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1 Introduction

The main contribution of this paper is to show that international trade disputes over Minimum Quality Standards (MQSs) are likely to arise even when standards are non-discriminating. More specifically, even if the costs of meeting the standards are exactly the same for all firms, domestic and foreign, the impact on profits may well differ, and firms will therefore prefer (and lobby for) different levels of the standard.

Most of the existing literature on the trade impact of MQSs assumes that standards are explicitly or implicitly discriminating in nature. Generally, if a Minimum Quality Standard imposes higher costs on foreign firms than domestic firms, by design, implementation or administration, there are obvious reasons to expect that international trade disputes and accusations of protectionism will arise. In Sturm (2006), this asymmetry is explicitly assumed.

Thilmany and Barrett (1997) and Ganslandt and Markusen (2001) suppose that domestic firms are already in compliance with the proposed MQS, while foreign firms are not. Implementing the regulation is therefore equivalent to imposing a tariff on foreign firms. Fischer and Serra (2000) propose a model in which both domestic and foreign firms are subject to compliance costs. However, compliance costs are higher for foreign firms than domestic firms, as only foreign firms are assumed to serve multiple markets each requiring different levels of quality implying extra fixed costs. A notable exception is Marette and Beghin (2010), who consider a non-discriminating MQS imposed to alleviate an externality. They show that if firms are identical, a nationally optimal MQS would generally be higher than a standard maximising global welfare (which according to the authors implies a protectionist measure). The reason is that the national policy maker balances gains secured by alleviating the externality, with losses incurred by consumers and domestic firms. However, the policy maker does not take into account losses faced by foreign firms.

I present a simple partial equilibrium trade model of a domestic market characterised by imperfect competition and heterogeneous consumers. A domestic and a foreign firm supply a homogeneous good in a Cournot duopoly. The two firms are identical in all respects except that the foreign firm faces transport costs. Thus, the model resembles the basic setup in Brander and Krugman (1983), which shows that the two firms can coexist in the market, as long as transport costs are not too high, albeit with the foreign firm

capturing a smaller market share than the domestic firm.

Consumers differ with respect to their willingness to pay for product quality. They are, however, unable to observe the quality of the product, generating a classic case of asymmetric information market failure (Akerlof, 1970). To address the market failure, the government imposes a MQS (Leland, 1979). Examples of cases that fit this description reasonably well are Maximum Residue Levels of pesticides in food products and hazardous chemicals in plastic toys, and safety standards for automobiles, electronic equipment and pharmaceutical products.

I show that the MQS has three effects on the market; i) it raises the costs of production; ii) it raises consumers' willingness to pay for the product; and iii) it changes the price elasticity of demand. As the MQS is non-discriminating, the first two effects influence both firms symmetrically. I argue that in most likely cases, the price elasticity of demand will increase, which hurts the foreign firm more than the domestic firm. As a result, the regulation, which maximises domestic welfare, is more restrictive than the one preferred by the foreign firm, and the possibility for trade disputes arises. It is, however, also possible that the price elasticity of demand declines, in which case the results are reversed: the MQS benefits the foreign firm more than the domestic firm, and the national welfare maximising standard becomes more lenient than the one preferred by the foreign firm.

The paper contributes to the literature on MQSs. A MQS is typically proposed in response to a market failure, of which three types are identified

in the literature; i) imperfect competition; ii) externalities; and iii) imperfect information.

Spence (1975) and Mussa and Rosen (1978) showed that qualities chosen by a monopolist were generally socially sub-optimal. Another distortion was identified by Shaked and Sutton (1982), who showed that duopolists would tend to over-differentiate their products to relax price competition. These issues were investigated further by a string of authors, including Das and Donnenfeld (1989); Ronnen (1991); Crampes and Hollander (1995) and Boom (1995), who showed that under various assumptions, MQSs could counter quality distortions generated by imperfect competition. Papers looking at MQSs in markets characterised by externalities include Fischer and Serra (2000); Sturm (2006) and Marette and Beghin (2010).

