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Eco-Labels and International Trade in Textiles

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Abstract

This paper provides a formal analysis of the welfare and trade implications of eco-labeling schemes. A simple model of vertical (quality) differentiation captures major stylized features of the textiles market in which trading takes place between an industrialized North (domestic) and a developing South (foreign). The paper investigates several labeling scenarios (labeling by North, labeling by both North and South, and harmonization). A labeling scheme in the North without the South's participation is detrimental to both the North's and the South's producers of conventional textiles. In aggregate, the North's textiles industry benefits from the introduction of the label. If the South creates its own label, it regains market share in aggregate, but at the cost of its conventional textiles sector; both of North's industries lose. Consumers gain with a wider choice and with higher quality of textile goods. They would favor upward international harmonization of eco-labels towards the higher quality of the North, as long as the South participates in production and provides some cost discipline.

Key Words: eco-labels, textiles markets

ECO-LABELS AND INTERNATIONAL TRADE IN TEXTILES

Introduction

We provide a formal analysis of the welfare and trade implications of eco-labeling schemes. We couch our analysis in the context of a stylized model of the textiles market in which trading takes place between an industrialized North (domestic) and a developing South (foreign). Textiles eco-labeling involves production-process standards, raising concerns of protectionism harming the South. We investigate several labeling scenarios (labeling by North, labeling by both North and South, and harmonization of both labels).

Our investigation fills a gap in the literature on eco-labeling and trade. Non-quantitative case studies constitute the bulk of the literature (Jha and Zarrilli, OECD, and Zarsky). Mattoo and Singh offer a simplistic model of eco-labeling that fails to formally differentiate quality. Kirchhoff provides the only formal treatment of some aspects of eco-labeling and associated standards in an open economy context. In a paper related to ours, Bureau et al. address the case of hormone labeling for the beef trade, accounting explicitly for quality.

We consider a large home country, the North, that imports conventional textile goods from the South, and produces importing-competing conventional textiles as well. Both the North's and the South's exhibit increasing marginal cost of textile production. Trade is initially distorted by the North's import tariff, as would be the case in the real world. In the absence of information on process standards, equilibrium in the textiles market prevents "green" credence attributes from emerging.

Introducing an eco-label allows markets to value process attributes (credence good) and to reward producers of environment-friendly attributes. The label increases the cost of production by imposing process-standards on the production of the green apparel. We model the eco-label as the information on a process attribute, which becomes a search attribute with labeling. We characterize the environmental attribute of textiles as a quality scalar, using a model of vertical differentiation. Conventional textile goods are at the lower bound on the quality attribute.

Eco-labeled goods meet some process standards and convey their higher environmental quality to consumers through the label.

For simplicity we assume that only one "quality" of conventional textiles exists. We further motivate this assumption in the model presentation. For its domestic market the home country then introduces the eco-label scheme. We initially assume that the labeling scheme precludes the foreign industry's presence in the eco-labeled market. Two goods are now present on the domestic market: eco-labeled textiles produced in the North and conventional textiles produced by both the North and the South.

The label has several effects. Consumers benefit from a larger choice set, and those who highly value the environmental quality of the textile good, switch to the higher quality. Demand for conventional textile decreases. Trade protection exacerbates the relative loss of market share for conventional imports. The domestic conventional textiles industry is also hurt by the label but to a lesser extent because of the tariff protection. Once the label is in place, both the North's textile producers (labeled and conventional) benefit from increasing the import tariff. The specific tariff has a direct protectionist effect on both industries in the North and an additional indirect substitution effect via the relative price of the two textile goods.

If the South responds with its own eco-label, it creates an intermediate quality between the conventional and the North's eco-labeled textiles. It regains some of the lost surplus. The welfare of the South's conventional textiles industry declines further. Northern consumers gain from the wider choice, but both the North's industries lose from the increased quality competition.

Surprisingly, under plausible conditions, the South's suppliers of eco-labeled textiles benefit more from upward- rather than downward–harmonization. As expected, the conventional textile industry in the South would rather harmonize the quality downward. It would regain market share in the export market with less quality competition. Northern consumers have their welfare increasing in all textile qualities and would never favor a downward harmonization of eco-labels.

We have another finding that goes against conventional wisdom of a "leveled playing field" in integrated international markets. We find that the North's textiles industry would rather not harmonize eco-labels and standards as long as these translate into valuable attributes as perceived by consumers.

Next, we give a brief history of eco-labels in general before focusing on the textile market in particular. We review important stylized facts and issues associated with eco-label schemes. Then we present a parsimonious model, which incorporates these stylized facts. Following that, we analyze the two eco-labeling cases described above and summarize numerical comparative-statics results pertaining to the harmonization of labels. Then, we present conclusions.

Brief History of Eco-Labels in General

Both in Europe and North America environmental concerns arose in the 1970's and 1980's to a prominence in public discourse never before known. Consumers were urged to put their money where their mouth was and purchase environmentally friendly goods so as to pressure firms to mend their ways. "Green consumerism" was born and with it came a deluge of greener than thou claims by manufacturers. Claims such as "eco-friendly," "environmentally safe," "recyclable," "biodegradable," "ozone friendly," "safe in a landfill," etc., bombarded consumers (West). Differentiating fact from fiction and meaningful from irrelevant became difficult and so the idea of third party certification via eco-labels was born. This section provides an overview of the development and difficulties of eco-labels from their start in 1978 with Germany's Blue Angel to the present.

Eco-labels are designed to inform consumers that the labeled product is more environmentally friendly than most in its product category. The hope is to harness latent or undirected consumer preferences for green goods to encourage firms to develop and adopt products and technologies that mitigate ecological externalities. The successful widespread implementation of eco-labels has yet to be achieved in part because of *de facto* barrier to trade concerns.

