"Food Standards and International Trade"*

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1. Introduction

In the post-war period, the distribution of goods within national markets and across borders has become increasingly affected by the proliferation of standards and technical regulations (Maskus and Wilson, 2001; Essaji, 2008), with increased regulatory intensity being particularly noticeable in the food and agricultural sector over the past two decades (Roberts, 1999; Josling, Roberts and Orden, 2004; Henson and Jaffee, 2008; Maertens and Swinnen, 2008).[1] Based on data for the two-digit Harmonized System (HS), Essaji finds that six of the ten sectors with the highest intensity of technical regulations (TR) cover food and agricultural products.[2]

The proliferation of standards and technical regulations in both, the food and agricultural sectors, as well as the wider manufacturing sector, is typically regarded as the response of policymakers to consumer demands for improved product safety, increased environmental protection, and greater product information (Roberts, 1999; Maskus and Wilson, 2001; Wilson, 2008; Essaji, 2009).[3] Roberts (1999) argues that standards and technical regulations "have as their *prima facie* objective the correction of market inefficiencies stemming from externalities associated with the production, distribution, and consumption of these products. These externalities may be regional, national, transnational, or global," (pp-337).

The key to this description is the role of technical regulations and standards in solving market failures. Josling *et al*. (2004), suggest that standards in the food and agricultural sector can be classified under two broad categories: (i) provision of public goods such as control of pesticide use in agricultural production; and (ii) reduction of transactions costs associated with

[1] Following Wilson (2008), the language "standards" and standards and technical regulations" are used interchangeably in this chapter. Roberts (1999) defines a standard as a "technical specification or set of specifications related to characteristics of a product or its manufacturing process" (pp-337).

[2] In descending order of TR-intensity, the specific sectors are: cereals (10); fish, crustaceans and other aquatic vertebrates (03); edible preparations of meat, fish and crustaceans (16); edible vegetables, roots and tubers (07); prepared vegetables, fruit, nuts and other plant parts (2); prepared cereals and flours (19) – the two-digit HS code is listed in parentheses (Essaji).

[3] See Antle (2001) for an extensive discussion of this in the context of food safety.

information asymmetries between producers and consumers concerning food product characteristics, e.g., the extent of pesticide residues in a product which consumers are unable to ascertain either before or after its consumption.

While the theory of optimal intervention prescribes that market distortions should be targeted at source (Bhagwati, 1984), there is also acknowledgement that they may also provide protection for domestic producers and are, therefore, subject to "regulatory capture" (Roberts, 1999; Fischer and Serra, 2000; Sturm, 2006; Essaji, 2008; Swinnen and Vandemoortele, 2009). Given the potential for standards and technical regulations to distort international trade, a key outcome of the Uruguay Round of the General Agreement on Tariffs and Trade (GATT) in 1994 was the securing of multilateral disciplines on their use through the World Trade Organization's (WTO) Agreement on the Application of Sanitary and Phytosanitary Measures (SPS), and the revised Agreement on Technical Barriers to Trade (TBT). The objective of these agreements is to ensure that standards and technical regulations, while potentially meeting legitimate economic objectives, are not disguised restrictions on international trade.[4]

Although the main focus of this chapter is not the intricacies of trade law and food standards, it is interesting to note that between 1995 and 2002, WTO members filed 32 requests for formal consultations related to food regulation trade barriers under the WTO's dispute settlement process (Josling *et al*., 2004). These covered a wide range of sectors and technical regulations, and involved both developed and developing countries as petitioners and respondents. Perhaps the most analyzed Panel and Appellate Board rulings were those involving the US complaint against the European Community's (EC) use of measures concerning the use of hormones in meat and meat products (Roberts, 1998), and India, Malaysia, Pakistan and

[4] See Josling (2008) for a detailed discussion of the institutional environment for food standards and international trade.

Thailand's complaint against the US prohibition of imports of certain shrimp and shrimp products (Charnowitz, 2002). More recently, the introduction of genetically modified (GM) crops and the European Union (EU) requirement for labeling of food products containing genetically modified organisms (GMOs) has attracted a good deal of attention from the popular media, non-governmental organizations (NGOs), as well economists (Sheldon, 2002; 2004).[5]

The tension between the notion that standards and technical regulations are, on the one hand consumer-driven, but on the other, may provide protection to domestic producers, characterizes much of their economic analysis. For example, early theoretical work on standards by Casella (1996), examines standards in the context of provision of public goods. Given that demand for public goods will depend on economic primitives such as factor endowments, consumer preferences, and technology, necessarily provision will differ between countries depending on their stage of development. Using a simple model, Casella shows that with international trade, standards of developed and developing countries will converge over time, if demand is a function of the level of income. The implication of this result is that if trade itself eventually results in countries establishing similar standards for the provision of public goods, there is no need for such standards to be harmonized as a pre-condition for trade liberalization.

In contrast to this benign view of standards, there has been considerable discussion of the problems of regulatory compliance faced by developing countries in accessing developed country markets, given the latter typically have higher levels of regulatory intensity than the former (Jaffee and Henson, 2004; World Bank, 2005; Essaji, 2008). Testing the hypothesis of "standards as barriers" has been a dominant feature of the limited amount of empirical research

[5] In 2006, the WTO ruled on a complaint by the US concerning the EU's (EU) regulation of GM crops. It found that the EU failed its WTO obligations by not lifting its moratorium on the approval of GM crops and delaying the approval of new crops. In addition, the WTO ruled against the marketing and import bans put in place by six EU member states (Sheldon, 2007).

on the impact of food safety regulations on trade flows of specific food and agricultural commodities, e.g., Calvin and Krissoff (1998); Paarlberg and Lee (1998); Otsuki, Wilson and Sewadeh (2001); Wilson and Otsuki (2004); Peterson and Orden (2005); and Anders and Caswell (2009). A common finding of these empirical studies is that more stringent standards imposed by developed countries act as barriers to trade.[6]

What is somewhat surprising about the extant literature on food standards and international trade is the lack of any extensive theoretical underpinnings for what has essentially been either descriptive or empirical analysis. The objective of this chapter, therefore, is to explore in more detail two different aspects of international trade and standards based on resolution of *either* a public goods *or* an asymmetric information problem. In the next section, a general equilibrium setting is developed, drawing extensively on existing work in the trade and environmental economics literature. This analysis is designed to capture some key stylized facts and basic hypotheses concerning North-South trade where standards and technical regulations are targeted at negative externalities in food production. In the following section, a partial equilibrium setting is developed, drawing on recent work by the current author examining the role of labeling standards in maximizing the gains from international economic integration. Finally, the discussion in the chapter is summarized, and some conclusions are drawn concerning potential future research on food standards and international trade.