The present paper differs from these contributions by assuming asymmetric information. I have not found many papers on MQSs which address asymmetric information problems. Darby and Karni (1973); Leland (1979) and Chambers and Weiss (1992) are notable exceptions, but they do not consider international trade. Bureau et al. (1998) and Giannakas and Fulton (2002) also investigate asymmetric information, but in their papers the quality decisions made by firms are discrete and fixed (e.g. genetically modified vs. conventional food), whereas in my paper product quality is continuous and endogenous. Also, they analyse the impact of a labelling requirement, providing full information to consumers, rather than a MQS, which only provide information regarding the lower bound of quality.

The remainder of this paper is structured as follows. The next section introduces the basic model. Sections 3 and 4 derive the market equilibrium in two distinct cases, whilst section 5 proves the main results of the paper. Section 6 concludes.

2 The model

2.1 Product quality and asymmetric information

A domestic and a foreign firm sell a product on the domestic market. As in Brander and Krugman (1983), markets are assumed to be segmented, so the domestic market can be viewed in isolation. The product is characterised by a level of quality, but consumers are unable to observe the quality before purchase or after consumption, which Darby and Karni (1973) refer to as a credence attribute. Note that the characterisation of quality as a credence attribute, as opposed to an experience attribute which is known by consumers upon consumption, precludes the building of reputation as a viable strategy for the firms. The attributes are, in principle, detectable but only through testing or the establishment of traceability systems, which is beyond any individual consumer. This form of asymmetric information also implies that goods are *de facto* homogeneous, as consumers are unable to detect any attempt at product differentiation. The examples mentioned in the introduction (e.g. pesticides in apples or chemicals in plastic toys) fit this description reasonably well.

The failure by consumers to observe product quality generates asymmetric information market failure, and as in Akerlof (1970), the unregulated equilibrium results in the under provision of quality. The argument is as follows: assuming quality is costly to provide, firms have incentives for lowering quality to a minimum to minimise costs (note that unlike Akerlof (1970), here quality is assumed to be endogenously chosen by the firms). If a firm was able to convince its consumers that its product was of superior quality, it would be able to capture part of the consumers' willingness to pay for the higher quality. However, as consumers have no way of verifying the claim, it is not credible. Firms have incentives for 'exaggerating' the level of quality, while supplying goods at minimum quality. Knowing this, consumers should not believe the firms' claim. As a result, both producers would provide the minimum level of quality, and consumers would consistently expect this.

To raise quality (and improve welfare), some kind of independent quality control is needed. One possibility is that firms hire a private third party certification agency to verify quality claims. If certification fees are low enough relative to consumers' willingness to pay for quality, a higher quality equilibrium could emerge, provided the certification is credible. This may not always be the case. As Jahn et al. (2005) point out, certification agencies are also economic agents, who may have incentives for skimping on verification efforts to land lucrative contracts. Also, when products are traded internationally, consumers in one country may not put much trust in other countries certification agencies.

An alternative to private certification is government quality control. This would be relevant if private certification is more costly or insufficiently credible. In this paper, I consider a governmentally enforced Minimum Quality Standard. The function of the standard is to provide information to consumers. When observing the standard, consumers know that product quality is not below the mandated level. Using the same line of reasoning as above, firms have no incentives to raise the quality above the minimum level. Thus, the MQS effectively forms consumers' consistent expectations about product quality.

2.2 Demand

Consumers are heterogeneous with respect to quality, in that some consumers are more sensitive about quality than others. I adopt a simple representation of consumer heterogeneity, which is based on Mussa and Rosen (1978). Let consumer heterogeneity be represented by a parameter, θ, which is normalised over the range $[0; 1]$. For tractability, θ is assumed to be uniformly distributed with unit density ($f(\theta) = 1$) over this range. This produces a linear demand function, which allows me to ignore the imperfect competition quality distortions demonstrated by Spence (1975).

Each consumer makes the discrete choice between buying one unit of the

product or choosing an outside option. Utility is given by

$$U = \begin{cases} V + \theta q - p & \text{if the regulated product is consumed} \\ \theta q_0 & \text{if the outside option is chosen} \end{cases}$$

where p and q are the price and quality of the product, V is the utility derived from consuming the regulated product irrespective of quality, and q_0 is the exogenous quality equivalence of the outside option.