The proliferation of confusing claims by manufacturers led to the proliferation of environmental labeling schemes, the sheer number of which, again, threatens consumer confusion and confidence in them (Lohr). Bringing fuller information about a product's environmental impact is the goal of eco-labels. There are essentially two types of eco-labels. The first focuses on the overall environmental impact of a product, often employing a life cycle or "cradle to grave" type analysis (LCA). This roughly corresponds to a Type I label as defined by

ISO 14024. The ISO defines these as "voluntary, multiple criteria based practitioner programs that award labels claiming overall environmental preference of a product within a particular category, based on life cycle considerations." LCA should play an important role in addressing ecological impacts with respect to extraction of resources, manufacturing, distribution, use, recovery, and disposal. There are a great deal of similarities between ISO 14024 or Type I labels and ISO 14040 which exclusively employs LCA analysis. The major distinction is that while LCA must play an important role it need not be the sole criterion.

The second type of eco-label is a single-issue label granted by a third party certification agency that refers to a specific environmental or sometimes ethical characteristic of a product, e.g., certified organic cotton, dolphin safe tuna fishing, or sustainable forestry. This roughly translates into an ISO 14000 Type IV label (Kuhre). The ISO has not yet released single-issue guidelines to the public. Type II labels are those environmental claims made by the manufacturer itself. Type III labels are known as quantified product information (QPI) labels. While less common than the other types, the idea is that the third party certification agency would use several environmental performance indicators (EPI), e.g., energy use, air emissions, water emissions, etc., to compile an environmental score for each product that consumers could use to compare different goods. They could then purchase the good with the best score. Our paper concentrates on Type I eco-labels.

Established in 1978, Germany's Blue Angel is the oldest and one of the most respected eco-label schemes. As of December 1996, 960 manufacturers or importers had been awarded the Blue Angel for a total of 4,100 products in 76 different product categories (OECD). While there are about 30 eco-labeling schemes in operation worldwide, after Germany's Blue Angel the other major ones include the Nordic White Swan, the Swedish Environmental Choice, the EU Eco-Label Award Scheme, the Canadian Environmental Choice Program, the American Green Seal, the Japanese Eco-Mark, and the French NF Environment (West). Most are government organizations but the U.S. Green Seal and the Swedish Environmental Choice programs are private. They all strive, albeit with varying degrees of stringency, to employ life cycle analysis in criteria determination. Although the details of the process vary across agencies, the general procedure for the development of eco-labels is characterized by the following sequential steps:

(1) product selection, (2) criteria development, (3) public review process, (4) adoption of final criteria, (5) application to competent body for eco-label, (6) testing and verification, and then (7) award of eco-label (OECD).

Analysis based on the life cycle approach is generally accepted as the ideal and indeed there has been a recent trend toward honest implementation of this approach. The lack of an accepted methodology for LCA implementation, however, has retarded its widespread application and most major certification agencies still focus on the use and disposal of the product. The fundamental problem centers on the inherent difficulty in assessing and comparing different ecological impacts. For example, it is difficult to compare a product that is biodegradable but produced in an energy intensive process with a product produced with less energy but has a half-life of five million years (Jha and Zarrilli). Although successful eco-label schemes must involve industry in the criteria development phase, if firms are expected to apply and pay for the labels, the criticism has been leveled that firms have too much influence. Although in theory LCA pleases everyone, who gets to determine how different ecological impacts are weighted is subject to great controversy and poses one of the major challenges facing successful implementation of eco-labels in a broader spectrum of products.

From the perspective of less developed countries (LDC) the most contentious source of debate centers on their concern that eco-labeling schemes may serve as *de facto* barriers to trade. They anticipate greater difficulty attaining the certification than do firms in the issuing countries. The World Trade Organization (WTO) faces the challenge of reconciling eco-label schemes with the technical barriers to trade (TBT) chapter of the 1993 Uruguay Round of trade negotiations (UR-GATT). One could argue that eco-labels are a form of a national certification system, implying that Article 7 of TBT applies. Article 7 mandates that such certification schemes must be implemented in such a way that they do not "have the effect of creating unnecessary barriers to trade" (Jha and Zarrilli).

There is some debate as to whether or not TBT applies to voluntary certification systems but, even so, successful implementation of eco-labels requires at least a good faith effort to consider the input and concerns of all potentially impacted parties. Jha and Zarrilli note that eco-labels may be considered to violate TBT if (1) "the determination of the criteria to which the

product must conform in order to qualify for the label, in particular with regard to use of raw materials and production and processing method, is not based on objective or scientific consideration or fail to take into account adequately the production processes prevailing in other countries; (2) procedures for verification in granting the label are unnecessarily strict or rigorous, thereby making it almost impossible for a foreign producer to obtain the label; or (3) the system is prepared and adopted for a product which is almost entirely imported, and the right to grant an eco-label rests entirely with authorities of the importing countries."

In 1992 Brazil was the first country to raise trade concerns over eco-labels when the Council of European Communities chaired by Denmark adopted criteria for a pulp and paper products eco-labeling scheme. Brazilian manufacturers/exporters were not involved in the criteria development phase and feared they would be adversely affected. The standards were determined with European but not Brazilian environmental needs and production practices in mind. This case is typical of the concerns expressed by LDC's. For instance, waste reduction is an environmental priority in the European Union (EU) and so the EU eco-labeling scheme rewards the use of recycled paper. Another country that exports paper products to the EU may benefit more from reforestation efforts and would prefer eco-labels to reward firms practicing sustainable forest management. Furthermore, with little environmental improvement, a LDC's comparative advantage may be adversely affected if qualifying for the eco-label means adopting the EU's capital intensive means of production required to incorporate recycling. Although voluntary, if the eco-labels ultimately result in a *de facto* standard required by consumers, non-consulted countries fear this may eventually affect their ability to export to the labeling country. This highlights the need for eco-labeling schemes to incorporate enough flexibility to reward different environmental goals as long as the net effect on the environment is positive (Jha and Zarrilli).