2. North-South Trade and Food Standards

As noted above, standards are often justified as a means of solving specific market failures such as externalities. However, it is typically claimed that developing countries are hampered in their ability to meet such standards due to a lack of necessary human capital and poor governance

[6] See also the survey of this literature in Wilson (2008).

(Maskus and Wilson, 2001; Essaji, 2008). Essaji also presents empirical evidence to support the hypothesis that the capacity to satisfy standards is correlated with real GDP per capita, developing countries specializing away from industries with heavier regulatory burdens.[7] It is interesting therefore to see how far one get with a general a model of North-South trade with standards that captures these stylized facts.

In order to do this, a model of trade and standards in the presence of environmental externalities originally due to Copeland and Taylor (1994; 1995), is adapted. Assume there is a bloc of countries representing the developed North, and a bloc representing the developing South, producing along a continuum of consumption goods, $z \in [0,1]$ with one primary input, effective labor *l*.[8] Part of this continuum consists of food consumption goods, the remainder being other non-food goods. Assume that a public bad *b* is produced jointly with each consumption good *z* in the continuum, e.g., in the case of food production this could be pesticide runoff. The output y of any good *z* in the continuum is a function of combining both effective labor *l* and the bad *b* via the following constant returns to scale Cobb-Douglas technology:

$$y(l,b;z) = \begin{cases} l^{1-\alpha(z)} b^{\alpha(z)} & \text{if } b \le \lambda l \\ 0 & \text{if } b > \lambda l \end{cases}, \qquad (1)$$

where $\lambda > 0$, $\alpha(z)$ varies across goods, and $\alpha(z) \in [\bar{\alpha}, \hat{\alpha}]$, with $0 < \bar{\alpha} < \hat{\alpha} < 1$.[9]

On the consumption side, consumers in the North and South have identical utility functions, consumption goods *z* and the public bad *b* being separable in utility; and given homothetic

[7] Essaji combines a measure of human resource capacity and capacity to implement testing and certification procedures to generate an index of a country's capacity to meet technical regulations.

[8] This model is essentially an adaptation of Dornbusch, Fischer and Samuleson's (1977) Ricardian model with a continuum of consumption goods. See also Copeland and Taylor (2003; 2004) for a Heckscher-Ohlin-type setting with two goods and two factors of production.

[9] Derivation of the technology in (1) can be found in the Appendix to Copeland and Taylor (1994).

preferences, the share of spending on each consumption good z in the continuum is a constant. The utility function of a representative consumer is given as:

$$U = \int_0^1 f(z)\ln[x(z)]dz - \frac{\beta D^{\gamma}}{\gamma}, \tag{2}$$

where $x(z)$ is consumption of z, $f(z)$ is the budget share for each good in the continuum, and the sum of budget shares is $\int_0^1 f(z)dz = 1$; D is aggregate production of the public bad; and $\gamma \geq 1$, implying consumers' willingness to pay for a reduction in the level of the public bad is non-decreasing in its aggregate level.

Without government regulation, firms have no incentive to abate the public bad, always choosing a point along the production ray $b = \lambda l$. However, if it is assumed that a public standard s is set for an allowable level of the public bad, and firms abate a small amount of the public bad, there will be an interior solution.[10] In enforcing the standard, it is assumed that the government imposes a per unit compliance cost c_b on firms that utilize the public bad in production, the compliance cost consisting of certification and monitoring costs. It should be noted that while the per unit compliance cost has similar effects to a per unit tax on pollution, there is no presumption, as in Copeland and Taylor (1994; 1995), that c_b is set optimally.

Given a return on a unit of effective labor w_e, and the per unit compliance cost c_b, cost minimization for any good in the continuum z implies that:

$$\frac{w_e}{c_b} = \frac{1-\alpha(z)}{\alpha(z)}\frac{b}{l}. \tag{3}$$

[10] Copeland and Taylor (1994) show that as long as $b/l < \lambda$ for all z, an interior solution exists.

Expression (3) indicates that the share in production costs of the compliance cost is a constant $\alpha(z)$, so that goods in the continuum can be ordered in terms of their intensity in generating the public bad, $\alpha'(z) > 0$.[11]

Suppose the technology in (1) is available to firms in both North and South, and each has the same endowment of workers L, but the supply of effective labor is greater in the North than the South, $A(h)L > A(h^*)L$, where h is the human capital/worker, and $h > h^*$ (* denoting the South). Given that the return to effective labor is higher in the North than the South, income per capita in the North exceeds that in the South, and if demand for the public good is income elastic, then the North will set both a higher standard s and, higher per unit compliance costs c_b will be charged to cover the costs of monitoring and enforcement.[12]

The unit cost function from (1) and (3) for a good z in the continuum can be written as:

$$a(w, c_b; h, z) = \kappa(z) c_b^{\alpha(z)} [w / A(h)]^{1-\alpha(z)}, \qquad (4)$$

where $\kappa(z) \equiv \alpha^{-\alpha}(1-\alpha)^{-(1-\alpha)}$ is a good-specific constant, and w is the wage rate for raw labor. For given wages and compliance costs, a good z in the continuum will be produced in the North if $a(w, c_b; h, z) \leq a^*(w^*, c_b^*; h^*, z)$, such that:

$$\omega \equiv \frac{w}{w^*} \leq \frac{A}{A^*}\left(\frac{c_b^*}{c_b}\right)^{\alpha(z)/(1-\alpha(z))} \equiv T(\tilde{z}). \qquad (5)$$

Conversely, a good z in the continuum is produced in the South if $\omega \geq T(\tilde{z})$. Given $c_b > c_b^*$, and $\alpha'(z) > 0$, $T(\tilde{z})$ is decreasing in z, i.e., the North's comparative advantage in producing any good z falls as compliance costs become a larger fraction of total production costs. Therefore, for any

[11] Both food and non-food consumption goods are assumed to be spread along this continuum in terms of their generation of the public bad. This ensures that both North and South will produce both food and non-food consumption goods in equilibrium.

[12] To keep the algebra to a minimum, compliance costs are being treated as exogenous here however, it is possible to derive them explicitly as a function of income (see Appendix).

given value of relative wages ω, there will be a critical industry $\tilde{z}$ on the $T(\tilde{z})$ schedule where goods are either produced in the North on the interval $z \in [0, \tilde{z}]$, or they are produced in the South on the interval $z \in [\tilde{z}, 1]$, with the North (South) producing the goods that are least (most)-intensive in their production of the public bad.

