Trade, Development, and the Political Economy of Public Standards

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Abstract

This paper presents a political economy model of public standards in an open economy model. We use the model to derive the political optimum and to analyze different factors that have an influence on this political equilibrium. The paper discusses how the level of development influences the political equilibrium. We also analyze the relation between trade and the political equilibrium and compare this political outcome with the social optimum to identify under which cases 'under-standardization' or 'over-standardization' results, and which standards can be labeled as (producer)protectionist measures.

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"Under the German [trade] law of 1880 imports of livestock were controlled for 'sanitary reasons'. By 1889 the government had all but closed the borders to imports of live animals. … A law of 1900 prohibited imports of sausages, canned meat and meat with preservatives; imports of pickled and salted meat had to be in pieces of at least 4 kg; imports of meat (other than pickled or salted) had to consist of whole beef carcasses or half pig carcasses, could enter only at certain ports and on certain days, and were subject to high inspection fees. If the quality of imported meat was judged doubtful, it was destroyed, though domestic meat of similar quality could be sold."[1]
Tracy (1989)

"Les frontières ne sont, pour ainsi dire,
jamais plus ouvertes que quand vous les déclarez fermées"[2]
Van Naemen (1897)

Introduction

In the last decades, the world market is experiencing a proliferation of standards. A growing number of public standards are being introduced globally, in a broad range and rich variety of areas, including nutrition (e.g. low fat), health (e.g. low lead or pesticide residue), safety (e.g. no small toy parts, equipment safety measures), environment (e.g. organic, no genetically modified organisms, low carbon dioxide emission) and social concerns (e.g. no child labor).

Trade economists have mostly interpreted this growth in the number and form of public standards as a political economy response to the constraints being imposed by

[1] Tracy (1989, p91-92)

[2] "The borders are, in a way of speaking, never more open than when you declare them closed." (Chambre des Représentants (Nov.18, 1897), cited in Van Molle, 1989, p. 230). This was Parliamentary Representative Van Naemen's reaction in Belgian parliament to the government's 1897 decision to restrict imports of livestock because of 'the danger of imports of diseases'. From a health point of view, the official closing of the borders had a perverse effect as it induced massive smuggling without any health inspection.

international trade agreements on traditional trade restrictions.[3] As the use of tariffs is progressively more limited, new forms of non tariff barriers (NTBs) are increasingly used (e.g. Baldwin 2001; OECD 2001; Sturm 2006). In this interpretation public standards are just a new form of NTBs and protection-in-disguise.[4] For example Fischer and Serra (2000) find that standards are biased against imports and favor domestic producers. Bredahl *et al.* (1987) illustrate this with the USA's implementation of a larger minimum size requirement on vine-ripened tomatoes – mainly imported from Mexico – than on green tomatoes produced in Florida. Anderson *et al.* (2004) argues that governments raise genetically modified (GM) food standards as protection against imports.[5] Fulton and Giannakas (2004) point out that producers will prefer GM labeling when they have low returns on GM food. In their infamous example, Otsuki *et al.* (2001) claim that a new EU standard on aflatoxins reduced health risk by approximately 1.4 deaths per billion a year, while decreasing African exports of cereals, dried fruits and nuts to Europe by 64 percent. Krueger (1996) concludes that, although it is not possible to generalize about labor standards' effects, many economists still argue that international labor standards are protectionist instruments.[6]

[3] In this paper we focus on public standards. For a discussion of the relation between public and private standards, see e.g. Henson (2006), McCluskey (2007).

[4] For literature related to the effects of standards as barriers to trade, see for example Barrett (1994), Sykes (1995), Thilmany and Barrett (1997), Schleich (1999), Suwa-Eisenmann and Verdier (2000), Barrett and Yang (2001).

[5] See also Baltzer (2006) who argues that domestic producers always favor more restrictive GMO standards because of positive border costs.

[6] In an earlier contribution, Bockstael (1984) argues that the same holds for domestic quality standards. She argues that these are mainly redistributive instruments and do not enhance welfare – they protect certain producer interests.

However, this trade-protection interpretation of public standards appears to conflict with some basic empirical observations. Many public standards, such as EU GM regulations, are introduced following demands by consumers, not producers. In fact, in many cases producers have opposed their introduction. If public standards would be merely protectionist instruments producers would support their introduction and consumers would oppose them. Tian (2003) demonstrates that an increase in the minimum required 'environmental friendliness' of imported goods is not necessarily protectionist in effect as it may hurt domestic firms and increase imports. In the framework of Marette and Beghin (2007) a standard is anti-protectionist when foreign producers are more efficient than domestic producers at addressing consumption externalities by the standard.

These observations are in line with insights from the literature on the economics of quality standards. For example, Ronnen (1991), Boom (1995) and Valletti (1995) all find positive effects of minimum quality standards on consumers' welfare, but find mixed effects on overall welfare. Leland (1979) shows that, in general, the effect of a minimum quality standard on welfare is ambiguous. In a vertical product differentiation framework Ronnen (1991) shows that minimum quality standards increase welfare under Bertrand competition between firms, while Valletti (2000) finds that welfare decreases but under Cournot competition.

This paper integrates these different perspectives in an open economy framework and develops a formal political economy model of public standards. Our analysis has three specific objectives, which are addressed in three parts of the paper. The first objective is to develop a political economy model of public standards in which both

producers and consumers are actively and simultaneously lobbying. In our model standards benefit consumers because of the standards' guarantee that the product satisfies certain characteristics preferred by the consumer. Producers' production costs increase with implementation of the public standard. However, we show that either producers or consumers may gain or lose, depending on the resulting market prices in an open economy where importers also have to satisfy the standards. With these potential welfare effects, we derive the political equilibrium and we analyze how the equilibrium is affected by several political and economic characteristics.

Our second objective is to derive if and why the political equilibrium standard changes with development. Empirically one observes important differences in the use of public standards across countries and there appears a positive correlation between public standards and income. An important question is what causes this correlation. Some have simply argued that rich consumers (countries) desire higher standards (Maertens and Swinnen 2007; Wilson and Abiola 2003). We find that the impact of development on the government's choice of standards is more complex and depends on several factors – including, besides consumer preferences, compliance costs and enforcement problems.

Our third objective is to analyze if or when public standards are protectionist instruments. In this third part of the paper we compare the political equilibrium with the social optimum and we derive under which conditions public standards can be considered 'protectionism'. We show that politically optimal public standards may be either too high ('over-standardization') or too low ('under-standardization') – a situation which is similar to other forms of price and trade policy which governments use to tax or subsidize certain sectors (Krugman 1987; Grossman and Helpman 1994).

The Model

A key issue is obviously how to model standards. The approaches in the literature differ importantly. Some (such as Bockstael 1984; Ronnen 1991; Valletti 2000) assume that consumers can costlessly observe product characteristics ex ante, while others (such as Leland 1979) assume that consumers are ex ante uncertain about the characteristics of the product. In the latter case standards can improve upon the unregulated market equilibrium by reducing the asymmetric information between consumers and producers. Yet other studies (such as Copeland and Taylor 1995; Fischer and Serra 2000; Anderson *et al*. 2004; Tian 2003; Besley and Ghatak 2007) model the effect of standards as their impact on consumption externalities. This could relate to, for example, minimum standards on catalytic converters in cars or GM foods. Most studies consider that the introduction of standards implies compliance costs for producers (amongst many others Leland 1979; Ronnen 1991; Valletti 2000), and this holds both for domestic producers and those in countries (interested in) exporting to the country that imposes the standard (Henson and Jaffee 2007; Suwa-Eisenmann and Verdier 2002).

Consider therefore an economy where consumers have heterogeneous preferences for a public standard[7] imposed in this sector. A standard which guarantees certain quality/safety features of the product affects utility as it reduces or solves informational asymmetries. Therefore a standard will induce to consume more of the product through an increased willingness to pay, ceteris paribus. For example consumers who perceive health problems with certain (potential) ingredients or production processes may increase consumption if they are guaranteed the absence of these elements. We call this the

[7] The standards under analysis have a direct effect on the utility of consumers. Hence these standards are 'quality standards' (see Fischer and Serra 2000) but for simplicity we refer to them as 'standards'.

'consumption effect'. To model this[8], assume that individuals consume at most one unit of the good and their preferences are described by the following utility function (see Tirole 1988):

$$u_i = \begin{cases} \phi_i(\varepsilon + s) - p & \text{if he buys the good with standard } s \text{ at price } p \\ 0 & \text{if he does not buy} \end{cases} \quad (1)$$

where ϕ_i is the preference parameter. Consumers with higher ϕ_i are more willing to pay for a product with a public standard s and the non-standard-related value ε of the product[9]. A higher s refers to a more stringent standard. ϕ_i is uniformly distributed over the interval $[\phi - 1, \phi]$ with $\phi \geq 1$ and $i \in \{1, \ldots, N\}$. Consumers with $\phi_i < p/(\varepsilon + s)$ will not consume this product which implies that the market will be 'uncovered'. The aggregate demand function[10] is:

$$\mathrm{c}(p, s) = N\left(\phi - p/(\varepsilon + s)\right) \quad (2)$$

On the production side, we assume that production is a function of a sector-specific input factor that is available in inelastic supply. All profits made in the sector accrue to this specific factor. The unit cost function $g = \mathrm{g}(q, s) = \mathrm{k}(q, s) + \mathrm{t}(s)$ depends

[8] Our approach of modelling standards is consistent with the standard approach in the literature on minimum quality standards (see e.g. Ronnen 1991, Jeanneret and Verdier 1996, Valletti 2000).