The impacts of a MQS depend crucially on how consumers compare the quality of the product with the outside option. The set of consumers that end up purchasing the product are those whose taste parameter satisfies $\theta(q_0 - q) \leq V - p$. If the product is considered low-quality (compared to the outside option), $q_0 > q$, and demand for the product is generated by the least quality-conscious consumers given by $\theta \leq (V - p) / (q_0 - q)$. For instance, consumers who are highly concerned about the possibility of hazardous chemicals in plastic toys can instead choose to buy wooden toys, which are not chemically treated. Or, if the quality attribute in question is vehicle safety, the outside option to buying an automobile could be taking public transportation, which is often viewed as a safer option.

In contrast, if the regulated product is considered to be a high-quality good (in terms of a particular quality attribute) ($q_0 < q$), the consumers that purchase the product are characterised by $\theta \geq (V - p) / (q_0 - q)$ – the most quality-conscious consumers. I would argue that we are most likely to

encounter the low-quality cases, not least because it makes more sense for the government to regulate low-quality products than goods that are already viewed as being a high-quality option. The examples mentioned in the introduction typically fall in the low-quality category, where the outside option is guaranteed safe. However, opposite examples can also be constructed. If the alternative to driving an automobile is riding a bike in heavy traffic, even a low-quality car may be the safer option. In this paper, I will show that results differ in these two cases, as high- and low-θ consumers react differently to changes in the quality of the product.

2.3 Supply

The domestic and the foreign firm are assumed to be identical, except that the foreign firm faces transport costs, t. The interpretation of t can be generalised to include other trade costs, such as specific tariffs, as well as any marginal costs difference between the two firms. Thus, $t < 0$ could represent a foreign firm that is sufficiently more productive than the domestic firm to outweigh the positive transport costs. I will assume $t > 0$ for the remainder of the paper. Assuming negative transport costs would not change the results qualitatively, it would be equivalent to switching the labels of the domestic and foreign firms.

Raising quality is costly for firms. I assume that marginal costs, $c(q) \geq 0$, are constant in output and sufficiently convex in quality for an interior solution to be obtained (the exact second-order condition is presented and

discussed in the appendix). Let quality be defined over a given range, $q \in [q_{min}; q_{max}]$ with $c'(q_{min}) = 0$, i.e. q_{min} is the level of quality that minimises costs of production. I distinguish the two possible cases such that in the low-quality case, $q_0 = q_{max}$, whereas in the high-quality case, $q_0 = q_{min}$.

3 Low-quality case

I normalise the quality of the outside option to zero, $q_0 = 0$, implying that the quality is negative, $q \in [q_{min}; 0]$. Given the price and quality of the product, the marginal consumer is exactly indifferent to buying the regulated product or choosing the outside option. He is represented by the taste parameter

$$\tilde{\theta}(p, q) = -\frac{V - p}{q} \tag{1}$$

which is positive for $V < p$ as $q \leq 0$. All consumers with $\theta \leq \tilde{\theta}$ purchase the product and the rest choose the outside option. Thus, aggregate demand is given by

$$X(p, q) = \int_0^{\tilde{\theta}} f(\theta)\, d\theta = \tilde{\theta} \tag{2}$$

using the assumption that $f(\theta) = 1$. As quality increases towards 0, aggregate demand increases until $\tilde{\theta} = 1$ and the market becomes satiated as all consumers choose the product over the outside option.

Aggregate inverse demand is

$$p(X, q) = V + qX \tag{3}$$

and profits of the two firms can be written as

$$\pi_d(x_d, q) = (V + q(x_d + x_f) - c(q))\, x_d \tag{4}$$

$$\pi_f(x_f, q) = (V + q(x_d + x_f) - t - c(q))\, x_f \tag{5}$$

where x_d and x_f are the outputs of the domestic and the foreign firm respectively. As argued above, given the assumptions of this model, the level of quality is effectively exogenous to the firms, so output is the only strategic variable. With Cournot conjectures, Nash equilibrium output levels are given by

$$x_d(q) = -\frac{V + t - c(q)}{3q} \tag{6}$$

$$x_f(q) = -\frac{V - 2t - c(q)}{3q} \tag{7}$$

As long as transport costs are not too high, $t < (V - c(q))/2$, the foreign firm will not be priced out of the market despite cost disadvantages, although it will capture a smaller share of the market (as previously demonstrated by Brander and Krugman (1983)).