In some cases the selection of criteria and thresholds can be so narrow as to effectively mandate a particular technology. This is particularly true for textiles. A private German eco-labeling scheme proposed two types of eco-labels—the MST (*Marke scadstoffgeprufter Textilien)* relates to attributes of the final product and the MUT (*Marke umweltschonender Textilien)* relates to the production process of textiles. There are several ways in which this could

constitute a trade barrier. German firms may be more able to comply with the standards because they were involved in development of the standards and may already possess the technical competence required. Most strikingly Jha and Zarrilli report that after examining the proposed MST label's requirements, the criteria would mean that LDC's would have to import dyestuffs from Germany or other EU countries. This would disproportionately raise the cost of certification for LDC's. Such inflexible guidelines almost mandate that a particular technology be used that prohibited natural dyes, often used by LDC's, even though in most cases they would be just as environmentally sound. The other proposed textile label, MUT, would require on-site inspections particularly costly for LDC's.

The Eco-Tex Standard 100 for textiles is another label developed in a more international context but still sponsored by German and Austrian research institutes. The impacts on human health not ecological concerns dominate the criteria. This was done in acknowledgement of the difficulty posed by on site inspections. Eco-Tex set standards for a textile eco-label but will not award such labels. Despite soliciting a broader range of concerns and inputs, the criteria are still similar to that of the MST label and would be expected to have similar trade effects. In general eco-labels for textiles have been slow in achieving widespread acceptance largely because, in the spirit of LCA, it is clear that any honest eco-label will have to incorporate on site inspections as well as limitations on inputs and technologies used, either of which could be considered a violation of the TBT.

This is particularly important in light of potential future increases in the range of products covered by eco-labels. Zarrilli looks at the importation of potentially eco-labeled products into the EU, the Nordic countries, and Canada. She finds in these three markets that the products included in the eco-label schemes represent fairly small percentages of total imports. In Canada they account for 1.2 percent of imports, in the Nordic countries the figure rises to 2.5 percent and is slightly larger at 3.3 percent for the EU. When focusing on imports from LDC's of products that are planned to be or are already included in eco-labeling schemes, larger differences amongst the three markets emerge. The share of "potentially" eco-labeled products from LDC's in total imports of eco-labeled products is a negligible 0.9 percent for the Nordic countries and fairly small for Canada at 5.8 percent but for the EU the figure rises to a much larger 44.9

percent. Since textiles and apparel items constitute a substantial portion of the imports from LDC's, the trade diversion impacts of eco-labels in this market is of particular interest (Zarrilli). Harmonization is often offered as a solution to the potential trade barrier problems posed by eco-labels (Jha).

Some Stylized Facts on Eco-Labels in Textiles

Third-party institutions, either nongovernment organizations (NGOs) or governmental agencies, administer eco-labels. These labels increase the cost of production by imposing fees and standards. This is particularly true for eco-labeling schemes in textiles, which require multiple production standards for dyes, fibers and bleaching chemicals (OECD). For illustration, Table 1 shows some of the EU process standards for maximum allowable heavy metal residues in dyes used in eco-textiles.

ble 1. Some EU standards for eco-labeled T-shirts and bed linens

Maximum amount of metals in pigments and dyestuff	**Pigments (PPM)**	**Dyestuff (PPM)**
Arsenic	250	50
Cadmium	50	20
Chromium	100	100
Copper	-	250
Mercury	25	4
Nickel	-	200
Lead	100	100
Zinc	-	1000

SOURCE: European Commission Directorate General

These standards increase cost of production. Data on cost of eco-textiles are scarce. In the United States, eco-labeled apparel items command a price premium of about 30 percent with respect to comparable conventional apparel items. This 30 percent markup appears to reflect cost of production, but the evidence is preliminary (Nimon and Beghin). Fees are imposed in most schemes. For example, Canada's Environmental Choice Program imposes a 0.5 percent charge based on the price of the good on sales up to Canadian $1,000,000. Fixed cost arises from the application and site inspection involved in the certification process.

Certification is another problem mentioned in the literature (Jha and Zarrilli, OECD, Zarsky). Developing countries have voiced their concern that certification with industrialized labeling schemes may be virtually impossible for them. A glance at the EU Commission's list of companies that have obtained the EU environmental label reveals a pattern consistent with this concern. Forty-eight licenses have been granted to 32 manufacturers and two importers (from Finland) covering 219 products. Hence none were granted to a developing economy's company. A surprising fact is the small number of licenses granted. In our formal analysis we consider this potential exclusion of developing economies from the eco-labeled textile market.

Eco-label schemes can be discriminatory, especially in textile markets dominated by the South's producers. For example, about 80 percent of the shirt, T-shirt and bed linen consumption in the EU is imported from developing economies and the EU eco-label scheme could be easily construed as targeting the foreign production of these goods. Domestic industries have more say in the definition of these standards than foreign competitors do (OECD, Jha and Zarrilli). Abstracting from political economy considerations, the standards are likely to address technologies, which are feasible in industrialized countries but perhaps reflect less concern for the input mix and technology set of developing countries. Further, what may be considered a green good in China may no longer be considered green in the United States, given the difference in their respective marginal utility of income. Local eco-labels are emerging now in developing countries, especially in timber-based products, in order to promote better practice and preempt discriminatory labeling in the North.

Hence, if an "optimum" label/quality could be defined, it would differ between the North and the South's trading partners. Harmonization of eco-labeling policies between the North and

the South implies that one or both parties must compromise on their environmental valuation or on the cost of production beyond what is socially optimal. Despite this inherent problem, harmonization is part of the "fair trade" debate on labor and environmental practices. We analyze the implications of harmonizing eco-labels downward and upward for welfare and trade flows.

Finally, this debate on labeling occurs in the context of a very protected textiles industry in the North. The last set of agreements from the Uruguay Round of the World Trade Organisation included a special agreement on textiles. Industrialized countries are supposed to phase out the Multi-Fiber Agreement quotas which will be tariffied and then progressively lowered. Currently, most industrialized countries have textile protection translating into an *ad valorem* tariff equivalent in excess of 100 percent.