[9] We assume that the non-standard-related value ε and the public quality standard s can be separated from one another, i.e. that they are additively separable in the consumer utility function, but that consumer preferences for ε and s run parallel with each other.

[10] For the reminder of this analysis we assume that $p/(\varepsilon + s) \leq \phi$ holds such that aggregate consumption is always positive. The (exogenous) constant ε ensures that consumption is positive when the standard is zero.

on output produced (q) and the level of standards in that sector (s), and is composed of production costs $\mathrm{k}(q,s)$ and transaction costs $\mathrm{t}(s)$.[11]

We assume that a standard imposes some production constraints or obligations which increase production and transaction costs. The idea behind this assumption is that all standards can be defined as the prohibition to use a cheaper technology. Examples are the prohibition of an existing technology (e.g. child labor) or of a technology that has not yet been used but that could potentially lower costs (e.g. GM technology). Also traceability standards can be interpreted as a prohibition of cheaper production systems which do not allow tracing the production. Therefore, standards may increase the production costs $\mathrm{k}(q,s)$ because of the obligation to use a more expensive production technology $\left(\frac{\partial k}{\partial s} > 0\right)$. Standards may also increase the transaction costs $\mathrm{t}(s)$ because of control and enforcement costs related to the standard[12] $\left(\frac{\partial t}{\partial s} > 0\right)$. This implies that the unit costs increase with higher standards $\left(\frac{\partial g}{\partial s} > 0\right)$ for $s > 0$[13].

The model assumes a small open economy where domestic firms are price takers and domestic prices of imported goods equal world prices. We assume that when the country

[11] This approach has two advantages. First it allows to differentiate between different types of costs in our analysis of the relation between development and the political economy of public standards. Second, it allows to distinguish between standards with scale neutral cost effects $(\mathrm{t}(s))$ and standards that reinforce (dis)economies of scale $(\mathrm{k}(q,s))$.

[12] We implicitly assume that control and enforcement costs are born by producers.

[13] Modelling the cost of standards with a unit cost function that is increasing in the standard is consistent with e.g. Fischer and Serra (2000) and Tian (2003).

imposes a standard, the production costs of the imported goods also rise as the standard is also imposed on imported goods – and is equally enforced. This leads to a price increase, henceforth called the 'marginal price effect' of a standard $\left(\frac{\partial p}{\partial s} > 0\right)$. More specifically, the unit cost function of foreign (f) producers is:

$$\mathrm{g}^f\left(q^f, s\right) = \mathrm{k}^f\left(q^f, s\right) + \mathrm{t}^f\left(s\right)$$

where $\mathrm{k}^f\left(q^f, s\right)$ are production costs, $\mathrm{t}^f\left(s\right)$ transaction costs and q^f is foreign production. The world price p then equals the unit costs of the foreign producers and as a result, we have $\mathrm{p}(s) = \mathrm{g}^f\left(q^f, s\right)$ and $\frac{\partial p}{\partial s} = \frac{\partial g^f}{\partial s}$.

A key result is that both producers and consumers may either gain or lose from (a change in) the standard. Consider first the producer effects. Producer profits are equal to

$$\Pi_p(s) = \max_q \left\{ q \cdot \left(\mathrm{p}(s) - \mathrm{g}(q, s)\right)\right\}$$

and by the envelope theorem the marginal effect on producer's profits $\Pi_p(s)$ of a standard is equal to

$$\frac{\partial \Pi_p}{\partial s} = q \cdot \left(\frac{\partial p}{\partial s} - \frac{\partial g}{\partial s}\right).$$

Producers' profits decrease with an increase of the standard when the marginal unit cost increase $\frac{\partial g}{\partial s}$ is larger than the marginal price effect $\frac{\partial p}{\partial s}$. When the marginal unit cost increase is smaller than the marginal price effect, the sector-specific capital owners gain from an increase of the standard.

Aggregate consumer surplus can be written as:

$$\Pi_c(s) = N \int_{p/(\varepsilon+s)}^{\phi} u_i \mathrm{d}\phi_i = N \frac{(\varepsilon+s)}{2}\left(\phi - \frac{p}{(\varepsilon+s)}\right)^2 .$$

The impact of a marginal change in the standard on aggregate consumer surplus equals

$$\frac{\partial \Pi_c}{\partial s} = \frac{N}{2}\left(\phi^2 - \left(\frac{p}{\varepsilon+s}\right)^2\right) - \frac{\partial p}{\partial s}\mathrm{c}(p,s).$$

Aggregate consumer surplus increases with the standard if the marginal 'consumption effect' $\frac{N}{2}\left(\phi^2 - \left(\frac{p}{\varepsilon+s}\right)^2\right)$ is larger than the marginal increase in cost of consumption $\frac{\partial p}{\partial s}\mathrm{c}(p,s)$. Vice versa, if the marginal increase in the cost of consumption outweighs the beneficial marginal consumption effect, aggregate consumer surplus decreases with the standard.

Finally, we define welfare $\mathrm{W}(s)$ as the sum of the producer profits and the consumer surplus in this sector, i.e. as $\mathrm{W}(s) \equiv \Pi_p(s) + \Pi_c(s)$. (3)

The Political Equilibrium

Consider a government that maximizes its own objective function which, following the approach of Grossman and Helpman (1994), consists of a weighted sum of contributions from lobbies and social welfare. Similar to Grossman and Helpman (1994), we restrict the set of policies available to politicians and only allow them to implement a public standard. We assume that producers and consumers of this sector are politically organized and that they lobby simultaneously. This assumption differs from Grossman and Helpman (1994), Anderson *et al.* (2004) and Cadot *et al.* (2004). We believe it is not

realistic to assume that consumers are not organized – or do not effectively lobby – on issues related to product standards. There is substantive evidence that consumers and producers lobby governments on issues of public standards[14].

The 'truthful[15]' contribution scheme of the specific-capital owners is equal to the function $\mathrm{C_p}(s) = \max\{0; \Pi_p(s) - b_p\}$, in which the constant b_p represents the share of profits the producers do not want to invest in lobbying the government. One could also interpret this constant b_p as a minimum threshold, a level of profits or surplus below which the producers believe the return from lobbying is less than its cost. Similarly, the 'truthful' contribution scheme of the consumers will be of the form $\mathrm{C_c}(s) = \max\{0; \Pi_c(s) - b_c\}$, with $\Pi_c(s)$ the aggregate consumer surplus as defined earlier. The constant b_c can be interpreted in the same way as in the contribution schedule of the specific-capital owners. The government's objective function is a weighted sum of the contributions of producers (weighted by α_p), the contributions of consumers (weighted by α_c) and the overall social welfare, where $\alpha_j \ (j = p, c)$ represents the relative lobbying strength:

$$\mathrm{V}(s) = \alpha_p \mathrm{C_p}(s) + \alpha_c \mathrm{C_c}(s) + \mathrm{W}(s) \qquad (4)$$

The government chooses the level of the standard to maximize its objective function (4). Each possible level of this standard corresponds to a certain level of

[14] In reality, consumer lobbying does not only occur through consumer organizations but also through political parties representing consumer interests. See also Gulati and Roy (2007) on lobbying of both producers and consumers with respect to environmental standards.

[15] The common-agency literature (e.g. Bernheim and Whinston 1986) states that a truthful contribution schedule reflects the true preferences of the interest group. This implies in our political economy model that lobby groups will set their lobbying contributions in accordance with their expected profits and how these are marginally affected by the standard. We refer to the Appendix for a proof of the truthfulness of the contribution schemes in our model.

producer profits and consumer surplus, and hence also to a certain level of producer and consumer contributions. This is driven by the functional form and the truthfulness of the contribution schemes that show that the government will receive higher contributions from producers (consumers) if the imposed standard creates higher profits (consumer surplus) for producers (consumers). Conversely, the government receives less producer or consumer contributions if the standard decreases respectively profits or consumer surplus. Therefore maximizing these contributions from producers (consumers) by choosing the level of standard is equivalent to maximizing their profits (consumer surplus). The government will thus choose the level of standards such that it maximizes the weighted sum of producer profits, consumer surplus, and social welfare. The politically optimal standard, s^*, is therefore determined by the following first order condition[16], subject to $s^* \geq 0$:

$$\left(1+\alpha_p\right)\left[q^*\left(\frac{\partial p}{\partial s}-\frac{\partial g}{\partial s}\right)\right]+\left(1+\alpha_c\right)\left[\frac{N}{2}\left(\phi^2-\left(\frac{p^*}{\varepsilon+s^*}\right)^2\right)-c^*\frac{\partial p}{\partial s}\right]=0. \qquad (5)$$

c^* and q^* denote respectively aggregate consumption and domestic production in the political optimum and p^* the equilibrium world price.