Differentiating (6) and (7) with respect to q reveals how the two firms

react to changes in the MQS

$$\frac{dx_g}{dq} = -\frac{x_g - \frac{1}{3}c'}{q} \tag{8}$$

for $g \in \{d, f\}$. x_g represents the output of firm g, but it is also a measure of the marginal consumer's willingness to pay for increased quality as perceived by firm g. So in their output decisions, firms balance the extra willingness to pay for higher quality products with the extra costs of compliance absorbed by the firm. As the domestic firm has a higher market share, it captures a larger share of consumers' extra willingness to pay, and $\frac{dx_d}{dq} > \frac{dx_f}{dq}$ (recall that $q < 0$), i.e. the domestic firm will always respond to an increase in the MQS by expanding output by more, or reduce output by less than the foreign firm.

An alternative interpretation can be obtained from figure 1, which illustrates the output decisions of the two firms in the low-quality case. The downward sloping solid lines (D) represent the perceived demand curve facing each individual firm. The dashed lines (MR) are marginal revenues, whilst the horizontal lines (MC), illustrating marginal costs, are higher for the foreign firm than the domestic firm due to transport costs.

An increase in the MQS generates two effects: Firstly, marginal costs rise as a higher quality is more expensive to produce. This effect is symmetric for both firms. Secondly, the demand curve rotates outwards. Consumers are willing to pay more for higher quality, but this premium is not the same for all consumers. When the regulated product is a low-quality good, only

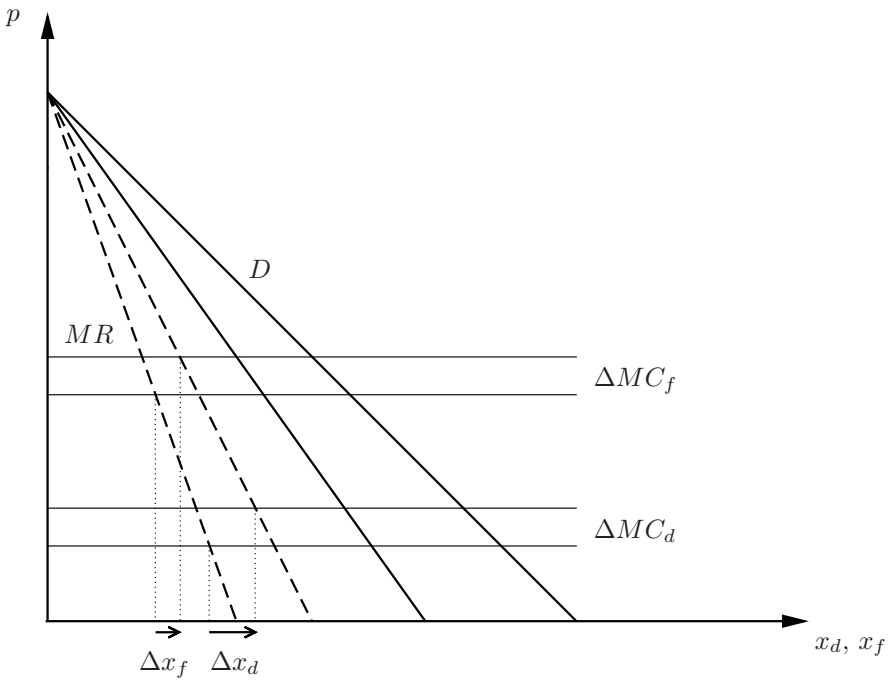

Figure 1: Change in the MQS for the low-quality case

the least quality-conscious consumers choose to buy the product for a given level of quality, whereas the most quality-conscious consumers choose the outside option. Thus, the marginal consumer increases his willingness to pay by more than the infra-marginal consumers, represented by the rotation in the demand curve.