A Model of Environmental Quality Differentiation

We follow the classical model of vertical (quality) differentiation (see Tirole, and Mussa and Rosen). Although abstract, this model has been recently applied by Bureau et al. to analyze the hormone beef dispute between the United States and the EU. Each consumer in the North consumes either one or no unit of the product. The heterogeneous quality of the good (its greenness) translates into a quality index k, which is valued by the consumer via a taste parameter θ. We assume the latter parameter is distributed uniformly over the consumers in the North. Utility, U, is a surplus measure and is as follows: U=0 if the agent does not buy, or $\mathrm{U} = \theta k - p$ if the agent buys a unit of quality k at price p.

We assume there are three textile goods, differentiated by quality. One good is conventional textiles, with quality k_c equal between the foreign and domestic producers. The choice of k_c represents a cost-minimizing level of the environmental attribute from optimum use of dyes and other pollution-generating inputs, given the constraint that it makes the conventional textiles acceptable to consumers, as in Shapiro. In our context, this quality of conventional textiles represents a minimum acceptable environmental quality for consumers based on search and experience attributes. Examples of such characterization would be the absence of negative health effects from wearing conventional clothing or of an unpleasant odor suggestive of toxic chemicals used in the production process.

Besides the conventional good, two "green" goods are introduced—one domestic with quality k_g and one foreign with quality k_g^*. We assume that the latter green quality levels are defined by third-party institutions and become exogenous parameters for producers. We have the following assumption for the perceived qualities, $k_c < k_g^* < k_g$. Tirole shows that a higher taste for quality, or θ being higher, reflects a higher income. This fact motivates $k_g^* < k_g$, because, in the South, environmental quality corresponds to lower marginal damage of pollution than it does in the North. Other reasons motivate this inequality. For example, environmental degradation occurs with emissions from transportation, and an imported good is presumably less green, other things being equal, because of emissions linked to transportation. Another motivation is the North's preference for the domestic environment or localized warm-glow.

We analyze three situations. First, we look at the market without any label as a reference case, and then we introduce the North's labeling scheme. Finally, we consider two competing labels, the North's and the South's. The specification of the demands for the three substitute goods varies, depending on the choice set in each of the three cases. Hence, we have three specifications for the demand for conventional textiles. We mimic label harmonization by shrinking the quality differential $\left(k_g - k_g^*\right)$, upward by increasing k_g^*, and downward by decreasing k_g.

Case 1: The Reference Case

In the reference case with no labeled goods, both the domestic and foreign firms produce the same conventional quality good. Since environmental impact attributes are credence goods, only the conventional pollution intensive product will be produced in the absence of an independent third party eco-label. In this scenario demand is determined by the marginal consumer who is indifferent between no consumption and consumption of the conventional quality, as in Mussa and Rosen. As in Mussa and Rosen, the taste parameter $\theta \in [0,1]$ is distributed uniformly and with a density of 1. Consumers have the following preferences.

(1) $U = \begin{cases} \theta k - p & \text{if he buys a good with quality k at price p,} \\ 0 & \text{if he does not buy.} \end{cases}$

The marginal individual's consumer surplus exactly equals zero so that

$\hat{\theta}_0 k_c - p_c = 0 \qquad \hat{\theta}_0 = \frac{p_c}{k_c}$. Integrating over the continuum of consumer types leads to a market demand for conventional textiles, Q_c.

(2) $Q_c = \int_{\frac{p_c}{k_c}}^{1} 1 \, d\theta = 1 - \frac{p_c}{k_c}$.

The derivation of the supply is a bit more complicated. We assume that individual producers have no market power and so pursue marginal cost pricing. Producer j (where a "*" will be used to denote the foreign firm) maximizes profit π_j w.r.t. output, q_{ij}.

(3) $\pi_j = p_i q_{ij} - \frac{1}{2} c_{ij} q_{ij}$ where p denotes price, c denotes unit cost, $i = c, g$ denotes quality (i.e., conventional, or green).

The cost parameter is a function a function of quality $c_{ij} = c_{ij}(k_i)$, and is assumed linear in the numerical exercise. While the foreign firm is assumed to possess a cost advantage in the production of the conventional good such that $c_c < c_c^*$ it faces a specific tariff (t). The foreign and domestic supplies of the conventional good are as given below.

(4) $q_c = \frac{P_c - t}{c_c}$, and

(5) $q_c^* = \frac{P_c}{c_c^*}$.

With market clearing the equilibrium price and quantity is then obtained by equating demand with the total market supply.

$$(6) \quad p_c^{equil} = \frac{k_c c_c^* c_c + t k_c c_c}{c_c^* c_c + k_c\left(c_c^* + c_c\right)}, \text{ and}$$

$$(7) \quad q_c^{equil} = \frac{k_1\left(c_c^* + c_c\right) - t c_c}{c_c^* c_c + k_c\left(c_c^* + c_c\right)}.$$

Since we assume that all consumption takes place in the North, the consumer surplus can be calculated by the following.

$$(8) \quad CS = \int_{\hat{\theta}}^{1} (\theta k_c - p_c) d\theta = \frac{k_c\left[k_c\left(c_c^* + c_c\right) - c_c t\right]^2}{2\left[c_c^* c_c + k_c\left(c_c^* + c_c\right)\right]^2}.$$

By imposing marginal cost pricing we solve for the foreign producer surplus.

$$(9) \quad PS^f = \int_0^{q_c^*} \left(p_c - t - c_c^* q_c^*\right) dq = \frac{c_c^*}{2}\left[\frac{c_c\left(k_c - t\right) - t k_c}{c_c^* c_c + k_c\left(c_c^* + c_c\right)}\right]^2,$$

where $\left(p_c - t - c_c^* q_c^*\right)$.