The first term in equation (5) captures the marginal impact on producers' profits weighted by their lobbying strength $\left(1+\alpha_p\right)$. As we explained earlier this marginal impact may be positive or negative. The second term represents the weighted marginal

[16] We assume that the domestic unit cost function $\mathrm{g}(q,s)$ and the world price $\mathrm{p}(s)$ (i.e. the foreign unit cost function) are sufficiently convex in the standard ($\frac{\partial^2 g}{\partial s^2}>0$, $\frac{\partial^2 p}{\partial s^2}=\frac{\partial^2 g^f}{\partial s^2}>0$, see e.g. Ronnen 1991; Valletti 2000; Fischer and Serra 2000) such that $\mathrm{V}(s)$ is concave in s and that first order condition (5) determines a global maximum.

impact of a public standard on aggregate consumer surplus which may also be positive or negative.

Optimality condition (5) implicitly defines s^* as a function of several variables, such as lobbying strength (α_j), consumer preferences (ϕ), and the marginal unit cost increase of domestic and foreign producers. The latter is reflected in the marginal price effect $\left(\frac{\partial p}{\partial s}\right)$. The impact of the exogenous variables (α_j, ϕ) on the optimal standard can be formally derived through comparative statics. We refer the reader to the Appendix for these formal derivations and restrict ourselves here to the presentation and discussion of the effects.

First, it is obvious from condition (5) that a change in the political weights α_j $(j = p, c)$, capturing exogenous differences in the political weight of a lobby group, affects s^*. When the political weight of a lobby group increases exogenously, it implies that its contributions are more effective in influencing the decisions of the government. However the sign of the effect on s^* depends on the relative benefits of s^* for the interest groups. More specifically, an increase in α_j leads to a higher standard s^* $\left(\frac{\partial s^*}{\partial \alpha_j} > 0\right)$, if and only if interest group j gains from increasing the standard beyond s^*, i.e. if $\frac{\partial \Pi_j}{\partial s} > 0$ at s^*. In this case the government will set the optimal standard at a higher level if α_j increases, and vice versa.

Second, an exogenous change in the quality preferences ϕ of consumers[17] will affect the politically optimal standard s^*. A shift in consumer preferences affects the aggregate demand and consumer surplus. Higher consumer preferences for quality lead to higher consumer surplus and higher contributions in favor of public standards, which lead to higher public standards i.e. $\frac{\partial s^*}{\partial \phi} > 0$, and vice versa.[18]

Third, the marginal cost increase of domestic and foreign producers will affect the politically optimal standards. Higher marginal unit costs for domestic producers $\left(\frac{\partial g}{\partial s}\right)$ reduce the benefits of standards for domestic producers, ceteris paribus. This leads to lower standards as producers will reduce their contributions for public standards. The marginal unit cost increase of foreign producers is reflected in the marginal price effect $\left(\frac{\partial g^f}{\partial s} = \frac{\partial p}{\partial s}\right)$ of a public standard as the international market price increase will equal the increase in unit costs of foreign producers to comply with the standard.

Notice that a higher marginal unit cost increase for foreign producers may increase or decrease the politically optimal standard, depending on other factors. On the one hand, the resulting higher marginal price effect reduces consumer benefits and their contributions. On the other hand, it increases profits and contributions of domestic

[17] Under our assumptions, a change in ϕ only affects the boundaries of the preference distribution, not the distribution itself. Therefore ϕ is a measure for the average consumer preferences.

[18] This is conditional on $\phi > \frac{\partial p}{\partial s}$ at s^*. Violation of this condition would however imply that the individual willingness to pay for a marginal increase of the standard is negative at s^*, even for the individual with the highest preference for quality $(\phi_i = \phi)$. By this condition we abstract from this case where consumption falls to zero.

producers. The size of these effects and the net effect depends on the relation between domestic production and consumption and on the functional form of the various functions. As a result, standards may move in either direction with changes in the marginal cost increase of foreign producers, depending on the relative benefits and the political weights of the different lobby groups.

Finally, an important general implication from this discussion is that either consumers or producers may lobby in favor or against standards, and that the political equilibrium may be affected by various factors.

Development and the Political Economy of Public Standards

We can now use these results to explain the empirically observed positive relationship between standards and economic development. It is often argued that this relationship simply reflects consumer preferences. While our model confirms that income-related preference (ϕ) variations play a role, it also suggests a more complex set of causal factors which affect the relationship between development and the political economy of public standards. Our analysis suggests several reasons for the wide variety in standards across the world, and in particular between developing ('poor') and developed ('rich') countries.

Define I as the country's per capita income, i.e. its level of economic development, and z as an indicator of the quality of the institutions in the country. Studies find that the quality of institutions (including institutions for enforcement of contracts and public regulations) is positively correlated with development $\left(\frac{\partial z}{\partial I} > 0\right)$

(North 1990). The impact of development on the politically optimal level of standards s^* can then be derived as:

$$\frac{\partial s^*}{\partial I} = \frac{\partial s^*}{\partial \phi}\frac{\partial \phi}{\partial I} + \left(\frac{\partial s^*}{\partial t_s}\frac{\partial t_s}{\partial z} + \frac{\partial s^*}{\partial k_s}\frac{\partial k_s}{\partial z}\right)\frac{\partial z}{\partial I} \tag{6}$$

where $t_s = \frac{\partial t}{\partial s}$ and $k_s = \frac{\partial k}{\partial s}$.

The first term is positive because lower income levels (I) are typically associated with lower consumer preferences for quality and safety standards as reflected in differences for ϕ in equation (6), with ϕ smaller for poorer countries $\left(\frac{\partial \phi}{\partial I} > 0\right)$. Because the effect on aggregate consumer surplus of a public standard is lower for lower ϕ, consumer contributions are lower in developing nations than in rich countries and this results in a lower politically optimal standard level in poor countries $\left(\frac{\partial s^*}{\partial \phi} > 0\right)$.

This is consistent with international survey evidence on consumer preferences for GM standards. Rich country consumers are generally more opposed to GM than poor country consumers. Consumers in rich countries have less to gain from biotech-induced farm productivity improvements compared to developing country consumers who have much to gain from cheaper food (McCluskey *et al.* 2003). This argument is also consistent with empirical observations that consumers from developed countries have generally higher preferences for other applications of biotechnology, such as medical applications (Costa-Font *et al.* 2008; Hossain *et al.* 2003; Savadori *et al.* 2004) which have more (potential) benefits for richer consumers.

The second and third term in equation (6) capture how the quality of institutions affects the relationship between development and the political economy of public standards. The impact of standards on both production and transaction costs depends on the quality of a country's institutions z.

The second term is also positive (with $\frac{\partial z}{\partial I} > 0$). Lower quality of institutions implies that enforcement and control costs of standards (i.e. the increase in transaction costs with higher standards) are higher such that $\frac{\partial t_s}{\partial z} < 0$ in our model. These higher enforcement costs will lead to lower politically optimal standards $\left(\frac{\partial s^*}{\partial t_s} < 0 \right)$.

The third term is also positive. While poor countries, with low wages and less urban pressure on land use, may have a cost advantage in the production of raw materials, better institutions of rich countries lower the marginal increase in production costs caused by standards $\left(\frac{\partial k_s}{\partial z} < 0 \right)$. A lower marginal increase in production costs could result from higher education and skills of producers, better public infrastructure, easier access to finance, etc. These factors will induce higher public standards as $\frac{\partial s^*}{\partial k_s} < 0$.

Development and Pro- & Anti-Standard Coalitions

In combination the factors which we discussed above are likely to induce a shift of the political equilibrium from low standards to high standards with development. If we define a 'coalition' as both groups having the same preferences, i.e. either $s = 0$ (anti) or

$s > 0$ (pro), then in extreme cases, the variations in the mechanisms identified here may result in a pro-standard coalition of consumers and producers in rich countries. In rich countries, in addition to consumers, also producers may support standards as they enhance their competitive position against imports as compliance may be less costly for domestic producers compared to importers. In contrast, an anti-standard coalition may be present in poor countries as, in addition to producers, consumers may also oppose standards since they may be more concerned with low prices than standards. Formally, a pro-standard coalition will exist when both $\frac{N}{2}\left(\phi^2 - \left(\frac{p}{\varepsilon + s}\right)^2\right) > c\frac{\partial p}{\partial s}$ and $q\frac{\partial p}{\partial s} > \frac{\partial g}{\partial s}$ at $s = 0$, and vice versa for an anti-standard coalition.