In order to determine equilibrium relative wages ω, and hence the critical industry $\tilde{z}$, it is necessary to follow the approach of Dornbusch, Fischer and Samuelson (1977), by introducing the demand side of the economy through a balance of trade schedule. Given the assumption of homothetic preferences, first define the proportion of income spent on Northern and Southern produced goods respectively:

$$\begin{aligned} \psi(\tilde{z}) &\equiv \int_0^{\tilde{z}} f(z)dz \\ 1-\psi(\tilde{z}) &\equiv \int_{\tilde{z}}^1 f(z)dz, \end{aligned} \tag{6}$$

and then define the balanced trade condition as:

$$[1-\psi(\tilde{z})]wL = \psi(\tilde{z})w^*L, \tag{7}$$

i.e., total imports of Southern goods by the North have to equal total exports of Northern goods to the South. Rearranging (7) generates a balance of trade schedule:

$$\omega = \frac{\psi(\tilde{z})}{1-\psi(\tilde{z})} \equiv B(\tilde{z}), \tag{8}$$

$B(0) = 0$, $B(1) = \infty$, and $dB/d\tilde{z} > 0$, $B(\tilde{z})$ sloping upwards to reflect the fact that as the range of goods produced in the North increases, its exports increase and its imports fall, so that the relative wages ω have to increase to balance trade. Combining both $T(\tilde{z})$ and $B(\tilde{z})$ schedules determines the equilibrium relative wage ω and critical industry $\tilde{z}$ - see figure 1.

Assuming that the public bad b is local, given $h > h^*$, and $s > s^*$, the equilibrium is one where the North specializes in goods that are intensive in their use of effective labor $z \in [0, \tilde{z}]$,

while the South specializes in goods that are intensive in their use of the public bad $z \in [\tilde{z},1]$. This reflects both the North's comparative advantage in producing goods that generate less of the public bad, as well as the fact that it sets higher regulatory standards. Over time, if there is technological change in the South, h^* increasing, the $T(\tilde{z})$ schedule in figure 1 shifts down to the left $T'(\tilde{z})$, the South increasing its production of goods that are intensive in their use of effective labor, and at the same time raising the level of their standards s^* as their per capita income rises.[13] In the limit though, if North and South end up with similar levels of effective labor, $h = h^*$, and therefore similar levels of standards, $s = s^*$, the pattern of trade will be indeterminate. However, if $A/A^* > 1$, then the North will be a net exporter of embodied labor services, while the South will be a net exporter of embodied public bad.

The result presented in figure 1 assumes that aggregate damage *D* from the public bad is only local in its effects, food standards being benign in that their level simply reflects the relative development of the North versus the South. Suppose, however, that the public bad produced in the South is assumed to have potential effects in the North. For example, if the local public bad in the South is pesticide runoff, consumers in the North may be concerned about the potential for pesticide residues on food consumption goods imported from the South.[14] As a result, consumers in the North demand that standards *s* also be applied to imported goods from the South. These standards can either be supplied publicly, or they could be private standards established for example by coalitions of food retailers in the North (Henson, 2008).[15]

[13] See the Appendix for how standards can be modeled endogenously as a function of income.
[14] Higher standards in the North may also be due to the fact they have higher quality institutions in place to enforce standards, and/or a different organization and structure of their media affecting consumer perceptions of risk (Swinnen and Vandemoortele, 2009).
[15] The way in which the model is set up, firms producing consumption goods have no private incentive to reduce production of the public bad. However, if retailers of final goods in the North are allowed for, they have an incentive to establish private standards as a means of mitigating reputational and commercial risks (Fulponi, 2007;

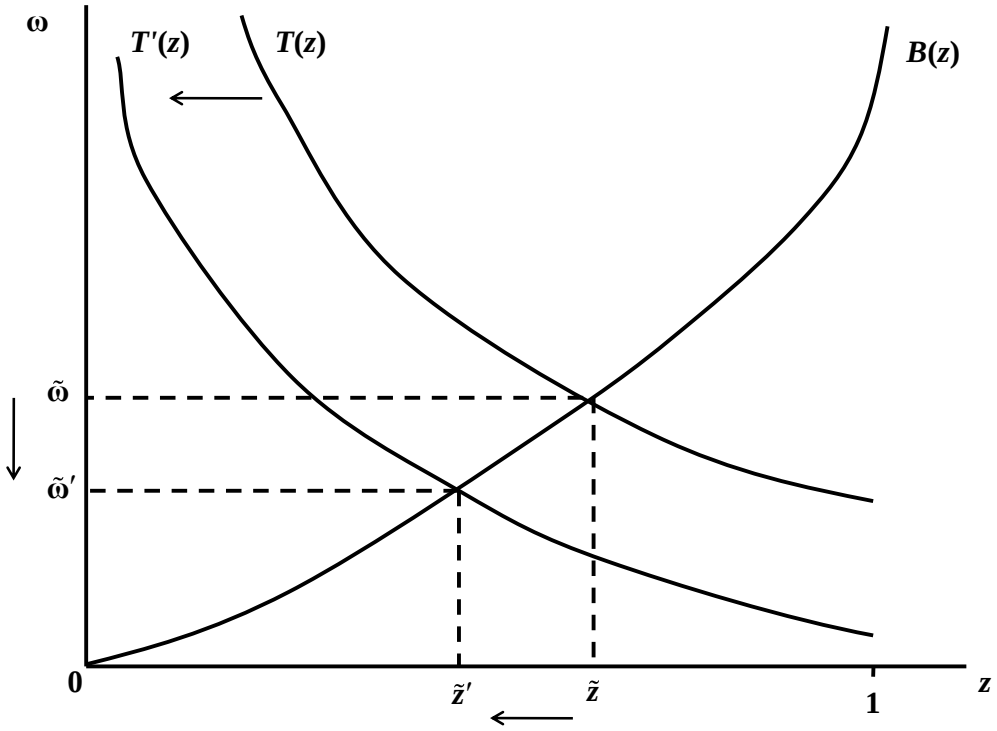

Figure 1

Following Dornbusch *et al*. (1977), the additional compliance costs due to application of the higher Northern standard *s* on the range of goods imported by the North, are modeled as iceberg transport costs, g^*.[16] This implies that only a fraction $g^*(z)$ of any commodity *z* actually arrives, the relationship between unit costs in the North and South being re-written as $a(w, c_b; h, z) \leq [a^*(w^*, c_b^*; h^*, z)]/g^*$. This results in a new schedule $T'(\tilde{z})/g^*$ in figure 2, such that at for a given relative wage ω, there will be a set of non-traded goods between $(\tilde{z} - \tilde{z}')$.[17] In

Henson and Jaffee, 2008; Maertens and Swinnen, 2008). See also Casella (2001) for theoretical analysis of private coalitions and standards setting.