Similarly the domestic producer surplus can be solved.

$$(10) \quad PS^d = \int_0^{q_c} \left(p_c - c_c q_c^*\right) dq = \frac{\left[k_c\left(c_c^* + t\right)\right]^2 c_{12}}{2\left[c_c^* c_c + k_c\left(c_c^* + c_c\right)\right]^2},$$

where $\left(p_c - c_c q_c\right)$ is the producer surplus.

The world welfare (W) then is just $W = CS + PS^d + PS^f + t q_c^* - L$, where L is the cost of the label and is assumed to be borne entirely by the home country.

$$(11) \quad W = \frac{k_c\left[k_c\left(c_c^* + c_c\right) - c_c t\right]^2 + \left[k_c\left(c_c^* + t\right)\right]^2 c_c + c_c^*\left[c_c\left(k_c - t\right) - t k_c\right]^2}{2\left[c_c^* c_c + k_c\left(c_c^* + c_c\right)\right]^2} - L.$$

Case 2: The North Introduces an Eco-Label

In this scenario we analyze the case where the North introduces an eco-label and only the domestic firm is able to qualify for it. This focuses on the fears expressed by less developed countries (LDC) that the criteria for obtaining the eco-label may be chosen for national advantage. Domestic firms may have more influence in the criteria development stage such that the criteria ultimately adopted may reflect the concerns and production technology of the domestic industries at the expense of those in less developed countries. The concern is that these eco-labels will become a *de facto* standard that firms in LDC's will effectively be unable to satisfy and their market share of the conventional item will shrink.

In the second case, two marginal consumers at opposite ends of the taste continuum determine the demand for conventional textiles. Arbitrage by the marginal consumer who is indifferent between the utility of consuming a unit of conventional or eco-labeled textiles $\left(\text{i.e. the } \theta_1 = \frac{p_g - p_c}{k_g - k_c} \text{ consumer}\right)$ truncates the demand for conventional textiles. If the consumer's taste parameter exceeds θ_1 then he purchases only the higher quality eco-labeled good, and if it is below that level he either purchases the lower quality conventional good or nothing at all. Recall that to purchase anything at all the taste parameter must be at least $\theta_0 = \frac{p_c}{k_c}$. This gives rise to the following derivation of the two demand functions.

$$(12) \quad Q_g = \int_{\frac{p_g - p_c}{k_g - k_c}}^{1} 1 \, d\theta = 1 - \frac{p_g - p_c}{k_g - k_c}, \text{ and}$$

$$(13) \quad Q_c = \int_{\frac{p_c}{k_c}}^{\frac{p_g - p_c}{k_g - k_c}} 1 \, d\theta = \frac{p_g - p_c}{k_g - k_c} - \frac{p_c}{k_c}.$$

The same basic framework as above is used to derive the supply of the labeled green and unlabeled conventional goods. In this case the market supply of the conventional good is the sum of the North's and the South's supply curves. Profits maximization gives the following supply curves.

$$(14) \quad Q_c = p_1\left[\frac{c_g + c_c^*}{c_c^* c_c}\right] - \frac{t}{c_c^*}, \text{ and}$$

$$(15) \quad Q_g = \frac{p_g}{c_g}.$$

Equating these supply and demand curves generates the market equilibrium prices from which the market equilibrium quantities can easily be found from (14) and (15).

$$(16) \quad p_c^{equil} = \frac{c_c k_c\left[c_c c_g + t\left(c_g + k_g - k_c\right)\right]}{k_c\left(c_c^* + c_c\right)k_c\left(c_g + k_g - k_c\right) + c_c^* c_c\left(c_g + k_g\right)}, \text{ and}$$

$$(17) \quad p_g^{equil} = \frac{c_c c_g k_c\left[\frac{c_c^* c_g}{c_g + k_g - k_c} + t c_g\right] + \left(k_g - k_c\right)\left[\left(c_c^* + c_c\right)k_c c_g + \frac{c_c^* c_c c_g\left(c_g + k_g\right)}{c_g + k_g - k_c}\right]}{\left(c_c^* + c_c\right)k_c\left(c_g + k_g - k_c\right) + c_c^* c_c\left(c_g + k_g\right)}$$

The next step is to solve for the consumer surplus.

$$(18) \quad CS = \int_{\theta_0}^{\hat{\theta}} \left(\theta k_c - p_c\right)d\theta + \int_{\hat{\theta}}^{1} \left(\theta k_g - p_g\right)d\theta = \frac{\left(p_g - p_c\right)^2 k_c + \left(k_g - k_c\right)\left[p_c^2 + k_c k_g - 2k_c p_g\right]}{2\left(k_g - k_c\right)k_c},$$

$$(19) \quad PS^f = \int_0^{q_c^*}\left(\frac{\left(p_c - t\right)}{c_c^*}\right) = \frac{\left(p_c - t\right)^2}{2c_c^*}, \text{ and}$$

$$(20) \quad PS^d = \int_0^{q_c} \left(p_c - c_c q\right)dq + \int_0^{q_g} \left(p_g - c_g q\right)dq = \frac{1}{2c_c c_g}\left[p_c^2 c_g + p_g^2 c_c\right].$$

For clarity of exposition expressions (18) through (20) are not given in their reduced form, but they can easily be made so by substituting in the equilibrium prices from (16) and (17). The world welfare (W) then is just $W = CS + PS^d + PS^f + tq_c^* - L$, where L is the cost of the label and is assumed to be borne entirely by the home country.

Case 3: The South Introduces an Eco-Label of its Own

In this scenario we analyze the case in which the South responds to the North's eco-label by introducing a label of its own. In this case only the North's firms can qualify for the eco-label denoting the highest quality (k_g) and the South's firms can only qualify for the eco-label denoting a lesser level of environmental quality, (k_g^*). The greenest quality also costs more for the North's firms to produce so not only is $k_c < k_g^* < k_g$ but $c_c^* < c_c < c_g^* < c_g$. This allows us to then consider the implications of harmonization of the two labels. This is particularly policy relevant because harmonization is considered by many to be an integral step towards the reduction of eco-label induced trade diversion.