Trade and the Political Economy of Public Standards

An important aspect of public standards which has attracted a lot of attention is their potential use as instruments of 'protection in disguise' (Vogel 1995). This is also reflected in the rapid increase of notifications of new sanitary and phytosanitary (SPS) measures to the WTO (see Figure 1). Among other things, member countries have to notify new SPS measures to the WTO when these measures have a significant effect on trade. This rapid increase in SPS measures notifications raises concerns on the potential protectionist nature of public standards. In fact, most studies on the political economy of standards in open economy models consider standards as protectionist instruments (Anderson et al. 2004; Fischer and Serra 2000; Sturm 2006).

To analyze this issue with our model it is important to first clarify some key elements in the relationship between trade and standards. As we will show in this section, standards can be set to benefit (or 'protect') producer or consumer interests. Hence, first

it is important to define 'protectionism' as producer protectionism (as it is usually understood) or consumer protection. Second, as with tariffs and trade restrictions, standards may either harm or benefit producers. Hence, unlike other studies suggest, there is no ex ante reason to see standards as producer protectionism. Third, while almost all standards affect trade, there is no simple relation between 'trade distortions' and 'producer protection'.

The rest of this section is organized as follows. We first identify the key factors which characterize the relationship between trade and standards and its effects. Then we identify under which conditions standards reduce trade, i.e. act as 'trade barriers' or enhance trade, i.e. act as 'trade catalysts'. Next we identify when there is 'over-standardization' and 'under-standardization' and finally we combine all these insights to evaluate the validity of the 'standards-as-(producer)protection' argument.

Comparative advantage and compliance with standards

Trade and the political optimal standards are interrelated in several ways. First, trade affects the net impact of standards on producers and consumers as reflected in expression (5) and hence the political contributions and their relative influence. For a given level of consumption (c), with larger imports $(m \equiv c - q)$ and lower domestic production (q), the effect of standards on aggregate producer profits will be smaller and hence producer contributions lower and the lower producer influence on policy. In the extreme case when there is no domestic production $(q = 0)$, only consumer interests affect government policy. Formally, in this case the first term in equation (5) drops out, and the political equilibrium condition equals the optimality condition for consumers. Vice versa, for a

given level of domestic production more imports and higher consumption levels imply that the effects on total consumer surplus will be larger and therefore consumer contributions and their influence on policy higher.

Second, standards may affect the comparative advantage in production between domestic and foreign producers. There are two potential cost effects. Recall that at the optimum s^* the marginal effect of a standard on domestic producer profits is

$$\frac{\partial \Pi_p}{\partial s} = q^* \left(\frac{\partial p}{\partial s} - \frac{\partial g}{\partial s} \right) = q^* \left(\frac{\partial g^f}{\partial s} - \frac{\partial g}{\partial s} \right) = q^* \left[\left(\frac{\partial k^f}{\partial s} - \frac{\partial k}{\partial s} \right) + \left(\frac{\partial t^f}{\partial s} - \frac{\partial t}{\partial s} \right) \right]$$

First, standards may affect the relative production costs of foreign and domestic producers differently, i.e. if $\frac{\partial k}{\partial s} \neq \frac{\partial k^f}{\partial s}$ at s^*. This is the argument used by Anderson et al. (2004) to argue why EU producers lobby against GMOs: they argue producers in countries such as the US and Brazil have a comparative production cost advantage in the use of GM technology and therefore it would be rational for EU producers to support (rather than oppose) cost increasing standards to ban GMOs. This argument makes assumptions on the nature of the supply functions and the technology, which may not hold in general. Standards will increase production cost advantages when they reinforce scale economies (reflected in a downward pivot of the supply function) but not when they have a scale neutral impact or when they have scale diseconomies (causing an upward pivot of the supply function). Differences in these effects will induce differences in reactions to standards by domestic producers. However the effects are conditional. Producers will oppose standards more (or support them less) if they have a comparative disadvantage and standards reinforce this $\left(\frac{\partial^2 k}{\partial q \partial s} > 0 \right)$, compared to when standards are

scale neutral $\left(\frac{\partial^2 k}{\partial q \partial s} = 0\right)$. The opposite holds when standards reduce the comparative disadvantage vis-à-vis foreign producers $\left(\frac{\partial^2 k}{\partial q \partial s} < 0\right)$.[19]

Second, standards may also affect the comparative advantage through differences in transaction costs $\left(\text{i.e. if } \frac{\partial t}{\partial s} \neq \frac{\partial t^f}{\partial s} \text{ at } s^*\right)$. The relative (domestic versus foreign) impact of standards on production costs and transaction costs may be quite different. Countries with high production costs (importers) may be more efficient at implementing or complying with standards. In such cases, standards will shift the cost difference between domestic producers and foreign producers in terms of the final cost of the product. As a consequence, such comparative cost advantage in transaction costs of complying with a standard (see e.g. Salop and Scheffman 1983, and Baldwin 2001 for examples) will lead to higher producer contributions which favor the standard, rather than against it $\left(\frac{\partial t}{\partial s} < \frac{\partial t^f}{\partial s} \text{ at } s^*\right)$.[20] Vice versa, when $\frac{\partial t}{\partial s} > \frac{\partial t^f}{\partial s}$ at s^* domestic producers will contribute less in favor of the standard.

In Figure 2 we illustrate the case of different transaction costs. We use a simple graph with parallel shifts of supply curves to simplify the comparison of producer profits before and after the introduction of the standard (our theoretical model is more general).

[19] Similarly, producers would support more (or oppose less) if they have a comparative advantage and standards reinforce this – and vice versa. However, our model focuses on the import case.

[20] While we do not formally model instrument choice here, if the government has the choice between different standards that induce the same effect on consumption, a government will be inclined to enforce a standard that is less costly for the domestic sector, or to forbid the use of a technology in which the domestic sector has a comparative disadvantage. Fischer and Serra (2000) argue therefore that governments tend to use minimum standards that are biased against imports.

The increase in transaction costs is depicted by an upward shift in the supply curve (S) and the price effect by an upward shift in the horizontal supply function of the outside world that determines the price (P). It is clear that when the shift in domestic supply (to S^1) is equal to the shift in the foreign supply (to P^s), producers' profits do not change; hence they are indifferent. When the domestic transaction cost increase is smaller than the foreign one (represented by the shift to S^2), producers' profits increase because the price effect is larger than the transaction cost effect. The gain in profits is the light grey area and the politically optimal standard will be higher than what is optimal for consumers. In contrast, a large upward shift in supply (S^3) – implying higher transaction costs of implementing the standard – results in a decrease in producer profits. The resulting loss is the dark grey area and the politically optimal standard will be lower than what is optimal for consumers.

Notice that, although these factors do relate standards and trade, they do not say anything about standards being trade distorting or protectionist measures.

Standards as Catalysts or Barriers to Trade?

In our model, standards are (almost) always affecting trade. Only in very special circumstances do standards not affect trade. This is when the effect on domestic production exactly offsets the effect on consumption. Define $D(c,s)$ as the inverse demand function with $D_c = \frac{\partial D}{\partial c} < 0$ and $D_s = \frac{\partial D}{\partial s} > 0$. Similarly, define $A(q,s)$ as the inverse supply function with $A_q = \frac{\partial A}{\partial q} > 0$ and $A_s = \frac{\partial A}{\partial s} > 0$. The effect of standards on trade (imports) is:

$$\frac{\partial m}{\partial s} = \frac{D_s}{|D_c|} + \frac{A_s}{A_q} - \left(\frac{A_q + |D_c|}{A_q |D_c|} \right) \frac{\partial p}{\partial s}. \qquad (7)$$

Notice that the sign of expression (7) may be positive or negative. If the sign of (7) is negative standards are 'trade barriers', i.e. they reduce trade. However, the sign of (7) can also be positive, and then imports increase and standards work as 'catalysts to trade'. This will be the case when the marginal consumption gain (loss) from the standard is larger (smaller) than the marginal gain (loss) from the standard in domestic production. Moreover, as we will discuss next, whether trade flows increase or decrease upon introduction of a standard in itself does not automatically relate to (or is not necessarily equivalent to) producer protectionism.

Over- and Under-standardization

To assess whether public standards reduce welfare (i.e. are set at sub-optimal levels) we use the same framework to identify optimal policy as is used in evaluating tariffs in traditional trade theory, that is by comparing to the socially optimal trade policy. The political equilibrium is said to be welfare reducing (suboptimal) when the politically optimal tariff t^* differs from the social optimum tariff $t^\#$. In a small open economy, this analysis leads to the well-known result that the socially optimal tariff level is zero and free trade is optimal, i.e. a positive tariff that constrains trade is harmful to social welfare.

