{HC} and South caters the low-income Northern consumers with a "lower" environmental quality.

Proof. By Lemma 2 it can be veri...ed that high-income Northern consumers will buy Northern good of quality A_{HC} from the Northern producers.

Consider now the low-income Northern consumers. From the assumed comparative advantage in (22a) - (22c), at A_{LC}

$$c^S(A_{LC}) < c^N(A_{LC})$$

That is,

$$u\,[\circledR\,(\mu_L)\,;A_{LC}] \; \text{¡} \; c^S(A_{LC}) > u\,[\circledR\,(\mu_L)\,;A_{LC}] \; \text{¡} \; c^N(A_{LC})$$

But at $A_{LS} < A_{LC}$ we have $u_A\,[\circledR\,(\mu_L)\,;A_{LS}] = c^S_A(A_{LS})$ so that by the curvature properties of the preference and cost structures de...ned in (2), (7) and (7a) we have,

$$u\,[\circledR\,(\mu_L)\,;A_{LC}] \; \text{¡} \; u\,[\circledR\,(\mu_L)\,;A_{LS}] < c^S(A_{LC}) \; \text{¡} \; c^S(A_{LS})$$

That is,

$$u\,[^{\circledR}(\mu_L)\,;A_{LS}]\;\mathbf{i}\;\;c^S(A_{LS}) > u\,[^{\circledR}(\mu_L)\,;A_{LC}]\;\mathbf{i}\;\;c^S(A_{LC})$$

Combining this with the earlier inequality we get,

$$u\,[^{\circledR}(\mu_L)\,;A_{LS}]\;\mathbf{i}\;\;c^S(A_{LS}) > u\,[^{\circledR}(\mu_L)\,;A_{LC}]\;\mathbf{i}\;\;c^N(A_{LC}) \qquad (27)$$

But this indicates that the μ_L-Northern consumers derive strictly positive

net utility from consuming the Southern good of environmental quality A_{LS}:

Hence the claim. ∎

Refer back to Figure 3. The Southern cost curve $c^S(A)$ satisfying condi-

tion (23) cuts the c^N curve from below at $\hat{A}$. As long as $\hat{A} > A_{LC}$, c^S lies

below I^0I^0 which indicates the (highest) net utility that the μ_L-Northern con-

sumers attained under autarchy consuming A_{LC}. Post liberalization, South-

ern ...rms o¤er a dirtier variety A_{LS}; but c^S being below I^0I^0; for such a variety

the low-income Northern consumers derive strictly higher net utility.

Therefore, despite of dirtier varieties being imported and consumed, there

are private gains for such consumers [see (27)]. This follows from their SS

constraints. Of course, had there been no private gain, they would not have

consumed the Southern goods and hence at equilibrium imports would have

been zero. However, this does not mean that there are social gains from such liberalization as well. In fact, given consumption externalities, free trade is sub-optimal. This is not surprising. However, this sub-optimal free-trade level of social gain is the benchmark level against which we need to weigh the welfare levels under regulation to justify use of such policies. To this we now turn. As a simpli...cation, and to avoid multiplicity of subcases, we assume throughout the rest of our analysis that the Southern cost advantage satis...es (23) so that both Northern and Southern ...rms operate in North but at the two segmented ends of the market.

3.2 Welfare implications of environmental standards

First of all, note that free trade with a consumption tax is the ...rst-best policy. This is straight forward to check. What we look at is whether environmental standards that were observed to be second-best under autarchy (see Propositions 2 and 3) are still so. In a sense, we examine whether environmental-standard restricted trade (ESRT) is Pareto-superior to free trade. We, however, limit our attention to the income distribution pattern de...ned in (19) and thus consider A_L^{π} as the reference minimum environmental standard that was the second-best under autarchy (see Proposition 3).

We start with the following question : What is the social welfare level

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attained when Southern ...rms are allowed to enter the Northern market provided their goods are at least of this minimum environmental quality? Before seeking the answer, in the following Lemma we specify such welfare level :

Lemma 2 Given (19), Northern welfare under ESRT with $\hat{A} = A_L^\pi$ is,

$$W^{ET} = n_L fu [® (\mu_L); A_L^\pi] ¡ c^N (A_L^\pi) ¡ ¯ (A_L^\pi)g$$

$$+ n_H fu [® (\mu_H); A_{HC}] ¡ c^N (A_{HC}) ¡ ¯ (A_{HC})g \qquad (28)$$

Proof. The second term on the right hand side in (28) is the net gain for the society from the (Northern) good catered to the high-income consumers. Recall our earlier assumption that $A_L^\pi = A_{HC}$: Hence, the minimum environmental standard just allows the Northern producers catering the high-income Northern consumers to o¤er the pro...t-maximizing (autarchic) environmental quality, A_{HC}. Hence, by Proposition 4 this gain is equal to the corresponding social gain under autarchy and free trade.