Again the demand is determined as before except now there are three quality levels instead of two. In this case the taste parameter that characterizes the consumer who is indifferent between buying the domestic eco-labeled quality k_g at price p_g and the imported eco-labeled quality of k_g^* at price p_g^* is $\theta_2 = \dfrac{p_g - p_g^*}{k_g - k_g^*}$. The demand for the imported eco-labeled textiles is truncated from below by θ_1 and from above by $\theta_2 = \dfrac{p_g - p_g^*}{k_g - k_g^*}$. With the same distributional assumption on θ, integration over the relevant ranges of the taste parameter gives the following demand functions for the three goods.

$$(21) \quad \mathrm{Q_c} = \int_{\frac{p_c}{k_c}}^{\frac{p_g^* - p_c}{k_g^* - k_c}} 1\, d\theta = \frac{p_g^* - p_c}{k_g^* - k_c} - \frac{p_c}{k_c},$$

$$(22) \quad \mathrm{Q_g^*} = \int_{\frac{p_g^* - p_c}{k_g^* - k_c}}^{\frac{p_g - p_g^*}{k_g - k_g^*}} 1\, d\theta = \frac{p_g - p_g^*}{k_g - k_g^*} - \frac{p_g^* - p_c}{k_g^* - k_c}, \text{ and}$$

$$(23) \quad Q_g = \int_{\frac{p_g - p_g^*}{k_g - k_g^*}}^{1} 1\, d\theta = 1 - \frac{p_g - p_g^*}{k_g - k_g^*}.$$

The supply schedule of each of the products follows, as before, from the profit maximization of the individual competitive firms pursuing marginal cost pricing. The supply of the conventional good is again the sum of the supply from both the North and the South, while the North supplies all k_g quality goods and the South all of the k_g^* quality.

$$(24) \quad \mathrm{Q_c} = p_c\left[\frac{c_c + c_c^*}{c_c^* c_c}\right] - \frac{t}{c_c^*},$$

$$(25) \quad Q_g^* = \frac{p_g^* - t}{c_g}, \text{ and}$$

$$(26) \quad Q_g = \frac{p_g}{c_g}.$$

Equating supply and demand for each of these inter-related markets yields equilibrium prices.

$$(27) \quad p_g^{*,equil} = \frac{\left\{\frac{c_g^* c_g}{c_g + k_g - k_g^*} + t + \frac{t c_c c_g^* k_c}{\left(c_c^* + c_c\right)k_c\left(k_g^* - k_c\right) + c_c^* c_c k_g^*}\right\}\frac{1}{\left(c_g + k_g - k_g^*\right)\left(k_g^* - k_c\right)c_g^*}}{\left\{\left[\left(c_c^* + c_g\right)k_c\left(k_g^* - k_c\right) + c_c^* c_c k_g^*\right]\left[\left(k_g^* - k_c\right)c_g^* + \left(c_g + k_g - k_g^*\right)\left(c_g^* + k_g^* - k_c\right)\right] - \left(c_g + k_g - k_g^*\right)c_c^* c_c k_c c_g^*\right\}}.$$

The other two prices can be more concisely expressed in terms of p_g^* as follows.

$$(28) \quad p_c^{equil} = \frac{\left[p_g^* c_c^* + t\left(k_g^* - k_c\right)c_c k_c\right]}{\left(c_c^* + c_c\right)k_c\left(k_g^* - k_c\right) + c_c^* c_g k_g^*}, \text{ and}$$

$$(29) \quad p_g^{equil} = \frac{c_g\left(k_g - k_g^* + p_2\right)}{c_g + k_g - k_g^*}.$$

The consumer surplus is given by the following.

$$(30) \quad CS = \int_{\frac{\mathrm{p_c}}{\mathrm{k_c}}}^{\frac{p_g^* - p_c}{k_g^* - k_c}} \left(\theta k_c - p_c\right)d\theta + \int_{\frac{p_g^* - p_c}{k_g^* - k_c}}^{\frac{p_g - p_g^*}{k_g - k_g^*}} \left(\theta k_g^* - p_g^*\right)d\theta + \int_{\frac{p_g - p_g^*}{k_g - k_g^*}}^{1} \left(\theta k_g - p_g\right)d\theta,$$

$$(31) \quad CS = \frac{\left(P^*{}_g - P_c\right)^2}{2\left(k^*{}_g - k_c\right)} + \frac{P_c^2}{2k_c} + \frac{\left(P_g - P^*{}_g\right)^2}{2\left(k_g - k^*{}_g\right)} + \frac{k_g}{2} - P_g.$$

Imposing marginal cost pricing we solve for the foreign producer surplus.

$$(32) \quad PS^f = \int_0^{q_c^*} \left(p_c - t - c_c^* q\right) dq + \int_0^{q_g^*} \left(p_g^* - t - c_g^* q\right) dq,$$

$$(33) \quad PS^f = \frac{\left(p_c - t\right)^2}{2c_c^*} + \frac{\left(p^*{}_g - t\right)^2}{2c^*{}_g}.$$

Similarly, one can solve for the domestic producer surplus.

$$(34) \quad PS^d = \int_0^{q_c} \left(p_c - c_c q\right) dq + \int_0^{q_g} \left(p_g - c_g q\right) dq,$$

$$(35) \quad PS^D = \frac{P_c^2}{2c_c} + \frac{P_g^2}{2c_g}.$$

As before the world welfare (W) then is just $W = CS + PS^d + PS^f + t\left(q_c^* + q_g^*\right) - L$.