[16] See Wilson (2008) for a discussion of the empirical evidence on the impact of standards on compliance costs. Alternatively, Maertens and Swinnen (2008) suggest it is the costs of non-compliance that are potentially high.

[17] If the North also faced iceberg transport costs *g* in exporting to the South, its unit cost function would also be adjusted, and the range of non-trade goods would become wider. See Dornbusch *et al*. (1977) for how to solve out for the equilibrium relative wage in the presence of non-traded goods.

other words the North continues to produce and export goods in the range $z \in [0, \tilde{z}]$, for which it has a comparative advantage, but it also produces goods in the range $(\tilde{z} - \tilde{z}')$ as it is cheaper than importing those goods, although it cannot export these goods to the South as they can still be produced more efficiently in the South. The South also produces non-traded goods in the range $(\tilde{z} - \tilde{z}')$, but its exports are reduced to the range $z \in [\tilde{z}', 1]$. This result also provides a motive for firms in the North to lobby for higher standards to be imposed on imports from the South, thereby allowing them to produce the range of non-traded goods that they otherwise would not produce.

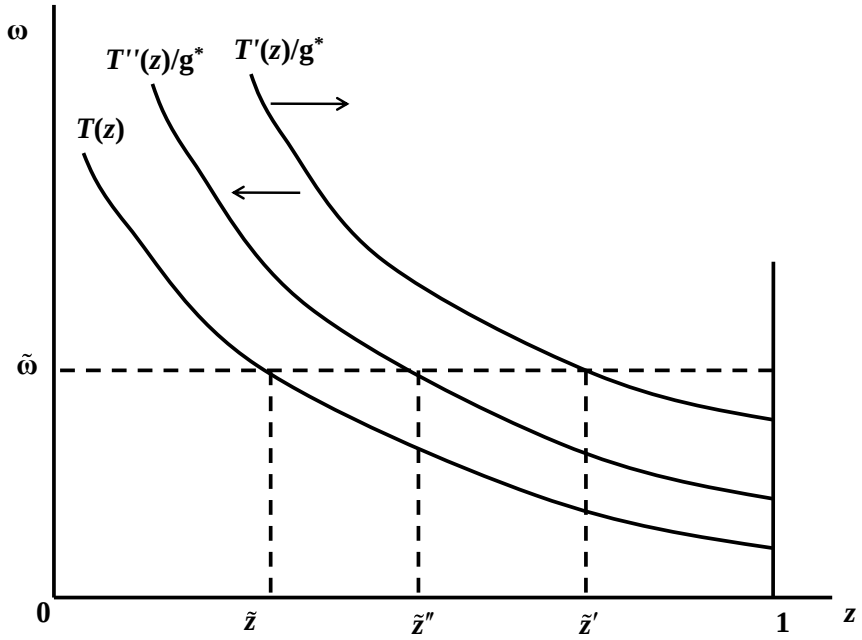

Figure 2

Introducing iceberg transport costs into the model can be interpreted as broadly capturing the "standards as barriers" hypothesis, illustrating the concerns developing countries have about proliferation of food standards and technical regulations in developed countries (both public and

private), and why calls for harmonization of standards by the North are often regarded with suspicion by developing countries.[18]

Recently, however, several authors have put forward the hypothesis that rather than barriers, higher food standards in developing countries may be a "catalyst to trade" (Henson and Jaffee, 2008; Maertens and Swinnen, 2008; Anders and Caswell, 2009).[19] Henson and Jaffee argue that being forced to comply with higher standards provides an incentive to firms and regulators in developing countries to invest in their ability to meet such standards. For example, they appeal to Porter and van de Linde's (1995) argument that there will be regulatory-induced innovation at the firm level.[20] While Maertens and Swinnen argue that higher standards may stimulate increased vertical coordination in developing country food supply chains. Crudely, the "standards as catalysts" hypothesis is represented in figure 2 by the shift in the $T'(\tilde{z})/g^*$ schedule to $T''(\tilde{z})/g^*$ as an increase in effective labor h^* in the South offsets the costs of complying with higher standards in the North. An alternative motivation for the increase in h^* is that multinational firms based in the North invest in the South in order to ensure public/private standards in the North can be complied with.[21]

[18] See Bhagwati (1996) for a good discussion of the issue of harmonization of standards.

[19] Swann, Temple and Shurmer (1996) provide econometric support for the hypothesis that idiosyncratic national standards can promote domestic product quality, and thereby increase exports.

[20] Anders and Caswell's recent analysis of the impact of US food safety standards on imports of seafood provides some early empirical support for the "standards as catalyst" hypothesis.

[21] Formally, the type of model presented in this section does not account for the possibility that international economic integration may result in developing countries having greater access to technology that would allow them to better comply with higher standards in developed countries (Copeland and Taylor, 1994). There is, however, empirical evidence that private standards are being applied in developing countries by multinational food retailers (Reardon and Berdegue, 2002).

3. Trade, Food Standards and Labeling

The model outlined in the previous section ignores not only the possibility that goods may be explicitly differentiated in terms of quality, e.g., organically produced, dolphin-safe, free-range, GMO-free etc., but also that consumers may be unable to verify any claims made about quality. Goods that suffer such *ex post* information asymmetries are a simplified version of credence goods (Darby and Karni, 1973; Dulleck and Kerschbamer, 2006). Labeling in combination with a standard is one method for addressing the credence good problem, requiring a number of regulatory choices concerning the labeling regime: compulsoriness (*mandatory* or *voluntary*), explicitness (*discrete* or *continuous*), and exclusiveness where only government labeling is available {*exclusive*}, or private firms may also certify {*non-exclusive*}.[22]

Drawing on Roe and Sheldon (2007), and Sheldon and Roe (2009a; 2009b), a model of vertical product differentiation can be used to analyze the efficiency and distributional implications of these regulatory choices under both autarky and international economic integration.[23] Assume initially that there is perfect information about quality and that consumers in a representative country have a unit demand for a quality-differentiated good. Consumer utility is:

$$U = u(y - p), \tag{9}$$

where $u \in [\underline{u}, \infty]$ is the quality level of the differentiated good, the lower bound $\underline{u} > 0$ meets a minimum quality standard, perfectly enforced by government, y is income, and p is the price of

[22] See Teisl and Roe (1998) for a complete typology of labeling regimes. See also Crespi and Marette (2001), and Segerson (1999) for discussion of mandatory versus voluntary labeling regimes.
[23] The underlying model was first introduced by Gabszewicz and Thisse (1979; 1980) and Shaked and Sutton (1982; 1983), and later extended by Boom (1995). Other models of quality and trade include Flam and Helpman (1987), Motta (1992), and Murphy and Shliefer (1997).

the differentiated good, where $(y - p)$ is expenditure on a Hicksian composite commodity.[24] If the consumer decides not to buy the differentiated-good, $u=0$; hence, the good is always purchased unless price exceeds income. Consumers derive the same surplus from a good of a particular quality, but differ in their ability to pay. Incomes are uniformly distributed on the interval $[a, b]$, $a > 0$, where n $(b - a)$ is a measure of the size of the representative economy.