The effect on demand is asymmetric for the two firms. The increase in the MQS makes demand more elastic, as the low-quality product becomes a closer substitute to the outside option. As the domestic firm has a larger share of the market than the foreign firm, the domestic firm faces a larger increase in its perceived elasticity of demand. Therefore, the domestic firm

reduces its mark-up by more than the foreign firm, which results in a larger increase (or smaller decline) in output compared to the foreign firm. I show later in the paper that the increase in output outweighs the decline in the mark-up such that the increase in domestic profits is still larger than the increase in foreign profits (or the reduction smaller).

4 High-quality case

When the regulated product is considered to be a high quality good, compared to the outside option, demand is generated by the most quality-conscious consumers, $\theta \geq (V - p) / (q_0 - q)$. Normalising $q_0 = 0$ as before (this time implying $q > 0$), it is clear that the case is not very interesting unless $p > V$ – if this was not the case, all consumers would buy the product irrespective of quality. Thus, we can also normalise $V = 0$ and simply assume positive prices. With these assumptions, the marginal consumer is given by

$$\tilde{\theta} = \frac{p}{q} \tag{9}$$

and aggregate demand becomes

$$X(p, q) = \int_{\tilde{\theta}}^{1} d\theta = 1 - \tilde{\theta} \tag{10}$$

with inverse demand given by

$$p(X, q) = q(1 - X) \tag{11}$$

Assuming Cournot conjectures, the Nash equilibrium output of the two firms can be derived as

$$x_d(q) = \frac{q + t - c(q)}{3q} \tag{12}$$

$$x_f(q) = \frac{q - 2t - c(q)}{3q} \tag{13}$$

As before, I proceed by deriving how the two firms respond to changes in the MQS

$$\frac{dx_g}{dq} = \frac{\frac{1}{3} - x_g - \frac{1}{3}c'}{q} \tag{14}$$

This time the perceived willingness to pay for higher quality by the marginal consumer is $\frac{1}{3} - x_g$, which is negatively related to output. The reason is that in the high-quality case, the regulated product attracts the most quality-conscious consumers, and the marginal consumer therefore has a lower willingness to pay for quality than the infra-marginal consumers. As a consequence, the domestic firm perceives a lower extra willingness to pay than the foreign firm, and we find that $\frac{dx_d}{dq} < \frac{dx_f}{dq}$, which is the exact opposite of the low-quality case. The domestic firm will expand output by less, or contract output by more, than the foreign firm.