Numerical Simulation

To asses the welfare and trade implications of the different cases, we choose to undertake numerical simulation and comparative statics, using synthetic values for the cost and quality (i.e., greenness) parameters involved in the model. Among the many possible values, our preferred parameterization reproduces key stylized facts of the textile market. For example, the set {t=0.008, k_c=0.4, k_g=0.405, c^*_c=0.006=0.015k_c, c_c=0.08=0.15k_c, c_g=0.081=0.15k_g} leads to a tariff rate of 165 percent on conventional textiles imports, a market share of 83 percent for the South in conventional textiles, and a price markup of 32 percent for green textiles in the North. We tried many alternative sets of values (see Appendix). Fortunately, our comparative statics results hold for a wide range of values. As shown in Tables 1 and 2, our results are as follows.

In the first case, when the home country introduces an eco-label for its domestic market, two goods are present on the domestic market: the North's eco-labeled good and the conventional textiles good produced by both the North's and the South's industries. Consumers benefit from a larger choice set as those with a high θ can switch to the higher quality.

Demand for conventional textiles, including imports, decreases. The presence of the specific tariff, t, worsens the decline of imports of conventional textiles induced by the label. The label also hurts the domestic conventional textiles industry. Once the label is in place, however, it creates compatible interests between North producers of eco-labeled and conventional textiles to lobby for increased tariff protection. The specific tariff has two effects: a protectionist effect on both the North's conventional and eco-labeled textiles production, and a substitution effect towards the higher quality eco-labeled good away from "lower" quality conventional good, as the relative price of the latter is inflated by the specific tariff. The net effect on the domestic producer of the conventional quality is positive for all parameterization values used in the comparative statics.

In the next case, when the South reacts by creating its own eco-label, an intermediate quality emerges between the conventional and the North's eco-labeled textile good. The South's textile industry regains some of the lost surplus via exports of its own eco-labeled good. Nevertheless, the South's producers of conventional textiles are even worse off. Hence, a strong divergence of interests would exist between adopters and non-adopters of the eco-label in the South. Consumers in the North gain with the expanded quality choice (three types of textiles).

We have two unexpected results. First, the South's suppliers of eco-labeled textiles would rather harmonize upward than downward, abstracting from the fixed cost of certification and as long as the increase in demand dominates the surplus loss from the marginal cost shift caused by the higher standards (a higher k_g^*). Closing the quality gap downward between the North's and the South's eco-labeled goods is beneficial to the South's textiles industry as a whole. However, for its eco-labeled segment, downward harmonization is less lucrative than an increase in its quality standards relative to the North.

Of course, the South's producers of conventional textiles would rather see a downward harmonization. It would allow them to regain market share in the export market because of decreased quality competition. Northern consumers are always better off when any of the three qualities (conventional, green in the North and the South) increases. Consumers would never favor a downward harmonization of green labels and standards. Upward harmonization imposes

further competitive discipline on the North's eco-labeled textile industry, hence benefiting consumers via lowered prices.

The North's textiles industry would rather not harmonize and benefit from a larger quality gap between the two competing green textile goods. This is contrary to conventional belief that industrialized countries want to establish fair trade and uniform environmental standards across trading partners. An unexpected political economy situation emerges. Conventional textile producers in the North and the South and green-textiles producers in the North would rather keep the quality of the green good in the South low.

Conclusions

We reviewed some important stylized facts of eco-labeling schemes focusing on textiles. Important features of these schemes motivated the main assumptions of our model and the questions addressed in our analysis of welfare and trade implications of eco-labels. The modeling approach incorporated vertical product differentiation in which quality referred to environmental attributes of the textile goods. The production side of the model reflects the cost advantage of developing economies in textile production, and the increase in cost resulting from production standards linked to the eco-label.

A labeling scheme in the North without the South's participation is detrimental to both the North's and the South's producers of conventional textiles. In aggregate, the North's textiles industry benefits from the introduction of the label. If the South creates its own label, it regains market share in aggregate, but at the cost of its conventional textiles sector; both of North's industries lose.

Consumers gain with a wider choice and with higher quality of textile goods. They would favor upward international harmonization of eco-labels towards the higher quality of the North, as long as the South participates in production and provides some cost discipline.

Appendix

Sensitivity of the Results to the Parameterization

Below are five inferences drawn in the paper based on our most preferred parameterization. In this section we choose 12 different parameterizations to intentionally stress the model to see if the inferences are robust to other specifications. The results are quite consistent across these alternative parameterizations. The following inferences were drawn from the original parameterization:

1. If the Northern country introduces a label then CS increases.
2. If the Northern country introduces a label then PS_d increases.
3. If the Northern country introduces a label then its market share of q_c decreases.
4. Once the label is in place both the domestic conventional and green makers benefit from increases in the tariff.
5. Once the domestic label is in place if the South creates a label of its own then the South regains market share (and the North loses market share).

To test the generality of the above claims, the analysis was re-performed given the following different specifications:

1. Medium quality Southern green good becomes cheaper to produce.
   $\left(C_g^* = 0.001k_g^* \quad \text{not} \quad C_g^* = 0.015k_g^*\right)$.
2. High quality Northern green good becomes more expensive to produce.
   $\left(C_g = 0.3k_g \quad \text{not} \quad \mathrm{C_g} = 0.15k_g\right)$.
3. High Quality Northern green good becomes much more expensive to produce.
   $\left(C_g = 0.5k_g \quad \text{not} \quad \mathrm{C_g} = 0.15k_g\right)$..
4. High Quality Northern Good becomes cheaper to produce.
   $\left(C_g = 0.03k_g \quad \text{not} \quad \mathrm{C_g} = 0.15k_g\right)$.

5. Conventional Quality becomes Cheaper to produce.

   $\left(C_c = 0.00075k_c \text{ not } C_c = 0.015k_c \text{ and } C_c^* = 0.01k_c \text{ not } C_c^* = 0.2k_c\right)$.

6. Small Decrease in the quality of conventional goods, $k_c = 0.38$.
7. Increase in the Quality of the Northern green good, k_g=0.9.
8. Both tariffs reduced to 0 percent.
9. The green tariff reduced to 54 percent.
10. The conventional tariff reduced to 0 percent.
11. Conventional tariff increased to 213 percent.
12. Both tariffs are doubled.