Similarly, we compare the politically optimal standards s^* with the socially optimal standard $s^\#$ in a small open economy. To determine $s^\#$ we maximize the welfare function as defined in equation (3). The social optimum standard $s^\#$ is determined by[21]:

[21] This first order condition is subject to $s^\# \geq 0$; otherwise $s^\# = 0$.

$$\left[q^{\#} \frac{\partial p}{\partial s} - \frac{\partial g}{\partial s} \right] + \left[\frac{N}{2} \left(\phi^2 - \left(\frac{p^{\#}}{\varepsilon + s^{\#}} \right)^2 \right) - c^{\#} \frac{\partial p}{\partial s} \right] = 0 . \qquad (8)$$

$c^{\#}$ and $q^{\#}$ denote respectively aggregate consumption and domestic production in the social optimum and $p^{\#}$ the equilibrium world price. Analogous to condition (5), the first term in condition (8) captures the impact on producers and the last term shows the effect of a standard on total consumer surplus. The interpretation of the different effects is analogous to the discussion following condition (5).

It is clear from comparing respectively conditions (5) and (8) that the politically optimal standard s^* will only equal the social optimum standard $s^{\#}$ when $\alpha_p = \alpha_c$ in the political equilibrium, and/or when both $\frac{\partial \Pi_p}{\partial s}$ and $\frac{\partial \Pi_c}{\partial s}$ equal zero at $s^{\#}$. Notice that $s^{\#} > 0$ is possible[22]. In this case trade flows may change from the imposition of the standard, but this change is socially optimal, i.e. it increases domestic welfare.

If the above condition is not fulfilled i.e. if α_p and α_c are different in the government's objective function, the political and social outcomes will be different.[23] Again, however, the diversion between both optima may be in either direction. Hence 'over-standardization' $\left(s^* > s^{\#} \right)$ or 'under-standardization' $\left(s^* < s^{\#} \right)$ may result (see Table 1 for an overview).

[22] This is for example consistent with the theoretical analysis of Lapan and Moschini (2004) who find that a standard prohibiting the sale of GM products in Europe may enhance European welfare.

[23] We do not discuss the case with different lobby weights where $\frac{\partial \Pi_p}{\partial s} = \frac{\partial \Pi_c}{\partial s} = 0$ at $s^{\#}$, implying that $s^{\#}$ is optimal for both lobby groups. In that case neither consumers nor producers have incentives to lobby for a different standard, and $s^* = s^{\#}$.

If $\alpha_p > \alpha_c$, this will result in over-standardization $\left(s^* > s^\#\right)$ when producers' profits increase with a higher standard $\left(\frac{\partial \Pi_p}{\partial s} > 0\right)$ at $s^\#$ and in under-standardization otherwise. The resulting over-standardization creates higher profits for producers than in the social optimum. Hence this over-standardization distorts trade to the advantage of the domestic sector. Inversely with $\frac{\partial \Pi_p}{\partial s} < 0$ at $s^\#$, the resulting under-standardization (given that $s^\# > 0$) reduces the negative effect of the standard on producers' profits. Hence domestic producers benefit from this under-standardization such that this under-standardization serves as protection in disguise. Box 1 illustrates the latter case.

In a similar fashion, $\alpha_c > \alpha_p$ results in over-standardization when $\frac{\partial \Pi_c}{\partial s} > 0$ and in under-standardization when $\frac{\partial \Pi_c}{\partial s} < 0$ at $s^\#$. Whether these suboptimal standards are 'protectionist' or not depends on the impact of standards on producers. However, at $s^\#$, $\frac{\partial \Pi_p}{\partial s}$ and $\frac{\partial \Pi_c}{\partial s}$ always have opposite signs (except for the trivial case where both equal zero and $s^* = s^\#$). Hence when over-standardization results $\left(\frac{\partial \Pi_c}{\partial s} > 0\right)$, producers always loose from this over-standardization with respect to their situation in the social optimum as $\frac{\partial \Pi_p}{\partial s} < 0$ at $s^\#$. The politically optimal standard s^* is then, although suboptimal, not 'protectionist'. Vice versa, producers will be hurt by under-standardization $\left(\frac{\partial \Pi_c}{\partial s} < 0\right)$ as $\frac{\partial \Pi_p}{\partial s} > 0$ at $s^\#$. Box 2 provides an illustration of the latter

case. In both cases the suboptimal standards result in trade distortions that do not protect domestic producers.

Discussion: Rational or biased perceptions

So far, we have assumed that consumers have rational expectations and unbiased perceptions of standards. However, studies claim that perceptions of the public may differ importantly from expert opinions on a diversity of issues (e.g. Flynn *et al.* 1993; Savadori *et al.* 2004). If so, it is clear that biased perceptions can be an important factor in the political economy of public standards.

Without going into detail into the micro-foundations of perceptions, we just want to point out that our model can be easily extended to include biased perceptions. To illustrate this formally, define λ as a measure of the bias in perception of consumers: λ is equal to 1 if consumers' perceptions of the standard's effects are unbiased. λs is the standard perceived by consumers and s^{λ} is the politically optimal standard when perceptions are possibly biased. It is intuitive that a bias in the perception of consumers will affect s^{λ} (See Appendix for the formal derivation of this result). A positive bias in consumer perceptions leads to increased consumer contributions, and hence higher politically optimal standards $\left(\frac{\partial s^{\lambda}}{\partial \lambda} > 0 \right)$ given that an increase in the standard increases

consumption at s^{λ} $\left(\frac{\partial c^{\lambda}}{\partial s} \geq 0 \text{ at } s^{\lambda}\right)$[24]; and vice versa for $\frac{\partial c^{\lambda}}{\partial s} < 0$ and low average consumer quality preferences.[25]

Several studies find that consumer perceptions are functions of the level of consumer trust in government regulators, attitudes toward scientific discovery, and media coverage (Curtis *et al.* 2004; Loureiro, 2003, Kalaitzandonakes *et al.* 2004). For example, a reason for the differences in perceptions across countries explored by Curtis *et al*. (2008) is the different organization and structure of the media in rich and poor countries. Mass media is the main source of information for consumers to form attitudes regarding many issues, including GMFs (Hoban and Kendall 1993; Shepherd *et al*. 1998). Commercial media is more likely to highlight potential risks associated with biotechnology in its reporting (McCluskey and Swinnen 2004). The increased cost of media information in developing countries leads to lower media consumption and to a proportionately stronger reduction in risk reporting. In addition, government control of the media is stronger in poor countries. This may lead to a more positive coverage of new technologies such as biotechnology, which in turn may contribute to more favorable perceptions of GMFs and biotechnology among consumers in these less developed countries. The public is most negative towards GMFs in most of the developed countries, especially in the European Union (EU) and Japan. The United States is an exception as consumers are largely ambivalent about GMFs. In lesser developed countries (LDCs)

[24] This is a sufficient but not a necessary condition for $\frac{\partial s^{\lambda}}{\partial \lambda} > 0$, see Appendix.

[25] $c^{\lambda} = N\left(\phi - p/\left(\varepsilon + \lambda s^{\lambda}\right)\right)$ denotes the aggregate consumption in the political optimum when consumer perceptions are possibly biased.

consumer attitudes toward GMFs are less negative and in many cases positive (see Curtis *et al.* 2008 for a review of the evidence). Therefore, the media structure and information provision is likely to induce a more pro-standard attitude $\left(\frac{\partial \lambda}{\partial I} > 0\right)$ in rich countries than in poor, as increased access to media will increase attention to risks and negative implications of low standards.

An additional related element is how the rural/urban population structure affects perceptions. McCluskey *et al*. (2003) find that people associated with agriculture are much more in favor of GM crops than urban consumers[26]. It is likely that consumers who are associated with agriculture have a better idea of the amount of pesticides used on non-GM crops than urban consumers, and hence of the benefits from GMF (such as pesticide resistant crops). As developing countries have a higher proportion of rural residents, this may contribute to explain the differences in preferences.

Hence, both perceptions factors may reinforce the effects of consumer preferences and quality of institutions in inducing a positive relationship between standards and development.

Conclusions

In this paper we have developed a formal model of the political economy of public standards. We use our theoretical model to derive the political optimum and to analyze the different factors that have an influence on this political equilibrium. Under the assumption of a small open economy and simultaneous consumer and producer lobbying, the political weights of the respective groups influence the optimal public

[26] Unpublished research of Scott Rozelle and Jikun Huang confirms this result for China.

standard and the direction and magnitude of these effects depend on the standards' relative benefits for the different interest groups. Domestic costs related to the standard affect the level of the public standard while an increase in the costs of foreign producers related to the standard may increase or decrease the politically optimal standard.

We also examine the positive relationship between standards and economic development. Higher income levels lead to more stringent standards because of higher consumer preferences for quality, less costly enforcement of standards and lower production costs related to standards for domestic producers. In combination these factors may result in a pro-standard coalition of consumers and producers in rich countries and an anti-standard coalition in poor countries.