Firms produce a single differentiated good, with all firms sharing the same production technology characterized by zero production costs and a fixed, quality-dependent cost, $F(u)$, which is sunk by the firm after entry into the market.[25] It is assumed that:

$$F(u) = \varepsilon + \alpha(u - \underline{u})^2 , \qquad (10)$$

where ε and α are strictly positive constants. Sunk costs are convex and strictly increasing in quality, a sunk cost of $\varepsilon > 0$ being necessary to achieve even minimum quality.

The choices of firms are characterized by the following game: at stage 1, each firm decides to enter or not enter the market, incurring sunk costs ε upon entry; at stage 2, firms that have entered simultaneously choose their good's quality level, incurring the additional fixed costs for producing the chosen quality; at stage 3, firms simultaneously set good prices in a Bertrand-Nash equilibrium. If the parameters of the income distribution are $4a > b > 2a$, then exactly two firms enter the market, so long as fixed costs plus labeling costs are not prohibitively high, and each entrant has a positive market share in equilibrium, i.e., a natural duopoly.[26]

The autarky equilibrium for a representative economy is described in figure 3. Firms' fixed costs $F(u)$ and revenue $sR(.)$ are plotted on the vertical axis against quality u, the low and high-

[24] A separate literature already exists focusing specifically on minimum-quality standards, e.g., Ronnen (1991), Boom (1995), Scarpa (1988), and Lutz (2000).

[25] The assumption of zero variable production costs can also be relaxed without altering the main results.

[26] This restriction on income dispersion also ensures that each consumer either purchases one unit of the differentiated good or is indifferent between purchasing the lowest quality and purchasing none, i.e., a 'covered' market. This result, the so-called "finiteness property" (Shaked and Sutton, 1982; 1983), ensures that equilibrium market structure is endogenous.

quality firm's revenue functions under autarky being $nR_1(u_1,u_2)$ and $nR_2(u_2,\underline{u})$ respectively. Suppose the low-quality firm chooses $\underline{u}$. If the other firm set its quality at this level, price competition drives firms' revenue to zero, given the assumption of zero variable production costs. In addition, due to sunk costs ε both firms would incur a loss. Consequently, the optimal choice of the other firm is to increase quality to u_2 in order to maximize profits given by the vertical distance ($v - w$). At the same time, this reduces price competition with the low-quality firm, allowing the latter to maximize its profits given by the vertical distance ($f - g$). If the low-quality firm were to increase its quality from the minimum $\underline{u}$ to $u_1 = u_2$, price competition again results in both firms incurring a loss. Hence, the equilibrium choice of qualities is the pair $\underline{u}$ and u_2.

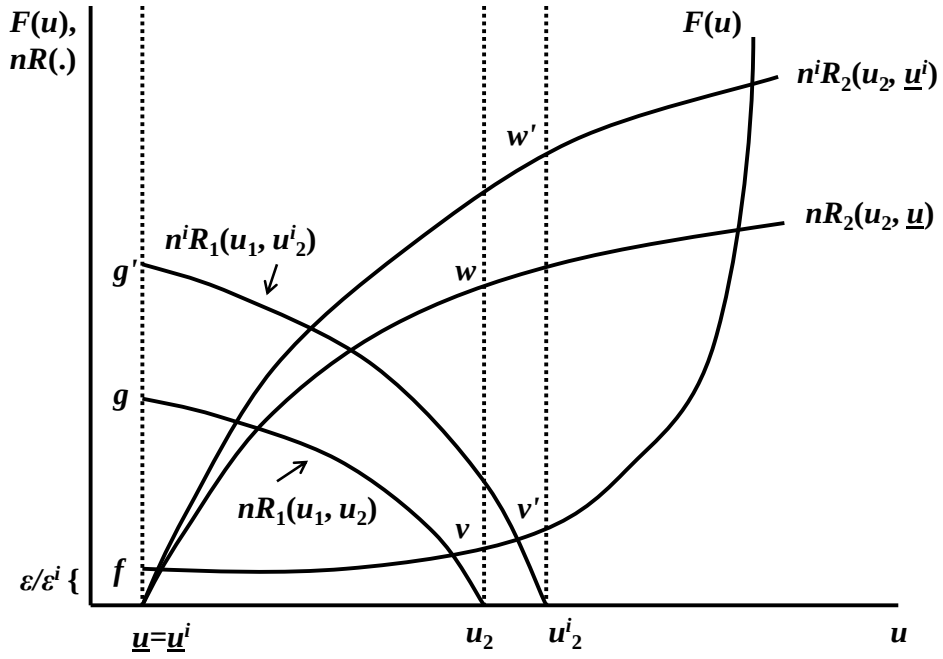

Figure 3

Now suppose that two North-North economies integrate, each of the same size n, with the same uniform distributions of income. Firms must incur some additional sunk costs ε^i in order to enter the integrated market, and each country has the same minimum quality standard $\underline{u}^i$ prior to integration. Due to the fact that each economy supports only two firms under autarky, the integrated equilibrium supports only two firms, i.e., two firms will exit, although the direction of trade is indeterminate.[27] In figure 3, given an increase in the population size to n^i, the high-quality firm's revenue function rotates upwards to $n^i R_2(u_2,\underline{u}^i)$, resulting in an increase in the quality of good 2 to u_2^i, and an increase in the high-quality firm's profits to the vertical distance $(v' - w')$. Given u_2^i, the low-quality firm's revenue function shifts out and rotates upwards to $n^i R_1(u_1,u^i{}_2)$, its profits increasing to the vertical distance $(f - g')$, the quality of good 1 remaining the same at the minimum $\underline{u} = \underline{u}^i$. As a result, in the integrated equilibrium, while the prices and profits of both firms increase due to increased vertical product differentiation, gains from economic integration come from increased quality.[28]

Now consider North and South economies, each having incomes uniformly distributed over the range $[a_k, b_k]$, and $4a_k > b_k > 2a_k$, where subscript k refers to either North (N) or South (S). In addition, assume that $a_N > a_S$, $b_N > b_S$, and, $b_N < 2b_S$, $a_N < 2a_S$, and that the same technology is available in North and South.[29] Under autarky, both North and South will be able to sustain two firms in equilibrium selling distinct qualities. Also assume that the North sets and enforces a higher minimum quality standard than the South, such that $\overline{u}_N = \underline{u} + \sigma$ with $\sigma > 0$, and $\overline{u}_S = \underline{u}$.