In all of the above 12 scenarios representing different parameterizations, all five of the above inferences are maintained with only one exception. This exception occurs when the conventional tariff is increased by 213 percent and the South introduces a label of its own. In this case the South's introduction of a label does not cause its overall market share to increase but rather it stays about the same at 54 percent. The above different parameterizations were specifically chosen to stress the model, and yet our inferences appear fairly insensitive to the changes. This gives us some confidence in the robustness of our claims.

A second set of predictions involving Table 2 are made in the paper.

1. Southern suppliers prefer to harmonize upwards rather than downwards.

   $\left(\text{i.e. } PS_{up}^{f} > PS_{down}^{f}\right)$

In all cases but one this inference appears to hold. If the conventional tariff is eliminated (Case 9) then the foreign producers surplus benefits from downward harmonization but is actually hurt by upwards harmonization as consumers substitute away from the conventional goods in favor of the green ones.

2. Northern consumers are better off when any of the three qualities $\left(k_c, k_g^*, \text{and } k_g\right)$ increase (i.e. CS increases with upward harmonization and decreases with downward harmonization and increases with k_g). This means that Northern consumers always prefer upward harmonization.

This holds for all of the 11 parameterizations analyzed.

3. Northern producers would prefer not to harmonize. This means that PS_d decreases with both upward and downward harmonization. This holds for all 11 parameterizations analyzed.

Table 2. A comparison of scenarios analyzed

	Reference Case	Domestic Label Only	Two Labels
Price of k_c	0.0128	0.0115	0.0095
Price of k_g^*			0.0103
Price of k_g		0.0152	0.0130
Consumer Surplus	0.1874	0.1889	0.1910
Foreign Producer Surplus	0.0020	0.0010	0.0010
Domestic Producer Surplus	0.0010	0.0027	0.0020
Domestic Welfare	0.1949	0.1962	0.1980
World Welfare	0.1968	0.1972	0.1990
Tax Revenue	0.0065	0.0046	0.0050
	Market Share	**Market Share**	**Market Share**
q_c^*	83.4	59.5	26.4
q_c	16.6	14.8	12.2
q_g^*			39.9
q_g		25.8	21.5

Table 3. Results of harmonization

	Initial Values	Upward Harmonization	Downward Harmonization
	$k_g^* = 0.402$ $k_g = 0.405$	$k_g^* = 0.404$	$k_g = 0.403$
Price of k_c	0.0095	0.0093	0.0096
Price of k_g^*	0.0103	0.0107	0.0104
Price of k_g	0.0127	0.0115	0.0112
CS	0.1909	0.1916	0.1908
PSf	0.0006570	0.00076	0.0007031
PSd	0.0019	0.0016	0.0016
Domestic Welfare	0.1981	0.1986	0.1979
World Welfare	0.1987	0.1994	0.1986
Tax Revenue	0.0052	0.0054	0.0054
	Market Share	**Market Share**	**Market Share**
q_c^*	26.4	22.3	27.4
q_c	12.2	11.9	12.3
q_g^*	39.9	46.3	41.2
q_g	21.5	19.5	19.1

References

Bureau, J.C., S. Marette, and A. Schiavina. "Non Tariff Barriers and Consumers' Information: The Case of the EU-US Trade Dispute on Beef," *European Rev Agr Econ*, forthcoming.

European Commission. Directorate General. "The EU Eco-label Homepage -Textiles," http://europa.eu.int/comm/dg11/ecolabel/textiles.htm, April 1999.

Jha, Veena. "Harmonization and Mutual Recognition: Are They Feasible?." *Eco-Labelling and International Trade.* Eds. Zarrilli, S., Jha, V., and Vossenaar, R. pp. 310-17. St. Martins Press, Inc. New York. 1997.

Jha, V., and S. Zarrilli. "Eco-labelling Initiatives as Potential Barriers to Trade," in *Life-Cycle Management and Trade,* OECD Documents, Paris, 1994, pp. 64-73.

Kirchhoff, S. Achieving Environmental Goals in a World of Trade and Hidden Action: The Role of Trade Policies and Eco-labeling," November 1998, Mimeo, University of Maryland.

Kuhre, W. Lee. *ISO 14020's Environmental Labelling Programs.* Paris, 1997, p 25.

Lohr, Luanne. "Welfare Effects of Eco-Label Proliferation: Too Much of a Good Thing?" University of Georgia Faculty Series Working Paper #98-22, December 1998.

Mattoo, A., and H. Singh. "Eco-Labelling: Policy Considerations," *Kyklos* 47(1)(1994):53-65.

Mussa, M., and S. Rosen. "Monopoly and Product Quality," *Journal of Economic Theory* 18(1978):301-17.

Nimon, W., and J. Beghin. "Are Eco-Labels Valuable? Evidence from the Apparel Industry," *American Journal of Agricultural Economics,* forthcoming.

OECD (Organisation for Economic Cooperation and Development). "Eco-Labelling: Actual Effects of Selected Programmes," Document OECD/GD (97)105, May 1997. Paris.

Shapiro, C. "Premium for High Quality Products as Returns to Reputations," *Quarterly Journal of Economics* 98(1983):659-80.

Tirole, J. *The Theory of Industrial Organization*, Boston, MA: MIT press. 1989.

West, Karen. "Ecolabels: The Industrialization of Environmental Standards," *The Ecologist*, 25(1)(1995):16-21.

Zarsky, L. "Towards an International Ecolabelling Framework," in *Life-Cycle Management and Trade,* OECD Documents, Paris, 1994, pp. 194-205.

Zarrilli, Simonetta. "Trade in Eco-Labeled Products: Developing-Country Participation and the Need for Increased Transparency." *Eco-Labelling and International Trade*. Eds. Zarrilli, S., Jha, V., and Vossenaar, R. pp. 328-47. St. Martins Press, Inc. New York. 1997.