Figure 2 is constructed in the same way as figure 1. As before, an increase

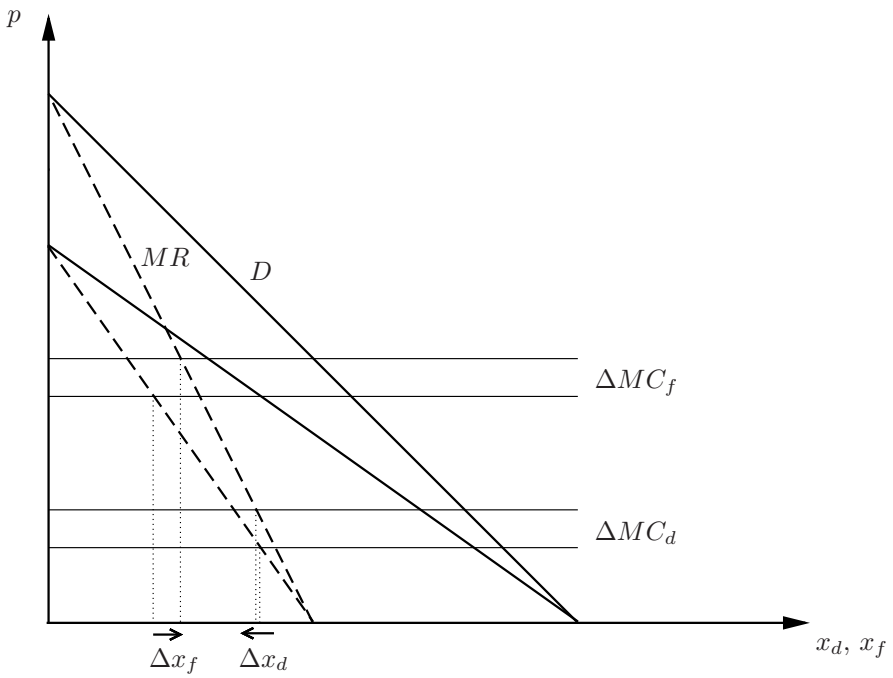

Figure 2: Change in the MQS for the high-quality case

in the MQS raises marginal costs and rotates the demand curve upwards. However, the mode of rotation is different. When the regulated product is the high-quality option, the most quality conscious consumers, who respond the most to an increase in quality, are situated in the upper part of the demand curve, whereas the more indifferent consumers are located at the bottom. As a result, the aggregate demand becomes less elastic, inducing both firms to increase their mark-ups. Just as before, the effects are larger for the domestic firm than for the foreign firm due to the differences in market shares.

5 Choice of standard

Having established how the markets respond to a product standard, we can now take a closer look at how firms and consumers are affected by the standard. It is easier to interpret the results if we consider the profit functions in their general form:

$$\pi_g(q) = [p(q, X(q)) - \tilde{c}_g(q)]\, x(q) \tag{15}$$

where $\tilde{c}_g(q)$ represents marginal costs inclusive of transport costs and is defined as

$$\tilde{c}_g(q) = \begin{cases} c(q) & \text{if } g = d \\ c(q) + t & \text{if } g = f \end{cases}$$

(note that $\tilde{c}'_g = c'$).

Let q_d and q_f denote the MQS maximising respectively domestic and foreign firm profits (15). The first order condition defining q_g is

$$\frac{d\pi_g}{dq} = (p - \tilde{c}_g)\frac{dx_g}{dq} + x_g\left(p'_q + p'_x\frac{dX}{dq} - c'\right) = 0 \tag{16}$$

where $p'_q \equiv \frac{\partial p}{\partial q}$ and $p'_x \equiv \frac{\partial p}{\partial x}$. From the first order condition determining optimal output, we have that $p - \tilde{c}_g = -x_g p'_x$, so we can rewrite (16) as

$$\frac{d\pi_g}{dq} = x_g\left[p'_q(q_g) - c'(q_g) + p'_x(q_g)\frac{dx_h(q_g)}{dq}\right] = 0 \tag{17}$$

for $g, h \in \{d, f\}$, $g \neq h$.

The level of MQS preferred by each firm is determined by a balance of three effects, i) higher willingness to pay for higher quality; ii) higher costs of production; and iii) a strategic interaction effect. A monopolist would lobby for a standard that balanced the increasing willingness to pay with the higher costs (the first two effects). However, in a duopoly, firms also consider their rival's response to higher quality. If an increase in the MQS induces the rival (firm h) to cut back on output, this would bring additional benefits to firm g ($p'_x < 0$ is the slope of the demand curve). A sufficient second-order condition for an interior solution is presented and discussed in the appendix.

I can now establish the following propositions:

Proposition 1. *If the regulated product is a low-quality good ($q < 0$), then $q_f < q_d$. If instead the regulated product is a high-quality good ($q > 0$), then $q_f > q_d$.*

Proof. From (17) we can see that q_d is characterised by

$$p'_q(q_d) - c'(q_d) = -p'_x(q_d)\frac{dx_f(q_d)}{dq} \tag{18}$$

Insert (18) into (17) for the foreign firm, evaluated at q_d to get

$$\begin{aligned} \frac{d\pi_f(q_d)}{dq} &= x_f\left[-p'_x(q_d)\frac{dx_f(q_d)}{dq} + p'_x(q_d)\frac{dx_d(q_d)}{dq}\right] && (19) \\ &= -p'_x(q_d)\,x_f\left[\frac{dx_f(q_d)}{dq} - \frac{dx_d(q_d)}{dq}\right] && (20) \end{aligned}$$

From (8) and (14) we have that in the low-quality case, $\frac{dx_d}{dq} > \frac{dx_f}{dq}$, implying that $\frac{d\pi_f(q_d)}{dq} < 0$ (note that $p'_x < 0$), and in the high-quality case, $\frac{dx_d}{dq} < \frac{dx_f}{dq}$, resulting in $\frac{d\pi_f(q_d)}{dq} > 0$. Hence, given $q = q_d$, foreign firm profits can be increased by reducing quality in the low-quality case and increasing quality in the high-quality case. □

Proposition 1 tells us that the domestic firm will always prefer a higher standard than the foreign firm in the low-quality case, and a lower standard than the foreign firm in the high-quality case. The interests of domestic consumers in aggregate are provided by Proposition 2.