[27] This is not uncommon in models where firms are essentially "footloose", i.e., firms can produce anywhere in the integrated market. To pin down which country trades which good, we would need additional structure; for example, in a Ricardian-type setting, differences in unit production costs would ensure a firm in one country has a comparative advantage in producing the high-quality good, the firm located in the other country having a comparative advantage in producing the minimum-quality good, i.e., intra-industry trade in vertically differentiated products.

[28] See Roe and Sheldon (2007) for a proof of the result that aggregate welfare increases with quality.

[29] The existence of footloose firms in this model is sufficient to ensure technology available in the North will also be available in the South.

Consequently, in the North, given the higher minimum quality standard, the high-quality firm, in order to escape the pressure of price competition, will also produce and sell a higher-quality good in equilibrium, resulting in the low and high-quality goods in the North under autarky being of higher quality than their counterparts in the South. This result is consistent with the earlier observation that demand for higher quality is income elastic, and hence correlated with the level of economic development.

Now allow the North and South to integrate, assuming as before that firms must incur some additional sunk costs ε^i in order to enter the integrated market. In addition, assume that North and South accept each other's minimum quality standard. It turns out that only three firms survive in the integrated equilibrium due to increased price competition.[30] As a result, there is an increase in the average quality of goods consumed, the lowest quality good exiting the market, with consumers in the South now being able to purchase the minimum-quality good produced in the North. [31] There may also be intra-industry trade, if the medium-quality good is produced in the South, and the minimum and high-quality goods are produced in the North although this is not guaranteed.

With imperfect information, all communication of quality has to occur through a label administered and verified by a separate certifier(s), who could be either a public agency or a combination of public agency and private firm.[32] Public and private certifiers are assumed to

[30] See Sheldon and Roe (2009a; 2009b) for a detailed proof of this result.

[31] The North and South could harmonize their minimum quality standard to that of the North, in which case, the South's minimum-quality good would be driven from the market by executive fiat. However, there will still be intensified price competition between the three remaining goods. Alternatively, if the North and South harmonize to the minimum quality standard of the South, as long as the cost of labeling the higher minimum quality is not too high, the lower minimum quality good is still likely to be driven from the market.

[32] There are several papers in the agricultural economics literature addressing labeling and regulation in credence good markets, e.g., Marette, Crespi and Schiavina (1999); Marette, Bureau, and Gozlan (2000); Giannakas and Fulton (2002); Fulton and Giannakas (2004); and Zago and Pick (2004). None, however, address the issue of labeling in an international trade context, and all are based on the Mussa and Rosen (1978) model of vertical differentiation where the number of goods in equilibrium is imposed exogenously as part of the analysis.

perfectly monitor and communicate the quality of individual firms *ex ante* for a fee paid by the firms.[33] The fixed cost of certifying and labeling the good is given as:

$$I^j(u) = I^j \text{ for } u > \underline{u} \qquad (11)$$

$$= 0 \text{ otherwise,}$$

where $j \in \{t, d\}$ and t and d stand for continuous and discrete labeling, respectively. Continuous labels communicate the exact level of quality while discrete labels merely communicate if quality meets or exceeds a particular quality threshold. Firms claiming quality meeting the minimum quality standard are never charged a fee, $I^j(\underline{u}) = 0$, because a firm has no incentive to produce a higher-quality good and market it as the minimum quality. Both private and public certifiers are assumed to provide labeling at the same cost, there exist no economies of size, and such costs are the same throughout the integrated economy. However, if labeling of quality above the minimum is mandatory, firms have to meet any government-set labeling regulations through public certification before incurring any additional costs of private certification. It is also assumed that discrete certification is less costly, $I^t(u) \geq I^d(u) \; \forall \; u > \underline{u}$, and that there are no variable costs of labeling.[34]

First consider the case where quality is opaque to the consumer and no labeling program exists. In both North-North and North-South integrated economies, the sunk cost of entry, ε^j, combined with the three-stage game supports the entry of only a single firm into the integrated market, while the opaqueness of quality and lack of labeling leads to production of the minimum

[33] The assumption of perfect monitoring, while strict, allows the market to be converted from one of credence goods to one of search goods. If monitoring were noisy, deduction of equilibrium would require a repeated game structure as in McCluskey (2000). Because monitoring is assumed to be perfect, repeating the current game would not change the resulting equilibrium.

[34] Monitoring a discrete standard is likely to be cheaper as it merely requires checking that processes meet or exceed a given threshold, i.e., going over a check list, while continuous labeling may require additional monitoring equipment to calibrate and report exact performance. Allowing for variable costs of labeling would be similar to allowing for variable costs of production.

quality standard $\underline{u}$. The resulting price and profit levels are the simple monopoly outcome, with the poorest consumers being unable to buy even the minimum quality good.

Second, suppose it is mandatory that any firm claiming equality higher than the minimum has to participate in an exclusive, continuous labeling program. The only difference to the perfect information case is the addition of the cost of continuous labeling, plus firms have to incur the additional sunk costs, ε^i, of entering the integrated market. As long as two firms enter the North-North market, or three firms enter the North-South market, the outcome is identical to the perfect information market with respect to prices, qualities and profits for the low-quality firm. Only the profits of the high-quality firm in the North-North case, and the profits of the medium and high-quality firms in the North-South case are different because of labeling costs. Hence, continuous labeling does not distort firm choices so long as it is not too expensive. Consumers experience no change in welfare compared to the perfect information case so long as two qualities are produced in the North-North case and three qualities in the North-South case, as labeling leaves price and quality unchanged in equilibrium, i.e., the gains from economic integration are still realized.

In contrast suppose firms claiming higher than minimum environmental quality, are mandated to implement a single harmonized, discrete standard u_2^g, firms being forbidden from certifying and communicating any other standard.[35] Focusing on the North-North case, if the harmonized standard u_2^g is set lower than u_2^i, the two qualities are closer together and price competition becomes more intense between the two firms - $u_2'^g$ in figure 4. This bodes well for consumers who purchase the low-quality good, who now pay a lower price, but consumers of the high-quality good would rather have the higher quality and pay the higher price. In addition, the

[35] Harmonization implies that when two countries integrate economically, an agreed upon standard applies in both countries (Leebron, 1996; Lutz, 2000).

more intense price competition reduces the profits of the low-quality firm to ($f - g'$), and the high-quality firm to ($v' - w'$).