We also identify the key factors which characterize the relationship between trade and standards and its effects. Trade affects the net impact of standards on domestic producers and consumers and hence their political contributions. Standards may also affect the comparative production cost advantage between countries, which may lead to either higher or lower standards. Similarly, the relative (domestic versus foreign) transaction (enforcement and control) costs of standards affect the politically optimal standard.

Finally, our model provides an analytical framework to determine whether standards serve as protection in disguise, or not. We show that standards may be 'barriers' to trade but also 'catalysts' to trade, and that both 'under-' or 'over-standardization' may occur, depending on a variety of factors. Our findings imply that the effects of specific standards should be analyzed carefully before categorizing them as protectionist instruments.

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Tables

Table 1: Protectionist characteristics of standards with different political weights

$\alpha_p > \alpha_c$		$\alpha_c > \alpha_p$	
$\frac{\partial \Pi_p}{\partial s} > 0$ over-standardization $\left(s^* > s^{\#}\right)$	$\frac{\partial \Pi_p}{\partial s} < 0$ under-standardization $\left(s^* < s^{\#}\right)$	$\frac{\partial \Pi_c}{\partial s} > 0$ over-standardization $\left(s^* > s^{\#}\right)$	$\frac{\partial \Pi_c}{\partial s} < 0$ under-standardization $\left(s^* < s^{\#}\right)$
Protectionist	Protectionist if $s^{\#} > 0$	Not protectionist	Not protectionist

Figures

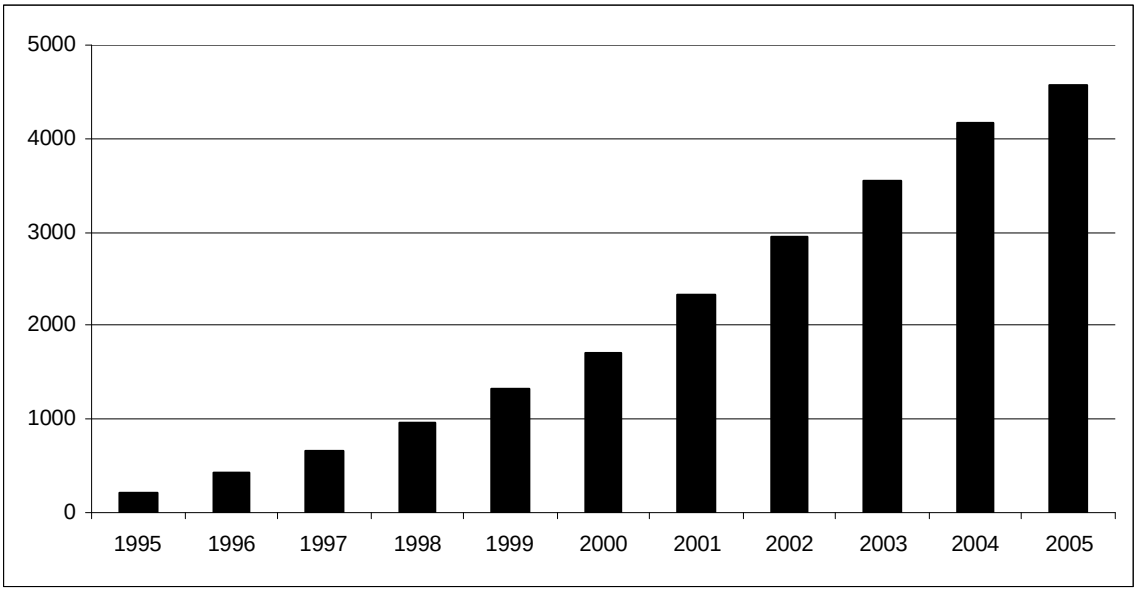


Figure 1: Notification of new SPS measures to the WTO (Source: Henson 2006)

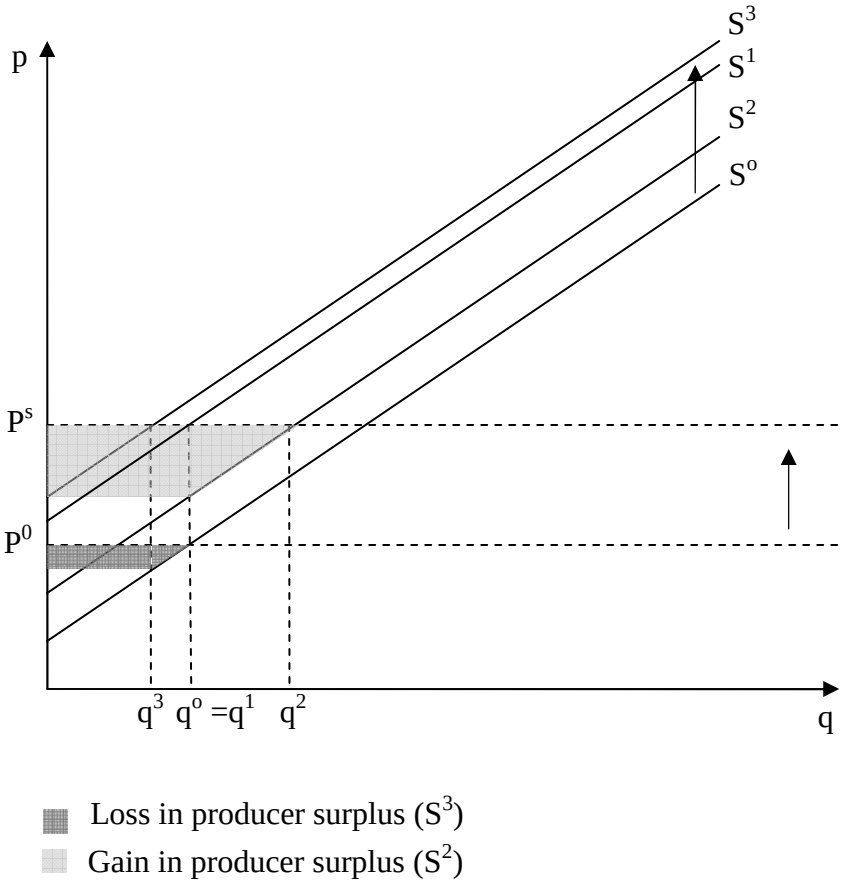
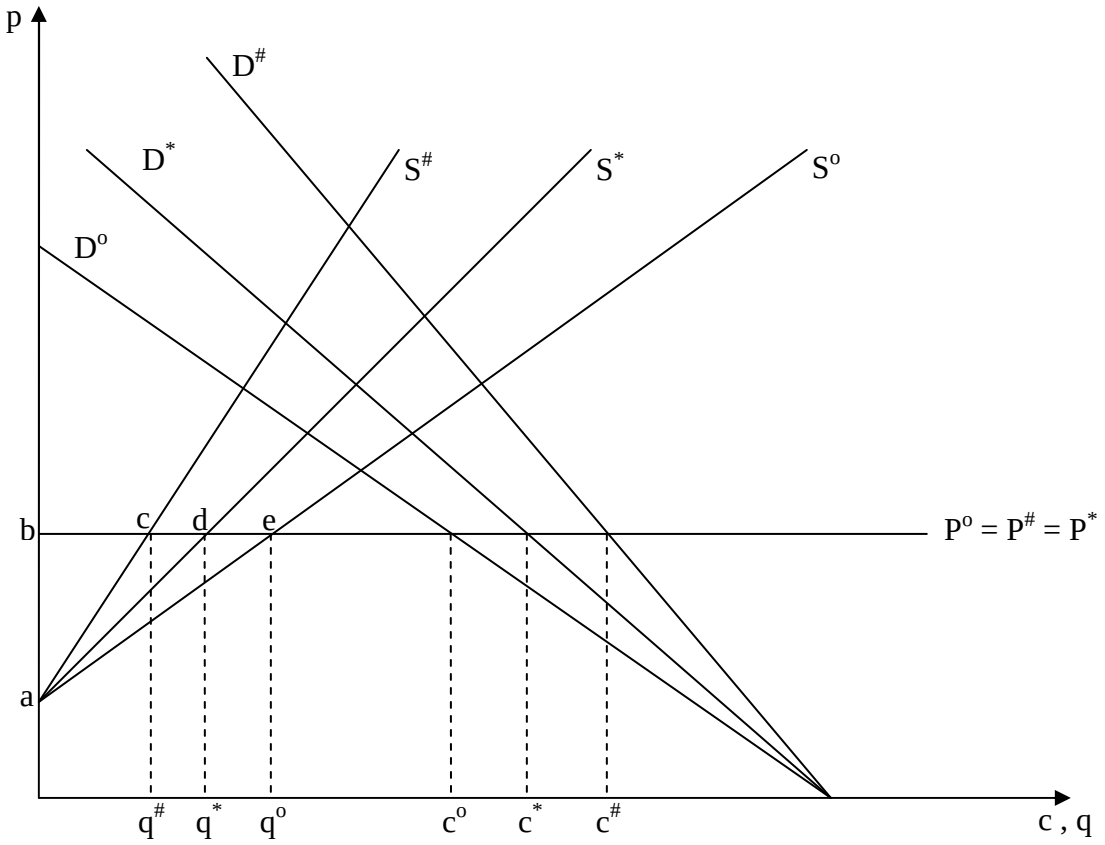