The ...rst term, on the other hand, is the net social gain in the lower segment of the market. By (18), both the Northern and the Southern producers o¤er $A_L^\pi = A_{HC}$. Since $\hat{A} < A_{HC} = A_L^\pi$; by the assumed comparative advantage (i.e., $c^S(A_L^\pi) > c^N(A_L^\pi)$), the price of Southern goods is higher. Thus, under the environmental regulation the low-income Northern consumers buy the (cheaper) Northern good with A_L^π o¤ered to them. ∎

The social gain (per capita) under ESRT in the lower segment of the Northern market is indicated in Figure 4 by the curve labeled $S_E S_E$ passing through the point E. The private gain equals the vertical distance between II and point E whereas the smaller social gain equals the vertical distance between OI and point E: This social gain under ESRT will be lower than that under free trade thereby making ESRT Pareto-inferior to free trade on the whole, if Southern cost advantage is such that the free trade equilibrium for low-income consumers occurs at a point like e_S below $S_E S_E$. This observation leads us to the following Proposition :

Proposition 5 :

If Southern ...rms' cost advantage is such that,

$$c^S(A_{LS}) < c^N(A_L^a) \ \text{¡} \ [^-(A_{LS}) \ \text{¡} \ ^-(A_L^a)] \ \text{¡} \ fu[^{®}(\mu_L); A_L^a] \ \text{¡} \ u[^{®}(\mu_L); A_{LS}]g$$

(29)

trade with pre-liberalization (second-best) environmental standard (A_L^a) is Pareto-inferior to free trade.

Proof. Since restriction on $c^S(A)$ in (29) implies that restriction in (27) is also satis...ed, by Proposition 4 and Lemma 2, all we have to compare are social gains in the lower segment of the Northern market under free trade and that under ESRT.

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By Proposition 4, the social gain under free trade is given as,

$$W_L = u[\circledast(\mu_L); A_{LS}] \,_{i} \, c^S(A_{LS}) \,_{i} \, {}^-(A_{LS})$$

Comparing this with the ...rst term on the right hand side in (28) we observe that free trade is Pareto-superior to ESRT if (29) holds. Hence the claim. ∎

However, since the Northern consumers do not internalize the consumption externality, free trade is not optimal. What is interesting to observe is that it is not even the second-best policy. Alternatively, if ESRT with $\!R = A_L^a = A_{HC}$ is Pareto-superior to free trade, it is not the second-best. Following the logic of Proposition 3, there exists a minimum (optimal consumption-tax equivalent) environmental standard that is second-best. But that minimum standard is certainly not the autarchic one as revealed by Proposition 5. In fact, as the following proposition states, it is a lower one. And this is irrespective of whether Southern cost advantage satis...ed (29) or not.

Proposition 6 :

Given (23), ESRT with a minimum standard A_{LS}^a lower than the autarchic standard, A_L^a, is the second-best policy.

Proof. Given Proposition 3, all we have to show is that when Southern ...rms have a cost advantage as de...ned in (23), as they cater only the

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low-income Northern consumers , the optimal quality under ...rst-best consumption tax, A^{π}_{LS}, is lower than the optimal quality in autarchy, A^{π}_L.

Note that A^{π}_{LS} is such that,

$$u_A[\circledR(\mu_L);A^{\pi}_{LS}] = c^S_A(A^{\pi}_{LS}) + {}^-_A(A^{\pi}_{LS}) \tag{30}$$

On the other hand, recall from (16) that A^{π}_L is such that,

$$ {}^-_A(A^{\pi}_L) = u_A[\circledR(\mu_L);A^{\pi}_L] \; ; \; c^N_A(A^{\pi}_L) \tag{16a}$$

Suppose, $A^{\pi}_{LS} \; , \; A^{\pi}_L$. Hence by (13a), ${}^-_A(A^{\pi}_L) \; , \; {}^-_A(A^{\pi}_{LS})$. That is,

$$u_A[\circledR(\mu_L);A^{\pi}_L] \; ; \; c^N_A(A^{\pi}_L) \; , \; u_A[\circledR(\mu_L);A^{\pi}_{LS}] \; ; \; c^S_A(A^{\pi}_{LS})$$

A little rearrangement yields,

$$c^S_A(A^{\pi}_{LS}) \; ; \; c^N_A(A^{\pi}_L) \; , \; u_A[\circledR(\mu_L);A^{\pi}_{LS}] \; ; \; u_A[\circledR(\mu_L);A^{\pi}_L] \tag{31}$$

If $A^{\pi}_{LS} \; , \; A^{\pi}_L$, by (2), the right hand side in (31) should be non-positive, i.e.,

$$c^S_A(A^{\pi}_{LS}) \quad c^N_A(A^{\pi}_L)$$

But this contradicts our assumption that South has lower MC of quality because by (7) that should mean,

$$c_A^S(A_{LS}^\pi) > c_A^S(A_L^\pi) > c_A^N(A_L^\pi)$$

Therefore, $A_{LS}^\pi < A_L^\pi$.