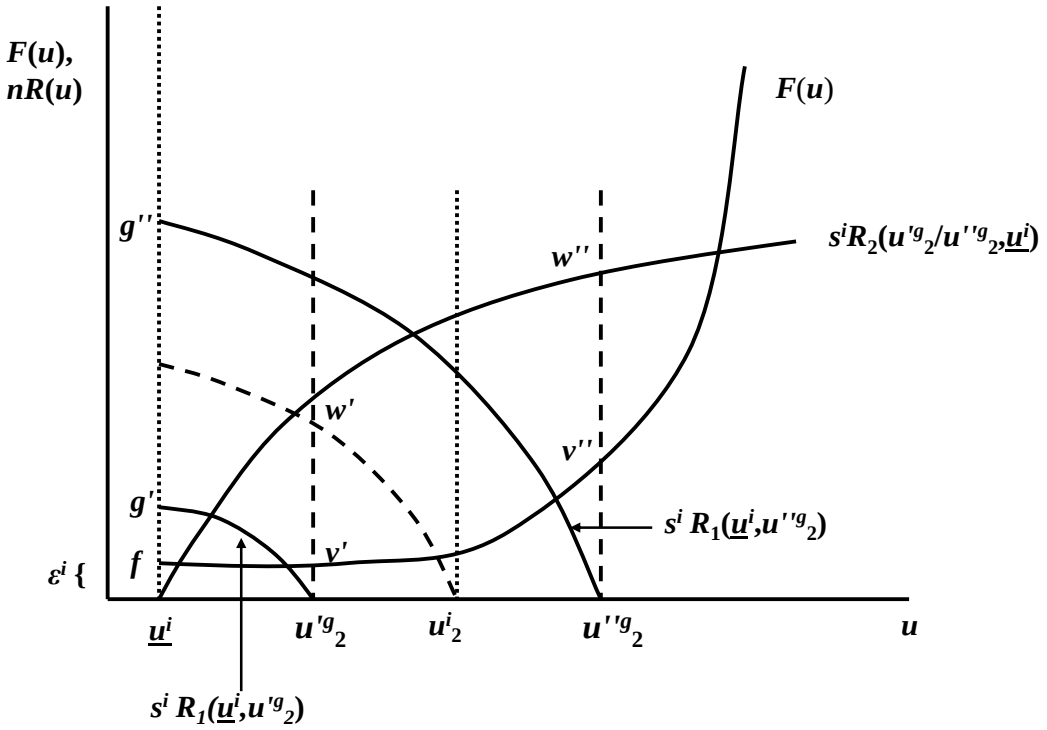

Figure 4

If the standard u_2^g is higher than u_2^i, price competition is relaxed - $u_2^{\prime\prime g}$ in figure 4. This harms consumers of the low-quality good, who now pay a higher price. Consumers of the high-quality good welcome the increase, as they value the quality increase more than they are harmed by the price increase. The relaxed price competition inflates the low-quality firm's profits to ($f - g''$). The high-quality firm also charges a higher price, but the convex, fixed cost of producing quality comes to dominate and drive the high-quality firm's profits down to ($v'' - w''$) . Therefore, the high-quality firm suffers regardless of the direction of the harmonized labeling standard's

deviation from the perfect-information quality choice. Of course if the standard is set too high, the high-quality firm does not enter the integrated market at all.

Under North-South economic integration, assume one harmonized labeling standard is set $u^g = u^k$. The impact of the labeling standard depends on its location relative to what would be optimal for the firms choosing qualities u_2^i, and u_3^i. First, if $u^g \leq u_2^i$, the highest-quality good is forced from the market, and it may force the medium-quality good out of the market as well if u^g is set too low, thereby intensifying price competition too much between the medium and minimum-quality goods. Second, if $u_2^i \leq u^g \leq u_3^i$, either the medium or the highest-quality good will be driven from the market, depending on the location of the harmonized public standard between the medium-quality and the high-quality goods. Essentially, if the standard is set not too far from the optimal level of quality, $u_2^i(u_3^i)$, the high-quality (medium-quality) good will be driven from the market, as only one good can survive at that level of quality. This will of course diminish competition between the remaining goods, because whether the medium or high-quality good survives, it is the case that $\overline{u}_N \leq u_2^i \leq u^g \leq u_3^i$. Finally, $u_3^i \leq u^g$, the medium-quality good will be forced from the market as it will be unprofitable for two firms to compete at a standard set higher than that preferred by the high-quality firm.

It is important to recognize that allowing for private labeling schemes affects the results of harmonized mandatory, discrete labeling.[36] In the case of North-North integration, high-quality firms may also pay a private certifier to certify and label another quality level beyond that mandated by the regulator. That is, if the regulatory authorities choose a harmonized standard

[36] For example, the Marine Stewardship Council (MSC) was formed in 1996 as a partnership between the World Wildlife Fund (WWF) and Unilever, a corporation with significant market share in the boxed frozen fish sector, its objective being to provide a mechanism for labeling seafood products harvested from a sustainable source (Wessells, Johnston and Donath, 1999).

the firm deems too low, the firm may hire a private certifier to verify and communicate a higher quality. Alternatively, if the regulatory authorities choose a harmonized standard the firm deems too high, the firm may hire a private certifier to verify and communicate a lower quality - though the regulatory authorities will communicate to the public that the firm fails the harmonized standard.

The high-quality firm compares the profits it gains from selling a good at its preferred level of quality to the additional labeling costs it pays the private certifier. If the harmonized standard is 'close enough' to the high-quality firm's desired quality level, the firm will not pay the additional cost of a second, private, certification. However, if the harmonized standard deviates too far from firm-preferred quality levels, the harmonized standard is disregarded and replaced by a standard chosen by the high-quality firm. Consequently, once the regulatory authorities allow private certification and labeling of credence goods, the benefits of North-North economic integration are more likely to be achieved, even if the harmonized standard does not coincide with the high-quality firm's optimal choice.

Similarly with North-South integration, firms will compare the profits they gain from selling a good at their preferred level of quality to the additional labeling costs they pay the private certifier. If the harmonized standard is 'close enough' to the medium-quality and/or the high-quality firm's desired quality levels, neither firm will pay the additional cost of additional private certification. However, if the harmonized standard deviates too far from firm-preferred quality levels, the harmonized standard is disregarded and replaced by a standard chosen by the medium-quality and/or the high-quality firm(s).[37] Therefore, if the regulatory authorities allow private certification and labeling of credence goods, the benefits of North-South economic

[37] It might be questioned whether firms based in the South will be in a position to hire private certifiers. If firms are footloose, it is always possible that a firm from the North will produce in the South and utilize private certification. There is also some evidence for private certification in developing countries (Cashore *et al*., 2006).

integration are more likely to be achieved, even if the harmonized standard does not coincide with the medium-quality firm's and/or the high-quality firm's optimal choice.