Figure 2: The possible effects of a public standard on domestic producers

Boxes

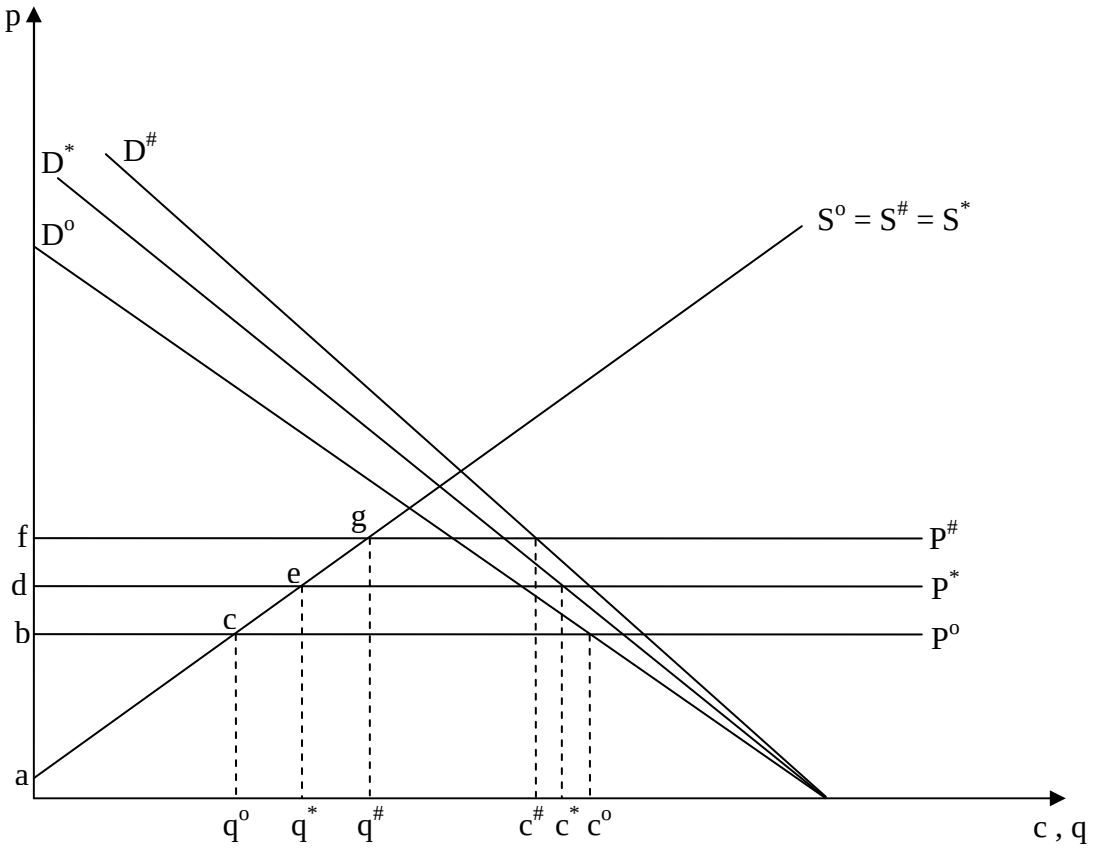
Box 1: **Under-standardization benefiting domestic producers**



The changes in supply S and demand D are represented by upward pivots for higher standards. For simplicity we assume that prices P are not affected by standards.

$\frac{\partial \Pi_c}{\partial s} > 0$ and $\frac{\partial \Pi_p}{\partial s} < 0$ at $s^{\#}$ and under-standardization $\left(s^* < s^{\#}\right)$ occurs given that $\alpha_p > \alpha_c$. Under-standardization is benefiting the domestic producers as their profits are higher compared to the social optimum (abd > abc). Notice also that $m^o < m^* < m^{\#}$.

Box 2: **Under-standardization hurting domestic producers**



The changes in demand D and prices P are represented by respectively upward pivots and upward shifts for higher standards. Supply S is not affected by standards.

$\frac{\partial \Pi_c}{\partial s} < 0$ and $\frac{\partial \Pi_p}{\partial s} > 0$ at $s^{\#}$ and under-standardization $\left(s^* < s^{\#}\right)$ occurs when $\alpha_p < \alpha_c$.

Under-standardization hurts domestic producers as their profits are lower compared to the social optimum (ade < afg). Notice also that $m^o > m^* > m^{\#}$.

Appendix

A1.Proof of the truthfulness of the contribution schemes

Define J as the set of active lobby groups i.e. $J=\{p,c\}$, s^* as the politically optimal standard, and C_j^* as the optimal contribution scheme for lobby group j. Following Lemma 2 of Bernheim and Whinston (1986) and Proposition 1 of Grossman and Helpman (1994), the equilibrium $\left(\{C_j^*\}_{j\in J}, s^*\right)$ is a subgame-perfect Nash equilibrium of the standard-setting game if and only if:

(a) C_j^* is feasible for all $j\in J$;

(b) s^* maximizes $\sum_{j\in J}\alpha_j C_j^*(s)+W(s)$;

(c) s^* maximizes $\Pi_k(s)-C_k^*(s)+\sum_{j\in J}\alpha_j C_j^*(s)+W(s)$ for every $k\in J$;

(d) for every $k\in J$ there exists a s^k that maximizes $\sum_{j\in J}\alpha_j C_j^*(s)+W(s)$ such that $C_k^*(s^k)=0$.

From condition (c) we derive the first order condition

$$\frac{\partial\Pi_k^*(s^*)}{\partial s}-\frac{\partial C_k^*(s^*)}{\partial s}+\sum_{j\in J}\alpha_j\frac{\partial C_j^*(s^*)}{\partial s}+\frac{\partial W(s^*)}{\partial s}=0 \text{ for all } k\in J. \qquad \text{(A1)}$$

Maximization of the government's objective function (condition (b)) requires the first order condition

$$\sum_{j\in J}\alpha_j\frac{\partial C_j^*(s^*)}{\partial s}+\frac{\partial W(s^*)}{\partial s}=0. \qquad \text{(A2)}$$

Taken together, conditions (A1) and (A2) imply

$$\frac{\partial C_j^*\left(s^*\right)}{\partial s}=\frac{\partial \Pi_j^*\left(s^*\right)}{\partial s} \text{ for all } j\in J\,. \tag{A3}$$

Condition (A3) proves that all contribution schemes are locally truthful around s^*. This implies in our political economy model that lobby groups will set their contributions in accordance with their expected profits and how these are marginally affected by the standard.

A2.Proof of Condition (5)

Production: Domestic producers maximize profits by choosing the optimal quantity q. With $\Pi_p=q\cdot\left[p-g\left(q,s\right)\right]$ this result in the first order condition

$$\frac{\partial \Pi_p}{\partial q}=p-\mathrm{g}\left(q,s\right)-q\frac{\partial g}{\partial q}=0\,;$$

hence $p=\mathrm{g}\left(q,s\right)+q\frac{\partial g}{\partial q}$. (A.4)

Expression (A.4) defines the optimal behavior of domestic producers in the equilibrium and implicitly defines q as a function $\mathrm{q}\left(p,s\right)$. Deriving $\Pi_p\left(s\right)$ with respect to s, and making use of the envelope theorem and equilibrium condition (A.4) results in

$$\frac{\partial \Pi_p}{\partial s}=\frac{\partial q}{\partial s}\left(p-\mathrm{g}\left(q,s\right)\right)+q\left(\frac{\partial p}{\partial s}-\frac{\partial g}{\partial s}-\frac{\partial g}{\partial q}\frac{\partial q}{\partial s}\right)=q\left[\frac{\partial p}{\partial s}-\frac{\partial g}{\partial s}\right] \tag{A.5}$$

Consumption: Only consumers with $\phi_i > p/\left(\varepsilon+s\right)$ will consume the product. Hence total consumer surplus is equal to $\Pi_c\left(s\right)=N\int_{p/(\varepsilon+s)}^{\phi}u_i\mathrm{d}\phi_i=N\frac{\left(\varepsilon+s\right)}{2}\left(\phi-\frac{p}{\left(\varepsilon+s\right)}\right)^2$. Deriving

$\Pi_c(s)$ with respect to s results in

$$\frac{\partial \Pi_c}{\partial s} = \frac{N}{2}\left(\phi^2 - \left(\frac{p}{\varepsilon + s}\right)^2\right) - c\frac{\partial p}{\partial s} \qquad \text{(A.6)}$$

with $\mathrm{c}(p,s) = N\left(\phi - p/(\varepsilon + s)\right)$.