Proposition 2. *Let q_{CS} denote the level of MQS maximising aggregate consumer surplus. With linear demand curves, q_{CS} always lie between q_d and q_f. If the regulated product is a low-quality good, then $q_d > q_{CS} > q_f$. If the regulated product is a high-quality good, then $q_d < q_{CS} < q_f$.*

Proof. With linear demand curves, profits and consumer surplus can be written as

$$\pi_g(q) = \delta q x_g(q)^2 \tag{21}$$

$$CS(q) = \frac{1}{2}\delta q X(q)^2 \tag{22}$$

where δ is used to denote the sign of q and defined as

$$\delta = \begin{cases} 1 & \text{if } q > 0 \\ -1 & \text{if } q < 0 \end{cases}$$

Differentiating (21) with respect to q yields

$$\frac{d\pi_g(q)}{dq} = \delta x_g(q)\left(x_g(q) + 2q\frac{dx_g(q)}{dq}\right) \tag{23}$$

Similarly, the derivative of (22) can be written as

$$\begin{aligned} \frac{dCS(q)}{dq} &= \frac{1}{2}\delta X(q)\left(X(q) + 2q\frac{\partial X(q)}{\partial q}\right) \\ &= \frac{1}{2}\delta X(q)\left(x_d(q) + 2q\frac{\partial x_d(q)}{\partial q} + x_f(q) + 2q\frac{\partial x_f(q)}{\partial q}\right) \end{aligned}$$

Using (23) we get

$$\frac{dCS(q)}{dq} = \frac{1}{2}\left(\frac{\partial \pi_d(q)}{\partial q}\frac{X(q)}{x_d(q)} + \frac{\partial \pi_f(q)}{\partial q}\frac{X(q)}{x_f(q)}\right)$$

Evaluated at q_d, $\frac{dCS}{dq}$ has the same sign as $\frac{d\pi_f}{dq}$, and evaluated at q_f, $\frac{dCS}{dq}$ has the same sign as $\frac{d\pi_d}{dq}$. It follows that q_{CS} must lie somewhere between q_d and q_f. □

Proposition 2 shows that the optimal regulation, seen from the perspective of consumers, in aggregate lies somewhere between the optimal regulation of the domestic and the foreign firm (leaning more towards the foreign

firm).

Results suggest that international trade disputes over MQSs are likely to arise in the plausible case that the regulated product is considered a low-quality alternative, even if the regulation is fundamentally non-discriminating. If the minimum quality level is chosen in order to maximise national welfare given by some (weighted) aggregation of profits and consumer surplus, it will be more restrictive than the MQS considered appropriate by the foreign firm, or the standard which maximises global welfare (accounting for foreign profits as well). According to Marette and Beghin (2010), such as standard would be protectionist.

On the other hand, it should be possible to find examples of MQSs that are not potentially the subject of dispute. If the regulated product is considered a high-quality alternative, the results are reversed. A nationally optimal standard would be less restrictive than what is preferred by the foreign firm ("anti-protectionist" in the terminology of Marette and Beghin (2010)).

I have so far referred to consumers as a collective, but as consumers are heterogeneous, it is relevant to look at how individual consumers are affected by the MQS. The standard not only increases product quality but also raises prices. The net utility effect is positive for the most quality-conscious consumers (if they choose the regulated product), but consumers that are more indifferent to quality tend to lose out as a result of such regulation. In the high-quality case, the least quality-conscious consumers choose the outside option and are unaffected by an increasing MQS, but for ranges of q, where

$\frac{dX}{dq} < 0$ (this is the case for q_{CS}), a number of consumers around the marginal consumer lose out, as the price increases by more than their willingness to pay and they drop out of the market. When the regulated product is a low-quality good, it is the other way around.