The possibility of private certification also has important implications for the debate about increased economic integration, especially the so-called "race to the bottom" in standards (Bagwell and Staiger, 2001). In the absence of any credence good regulations, only the minimum-quality good is produced in equilibrium, and *de facto*, standards never leave the bottom. In contrast, once there is mandatory discrete labeling, as long as additional private certification of is permitted, there will be no race to the bottom as firms have a private incentive to produce higher than minimum quality goods in equilibrium, i.e., even if the regulatory authorities "harmonize-down" standards in a race to the bottom, private certification ensures that the full gains of economic integration will be realized.

The results may also be sensitive to the assumption that on integration, economies harmonize their labeling regulations, when in fact they may mutually recognize each other's existing labeling regimes.[38] It turns out that this does not matter in the case of mandatory, exclusive continuous labeling, because there is no divergence between countries' standards, i.e., no standards are set as labeling is continuous. However, mutual recognition of standards can affect the results in the case of mandatory, exclusive, discrete labeling. Specifically, for North-North economic integration, if one standard is close to what is optimal for the high-quality firm, mutual recognition of standards may ensure that a high-quality firm will enter the integrated market. Likewise, in the North-South case, if one standard is closer to what is optimal for the medium-quality firm, and one is closer to what is optimal for the high-quality firm, then under

[38] In contrast to harmonization, mutual recognition implies a country-of-origin principle is applied, i.e., a standard applied in one country is recognized in the other country. Likewise, any standard set in the latter country is recognized in the former country (Leebron, 1996; Lutz, 2000). See Wilson (2008) for a useful discussion of mutual recognition vs. harmonization of standards.

mutual recognition, either one or both firms will have an incentive to enter the integrated market. However, if there is little divergence between the standards of the integrating countries, and assuming there no private certification is allowed, then the previous results for mandatory discrete labeling will hold even with mutual recognition, i.e., the high-quality firm may be driven out in the North-North case if the standards are set too low, while either the medium-quality and/or the high-quality firm may be driven out in the North-South case if the standards are either set too low, or too high. The key point is that compared to harmonization of standards, mutual recognition by countries of each other's labeling regimes may increase the probability that the benefits of integration will be achieved.

4. Summary and Conclusions

Given the proliferation of food standards and technical regulations in the past two decades, the focus of this chapter has been on the interaction between such standards and international trade. Specifically, this interaction was set in the context of the tension between food standards as a response to market failures and the potential for protection to domestic producers. The analytical results presented reinforce an observation made by Wilson (2008): food standards are not like tariffs if their objective is to take care of market failures, however, it is important that not only are they applied in a non-discriminatory manner, but also any agreement between countries about standards has to ensure the benefits of economic integration are realized, without undermining the resolution of market failures.

First, based on production of local public bad(s), a Ricardian-type model of international trade was presented showing that compared to developing countries (the South), if developed countries (the North) have more effective labor, and higher standards, the North specializes in

producing and exporting food consumption goods intensive in their use of effective labor, while the South specializes in producing and exporting food and consumption goods intensive in their use of the public bad. With an increase in effective labor in the South, their standards converge on those of the North, reinforcing Casella's (1996) original argument that harmonization of standards as a pre-condition for trade liberalization is unnecessary. However, if the public bad produced in the South has the potential to impose damage on consumers in the North, exports of food consumption goods from the South are likely to face higher standards (public or private) imposed in the North. Treating higher standards on Southern exports as iceberg transport costs, results in a range of non-traded goods – the hypothesis of "standards as barriers", one that has support in much of the empirical work on food standards and trade. However, the hypothesis of "standards as catalysts" can also be nested in the model as an increase in effective labor, allowing the South to better comply with higher Northern standards.

Second, a model of vertical product differentiation was used to analyze the problem of trade in food consumption goods with credence characteristics. With perfect information, minimum and high-quality goods are supplied in equilibrium, maximizing the benefits of both North-North and North-South economic integration. With asymmetric information, whether or not high-quality goods are supplied in equilibrium is contingent on the labeling regime for both North-North and North-South economic integration: with no labeling, only minimum quality is supplied; with continuous labeling, the perfect information equilibrium is replicated; while with harmonized, exclusive, discrete labeling, supply of high-quality goods is dependent on the choice of public standard relative to the optimal choice of firms, i.e., regulators run the risk of driving out high-quality goods if the harmonized standard is set too high or too low. However, the benefits of economic integration are more likely to be achieved if private certification of labeling

claims is allowed to co-exist with public certification. In addition, if North-North and North-South agree to mutual recognition of each other's standards, the benefits of economic integration are more likely to be achieved.

In conclusion, while these models are pretty robust in terms of their analysis of public standards, there is need for more rigorous modeling of two issues that have received increasing attention from researchers. First, standards set by private coalitions need to be more thoroughly embedded into models where by assumption, firms have no real incentive to reduce their production of public bad(s), and where no explicit account is taken of the vertical nature of the food production system. Second, the rather *ad hoc* hypothesis of "standards as catalysts" requires an underlying dynamic theory of why developing countries innovate in the face of higher standards in developed countries.

Appendix

Suppose the public bad is purely local, it is possible to derive what would be the optimal level of production of the public bad if the policy maker were to maximize the representative consumer's indirect utility subject to per capita income. Writing the indirect utility function as:

$$V = \int_0^1 f(z)\ln[x(z)]dz - \int_0^1 f(z)\ln[p(z)]dz + \ln\left(\frac{I}{L}\right) - \frac{\beta D^{\gamma}}{\gamma}, \qquad \text{(A1)}$$

where $p(z)$ is the continuum of prices for the consumption goods z, and the first-order condition for the level of the public bad is, $V_p dp/dD + V_I dI/dD + V_D = 0$. Assuming North and South are too small to influence world goods prices, $dp/dD = 0$, the first-order condition can be re-arranged as $dI/dD = -V_D/V_I$, the latter part of the expression measuring marginal damage incurred by the representative consumer. If the government acts optimally the compliance costs faced by producers should be set equal to aggregate marginal damage, i.e., $c_b = -L.V_D/V_I = \beta D^{\gamma-1} I$, the level of compliance costs, and by implication the standard *s*, varying positively in income *I*.

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