Hence the claim. ∎

This Proposition has far reaching implications for post-liberalization environmental policy. This reveals how the government in the North should react to dirty varieties being exported by the South. In no way export from South should be restricted nor it should be subjected to the minimum environmental standard that was in force before liberalization. Instead, the minimum standard should be lowered as long as South has a genuine cost advantage in dirty varieties. That is, if physical regulations aim at inducing South to export the same quality as the Northern ...rms were o¤ering ($A_L^\pi = A_{HC}$), these are certainly welfare reducing. The reason is simple. When the Northern government sets the higher (autarchic) environmental standard A_L^π for the Southern exporters, individual and aggregate welfare increases since marginal utility is strictly positive. But higher environmental quality can be provided only at a higher price to cover additional costs. Since cost increases faster than the gain in utility for any $A > A_{LS}^\pi$ (as evident from

the marginal condition corresponding to A_{LS}^n and (7a))[7]; so additional price

paid by the Northern consumers is more than the additional gain from the

higher environmental quality set by the higher environmental standard. In

other words, The loss associated with lowering of environmental standard

from A_L^n to A_{LS}^n is more than compensated for the North by the lower prices

of the Southern goods under competitive conditions. Consequently, social

welfare falls[8].

4 Conclusion

This paper has examined the optimality of physical environmental regula-

tions that are typically observed in the context of North-South trade. The

analysis is couched in terms of a benchmark model of consumers' demand

for and ...rms' choice of environmental quality of a traded good. Di¤erent

marginal willingness-to-pay for environmental quality due to income dispar-

ity in the North in‡uences the choice of environmental quality of the good

by the competitive ...rms. However, with private willingness to pay failing to

internalize the consumption externality implied by the consumption pollu-

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[7]In particular, this follows from the second order condition : $u_{AA} [\circledast (\mu_{iH}); A_{is}^n]$ i

$^-(A_{is}^n) < c_{AA}^s(A_{is}^n)$:

[8]Note that since consumption tax merely redistributes income from the Northern con-
sumers to the Northern government, the gain in welfare for the Northern consumers under
physical regulation due to zero tax burden is exactly matched by corresponding revenue
loss for the government.

tion makes such pro...t-maximizing competitive environmental qualities sub-optimal. A consumption tax, instead of (uniform) minimum environmental standard, appears to be the ...rst-best policy both under autarchy and free trade. The particular level of minimum standard that is second-best, on the other hand, depends on the income distribution.

When trade is liberalized in North, such autarchic minimum standard is not the second-best policy. Moreover, welfare may fall below the free trade level even if South exports dirtier variety. In fact, neither free trade nor the autarchic standard is second-best. This requires lowering of the minimum standard from the autarchic level. This re⁞ects the bene...ts to be had from trade when South has a (genuine) cost advantage in dirty varieties.

The demand-approach considered here enables to focus on the intra-industry character of trade and investment liberalization with dirty and clean varieties belonging to the same product group in contrast to usual focus on inter-industry trade in the existing literature on trade and environment. With the notable exceptions of Barrett (1994) and Ulph (1992, 1996), the intra-industry character of the debate has not been addressed fully. But just as the other conventional characteristics, environmental quality of a good has become an integral part of a particular variety and has been used as a strategy variable by the ...rms competing in the market for consumers' budget. Indian automobile industry is a typical example. New entrants in the

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post-liberalized era beginning in mid-1990s like Ford India, Hyundai Motors, Honda Siel, Mercedes Benz, and Pal Puegeot projected their respective models being Euro-II environmental standard compliant in contrast to the non-compliant popular models of Maruti Udyog Ltd (a joint venture with Suzuki Corporation), the incumbent market leader in the passenger car division. Only of late Maruti Udyog Ltd has made its Maruti-Zen model, a product variety targeted for higher-income group people, Euro-II compliant which is of course partly strategic and partly due to strict enforcement of environmental standards in the automobile sector.

It is this strategic aspects of environmental quality that may be the major direction in which the present analysis can possibly extended. Of course, for that we need to relax the assumption of perfect competition. Such an extension would be signi...cantly di¤erent from the analyses of Barrett (1994) and Ulph (1996) who consider the strategic aspects of environmental policies rather than that of environmental qualities of the good. In other words, this paper leaves scope for a shift of focus from policies as strategy variables of the national governments manipulated for the advantage of their national ...rms to qualities as strategy variables for the ...rms manipulated to gain strategic position against each other. This is what is in our future research agenda.

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