Viewed from a political economy perspective, these results have interesting implications. Suppose it is easier for the most quality-conscious consumers to organise for lobbying purposes than it is for the least quality-conscious consumers. Then one could imagine that a MQS determined by a coalition representing high-quality consumers and domestic industry would be very restrictive and subject to accusations of protectionism. However, unlike protectionism in the traditional sense (protecting domestic industry at the expense of foreign industry and consumers), this trade barrier also represents a form of "consumer-protectionism", protecting domestic industry and quality-conscious consumers at the expense of foreign industry and quality indifferent consumers (such protectionism has been noted before, see e.g. Kerr (2004)).

6 Conclusion

In this paper I have shown that international trade disputes over a Minimum Quality Standard (MQS) are likely to arise under plausible circumstances. If the regulated product is considered to be a low-quality product relative to relevant outside options, a MQS would affect demand in such a way that a do-

mestic firm would lobby for a more restrictive standard than would domestic consumers (in aggregate) and foreign firms. To the extent that such lobbying is successful, the enacted regulation could be considered protectionist. On the other hand, examples can be constructed where the regulated product is considered to be a high-quality alternative, in which case the results are reversed, and international trade disputes would be unlikely.

The results are based on a simple example of an international Cournot duopoly (with no entry/exit), consumer heterogeneity with respect to quality, asymmetric information, identical firms and linear demand curves. However, the results may possibly be generalised to less restrictive models. The main results hinge on the fact that changes in quality affect demand elasticities, which in turn have differing implications for firms' mark-ups due to differences in market shares. These relationships should not be limited to this simple example, and generalising the results could be an interesting topic for future research.

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Appendix

A sufficient second order condition for the interior existence of q_g can be derived as

$$\frac{d^2\pi_g}{dq^2} = \left(p'_q - c' + p'_x\frac{dx_h}{dq}\right)\frac{dx_g}{dq} + x_g\left(p''_q - c'' + p''_{xq}\frac{dx_h}{dq} + p'_x\frac{d^2x_h}{dq^2}\right) < 0 \tag{24}$$

for all q. The condition looks rather complicated, but it all boils down to a requirement that c'' is large enough. If we ignore the strategic effect for a moment, we see that both costs and consumers' willingness to pay increases with quality, and if costs increase too slowly, firms will always prefer a higher MQS. The second order condition is more likely to hold in the high-quality case, as $p''_q = -\frac{dX}{dq}$. As illustrated in figure 2, the marginal consumer has

a lower willingness to pay for quality than the infra-marginal consumers, so as demand increases, the less quality-conscious consumers switch to the regulated product, and the marginal willingness to pay for quality declines. Although demand is likely to increase with the MQS at relatively low quality levels, the appetite for higher standards quickly diminishes and is overtaken by the higher costs.

In the low-quality case, however, $p''_q = \frac{dX}{dq}$, and demand for higher MQS can quickly spin out of control if c'' is small. Figure 1 illustrates that as demand increases, the more quality-conscious consumers enter the market increasing the marginal willingness to pay for higher quality. If costs rise slowly, this induces firms to lobby for an even higher MQS generating even greater willingness to pay for higher quality and so on. This doesn't imply that the standard becomes infinitely high, as at some point all consumers will choose the regulated product over the outside option and demand ceases to rise ($p''_q = 0$). However, such a corner solution is not very interesting and I rule it out by assumption.

The strategic effect (the last two terms of (24)) is the joker in the second order condition, as the sign of the effect is indeterminate. However, there is reason to believe that the strategic effect would generally work in favour of the second-order condition holding. As long as the MQS has a positive effect on demand, the strategic effect would tend to hold firms back in their desire for a higher standard. The tighter standard not only benefits my own firm, but would also tend to induce my rival to expand output as well.

In this paper, I assume that c'' is sufficiently large for the second-order condition to hold. A corner solution is possible, but not very interesting in this context. If the costs of raising quality remain very low, everybody would agree that a high MQS should be set to overcome the asymmetric information problem, and there would be no grounds for disagreement between firms, consumers or governments over regulation.