Government: The government's objective function is

$\mathrm{V}(s) = \alpha_p \mathrm{C_p}(s) + \alpha_c \mathrm{C_c}(s) + \mathrm{W}(s)$ in which the political weights α_j are exogenously given. We have that $\frac{\partial V}{\partial s} = \alpha_p \frac{\partial C_p}{\partial s} + \alpha_c \frac{\partial C_c}{\partial s} + \frac{\partial W}{\partial s}$. From the functional form and the truthfulness of the contribution functions we have that $\frac{\partial C_p}{\partial s} = \frac{\partial \Pi_p}{\partial s}$ and $\frac{\partial C_c}{\partial s} = \frac{\partial \Pi_c}{\partial s}$ around the politically optimal s^* (see condition (A3)) and from equation (3) we find that $\frac{\partial W}{\partial s} = \frac{\partial \Pi_p}{\partial s} + \frac{\partial \Pi_c}{\partial s}$ so that $\frac{\partial V}{\partial s} = (1+\alpha_p)\frac{\partial \Pi_p}{\partial s} + (1+\alpha_c)\frac{\partial \Pi_c}{\partial s}$ around the optimum. The government maximizes its objective function with respect to s $\left(\frac{\partial V}{\partial s} = 0\right)$ subject to $s \geq 0$. Using the expressions (A.5) and (A.6) we obtain the result that:

$$\frac{\partial V}{\partial s} = (1+\alpha_p)\left[q^*\left(\frac{\partial p}{\partial s} - \frac{\partial g}{\partial s}\right)\right] + (1+\alpha_c)\left[\frac{N}{2}\left(\phi^2 - \left(\frac{p^*}{\varepsilon + s^*}\right)^2\right) - c^*\frac{\partial p}{\partial s}\right] = 0 \qquad \text{(A.7)}$$

This first order condition determines the resulting standard under the condition that $s^* \geq 0$; in any other case $s^* = 0$. c^* and q^* denote respectively the consumption and domestic production in the optimum, with $c^* = N\left(\phi - p^*/(\varepsilon + s^*)\right)$.

A3.Comparative Statics

Comparative statics analyses on s^* only applies to when $s^* > 0$ in condition (A.7). For cases in which condition (A.7) results in $s^* = 0$, comparative statics results are trivial and equal to zero.

Condition (A.7) implicitly defines s^* as a function of several variables. Hence:

$$\frac{\partial s^*}{\partial x} = -\frac{\partial^2 V / \partial s \partial x}{\partial^2 V / \partial s^2} \tag{A.8}$$

From our assumptions on the convexity of $g(q,s)$ and $p(s)$ in s, it follows that $\partial^2 V / \partial s^2 < 0$ [27]. Hence the sign of $\frac{\partial s^*}{\partial x}$ is determined by (is the same as) the sign of $\partial^2 V / \partial s \partial x$.

Political weight of producers α_p:

$\frac{\partial^2 V}{\partial s \partial \alpha_p} = q^* \left(\frac{\partial p}{\partial s} - \frac{\partial g}{\partial s} \right)$ which is equal to $\frac{\partial \Pi_p}{\partial s}$ at s^*. Therefore $\frac{\partial s^*}{\partial \alpha_p}$ has the same sign as $\frac{\partial \Pi_p}{\partial s}$ at s^*.

Political weight of consumers α_c:

$\frac{\partial^2 V}{\partial s \partial \alpha_c} = \frac{N}{2} \left(\phi^2 - \left(\frac{p^*}{\varepsilon + s^*} \right)^2 \right) - c^* \frac{\partial p}{\partial s}$ which is equal to $\frac{\partial \Pi_c}{\partial s}$ at s^*. Therefore $\frac{\partial s^*}{\partial \alpha_c}$ has the same sign as $\frac{\partial \Pi_c}{\partial s}$ at s^*.

Consumer preferences ϕ:

[27] See footnote 16.

$\frac{\partial^2 V}{\partial s \partial \phi} = (1+\alpha_c) N\left(\phi - \frac{\partial p}{\partial s}\right)$. This expression is positive, and hence $\frac{\partial s^*}{\partial \phi} > 0$, if $\phi > \frac{\partial p}{\partial s}$ at s^*. Violation of this condition would imply that the individual willingness to pay for a marginal increase of the standard is negative at s^*, even for the individual with the highest preference for quality $(\phi_i = \phi)$. We abstract from this case where consumption falls to zero by assuming that this condition holds.

A4.Effect of a standard on imports m

Deriving consumption $\mathrm{c}(p,s) = N\left(\phi - p/(\varepsilon + s)\right)$ with respect to s is equal to

$$\frac{\partial c}{\partial s} = \frac{N}{\varepsilon + s}\left(\frac{p}{\varepsilon + s} - \frac{\partial p}{\partial s}\right). \tag{A.9}$$

Making use of the inverse demand function $D(c,s) = (\phi - c/N)(\varepsilon + s)$ we can rewrite (A.9) as:

$$\frac{\partial c}{\partial s} = \frac{D_s - \partial p/\partial s}{|D_c|} \tag{A10}$$

with $D_c = \frac{\partial D}{\partial c}(<0)$ and $D_s = \frac{\partial D}{\partial s}(>0)$.

Similarly, deriving the equilibrium condition for producers (condition (A.4)) with respect to s gives

$$\frac{\partial q}{\partial s} = \frac{\partial p/\partial s - \partial g/\partial s - q \cdot \partial^2 g/\partial q \partial s}{2 \cdot \partial g/\partial q + q \cdot \partial^2 g/\partial q^2}. \tag{A.11}$$

Making use of the inverse supply function $A(q,s) = \mathrm{g}(q,s) + q\frac{\partial g}{\partial q}$ (see expression (A.4)) we can rewrite (A.11)as:

$$\frac{\partial q}{\partial s} = \frac{\partial p/\partial s - A_s}{A_q} \tag{A12}$$

with $A_q = \frac{\partial A}{\partial q} > 0$ and $A_s = \frac{\partial A}{\partial s} > 0$.

Imports m are defined as $m \equiv c - q$, hence using expressions (A10) and (A12):

$$\frac{\partial m}{\partial s} = \frac{\partial (c-q)}{\partial s} = \frac{D_s}{|D_c|} + \frac{A_s}{A_q} - \left(\frac{A_q + |D_c|}{A_q |D_c|} \right) \frac{\partial p}{\partial s}, \tag{A.13}$$

which cannot be signed unambiguously.

A5.Consumer perceptions

We define λ as a measure of the bias in perception of consumers: λ is equal to 1 if consumers' perceptions of the standard's effects are unbiased. λs is the standard perceived by consumers and we redefine utility as

$$u_i = \begin{cases} \phi_i (\varepsilon + \lambda s) - p & \text{if he buys the good with standard } s \text{ at price } p \\ 0 & \text{if he does not buy} \end{cases} \tag{A.14}$$

The politically optimal standard, s^λ, is then determined by the following first order condition, subject to $s^\lambda \geq 0$:

$$\frac{\partial V}{\partial s} = (1+\alpha_p) \left[q^\lambda \left(\frac{\partial p}{\partial s} - \frac{\partial g}{\partial s} \right) \right] + (1+\alpha_c) \left[\frac{N\lambda}{2} \left(\phi^2 - \left(\frac{p^\lambda}{\varepsilon + \lambda s^\lambda} \right)^2 \right) - c^\lambda \frac{\partial p}{\partial s} \right] = 0. \tag{A.15}$$

$c^\lambda (p,s) = N\left(\phi - p/(\varepsilon + \lambda s^\lambda)\right)$ and q^λ denote respectively the aggregate consumption and domestic production in the political optimum and p^λ is the equilibrium world price.

Deriving expression (A.15) with respect to λ, we get

$$\frac{\partial^2 V}{\partial s \partial \lambda} = (1+\alpha_c) \left[\frac{N}{2} \left(\phi^2 - \left(\frac{p^\lambda}{\varepsilon + \lambda s^\lambda} \right)^2 \right) + \frac{s^\lambda p^\lambda}{\varepsilon + \lambda s^\lambda} \frac{\partial c^\lambda}{\partial s} \right].$$

A sufficient but not necessary condition for this expression to be positive is that $\frac{\partial c^{\lambda}}{\partial s}$ is positive at s^{λ}. Hence, when consumption is increasing in the standard at s^{λ}, we find that $\frac{\partial s^{\lambda}}{\partial \lambda} > 0$. However, when average consumer preferences ϕ are low such that $\phi^2 < \left(\frac{p^{\lambda}}{\varepsilon + \lambda s} - \frac{2s}{N} \frac{\partial c^{\lambda}}{\partial s} \right) \frac{p^{\lambda}}{\varepsilon + \lambda s}$ for $\frac{\partial c^{\lambda}}{\partial s} < 0$ at s^{λ}, we find that $\frac{\partial s^{\lambda}}{\partial \lambda} < 0$.