Product standards and international trade

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Abstract

In this paper I show that the impacts of product standards on international trade and the relative ordering of the interests of domestic producers, foreign producers and consumers depend on the quality characteristics of the product in question relative to close substitutes. If the substitute is a higher quality alternative (what I refer to as a negative quality case), domestic firms would lobby for a more restrictive product standard than would domestic consumers and foreign firms, thus generating the potential for international trade dispute. On the other hand, if the substitute is a lower quality alternative (the positive quality case), the ordering is reversed and the foreign firm would prefer the higher standard. In the latter case, international trade dispute is more unlikely.

1 Introduction

Intuitively we would expect product standards to have similar impacts on trade whether the regulation relates to positive quality, such as Minimum Quality Standards (MQSs) for automobile fuel efficiency, or ‘negative’ quality, for instance in the form of Maximum Residue Levels (MRLs) of a food contaminant. Usually, the literature makes that assumption implicitly, or at least they do not make the distinction, see e.g. Fischer and Serra (2000), Boom (1995) and Das and Donnenfeld (1989). This paper shows that the two types of standards are generally not equivalent.

I present a simple partial equilibrium model of an international duopoly selling on the domestic market. Firms are assumed to be identical, but the foreign firm faces positive transport costs. With Cournot conjectures this
implies that the domestic firm has a higher market share than the foreign firm (as in Brander and Krugman (1983)). Consumers are heterogeneous with respect to their valuation of product quality, but they are unable to observe the quality of the product. This generates an asymmetric information market failure and the government may improve welfare by imposing a product standard. The paper shows that when quality is a positive variable, and the product standard mandates a minimum level, the foreign firm will benefit more from the regulation than the domestic firm and consumers on average and will therefore favour a higher standard. However, if the quality is a negative variable and the regulation determines a maximum level of contaminant, the domestic firm will lobby for a more restrictive regulation than the foreign firm and consumers on average prefer. The distinction is crucial as the latter form of standard may give rise to allegations of protectionism, whereas the former should not.

My use of the terms, positive and negative quality, is essentially a short hand way of describing the relative qualities of a product in question (hereafter generally referred to as ‘the product’) and a close substitute (hereafter just ‘the substitute’). If the substitute is generally of lower quality than the product, I will call it a positive quality case. Conversely, when the substitute is the higher quality alternative, I refer to a negative quality case (thus, basically normalising the quality of the substitute to zero).

The difference between positive and negative quality can be appreciated by a simple example. Suppose the product is a small car and the substitute an SUV. If the quality attribute in question is vehicle safety, the substitute is considered a high-quality alternative – an SUV is typically safer (for its passengers) than a small car due to its mass and sturdiness. Then, for any price and quality of the small car, demand is generated by the least quality conscious consumers. Consumers of the SUV (if any) are the ones that are most concerned about vehicle safety. In this case, small car quality can be characterised as ‘negative’ quality relative to the substitute, and raising quality involves reducing the gap between quality levels of the product and the substitute.

Suppose instead that the quality attribute in question is CO\textsuperscript{2} emissions. In this case, the substitute is a low-quality alternative, and for any price and quality of the small car, the most quality conscious consumers will purchase the product. Increasing product quality thus expands the gap between the quality levels of the product and the substitute. This is what I will refer to as positive quality.

The literature on product quality and standards seldom make the distinction between positive and negative quality explicitly. Fischer and Serra (2000), Sturm (2006) and Marette and Beghin (2008) assume that the quality
of the product only has external effect and does not affect demand at all. In a string of literature including Das and Donnenfeld (1989), Ronnen (1991), Crampes and Hollander (1995) and Boom (1995) quality is observable by consumers and a MQS serves to narrow the quality gaps between different qualities. As such they most closely resemble negative quality cases. Other negative quality examples are found in Fulton and Giannakas (2004) and Lapan and Moschini (2007), in which GM products are considered together with higher quality non-GM substitutes.

The paper proceeds by presenting the basic model in the next section, followed by analyses of how a MQS affects demand and output decisions of the two firms in the positive and negative quality cases. Then I analyse the optimal choice of MQS seen from the perspective of the different agents in the economy, firms, consumers and government, and discuss how incentives differ in the two cases. The final section concludes.

2 The model

A domestic and a foreign firm sell a product on the domestic market. The product is characterised by a level of quality, but consumers are not able to observe the quality before purchase as well as after consumption – what Darby and Karni (1973) characterise as a credence attribute. Examples of such credence attributes include the absence of pesticide residues in food, the environmental sustainability of the wood used in furniture or the safety characteristics of automobiles. The characteristics are in principle detectable, but only though testing or establishment of traceability systems, which is beyond any individual consumer.

This failure by consumers to observe product quality generates an asymmetric information market failure, and as in Akerlof (1970) the unregulated equilibrium results in underprovision of quality. The argument is as follows: assuming that raising quality is costly, firms have incentives to lower quality to a minimum level to minimise costs. If a producer could convince consumers that his product is of a superior quality, he could extract part of consumers’ willingness to pay for higher quality and increase profits. However, as consumers have no way of verifying that claim, it is not credible. The producer would have an incentive to ‘exaggerate’ the level of quality, while producing at minimum quality. Knowing this, consumers should not believe the producers’ claims. As a result, both producers would deliver products of the lowest 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 producers 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 may be found, 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 incentive to skimp on verification efforts in order to land lucrative contracts. Also, when products are traded internationally, consumers in one country may not put much trust in other countries’ certification agencies. For instance, Chinese quality certificates may not reassure European consumers to a great extent. Finally, in some countries public authorities simply have more credibility than private agents (justly or not). The alternative to private certification is public quality control. This would be relevant if private certification is more costly or not sufficiently credible.

In this paper, I consider a product standard – a minimum level of quality, below which products are not allowed to enter the market. The function of the standard is to provide information to consumers. Observing the standard, consumers now know that product quality is not below the mandated level. Using the same line of argument as above, producers have no incentive in raising quality above the minimum level. Thus, the product standard effectively forms consumers’ consistent expectations about product quality.

2.1 Positive and negative quality

Consumer tastes are heterogeneous with respect to quality – some consumers are more conscious about quality than others. I adopt a simple representation of consumer heterogeneity based on Mussa and Rosen (1978). Let consumer heterogeneity be represented by a parameter, \( \theta \), which is normalised over the range of \([0; 1]\). For tractability \( \theta \) is assumed to be uniformly distributed over this range. Each consumer chooses between buying one unit of the product or one unit of a substitute. Indirect utility of a consumer represented by \( \theta \) is given by

\[
U = \begin{cases} 
V + \theta q - p & \text{if the product is consumed} \\
V_0 + \theta q_0 - p_0 & \text{if the substitute is consumed} 
\end{cases}
\] (1)

where \( p \) and \( q \) are the price and quality of the product and \( V \) is the utility derived from consuming the product irrespective of quality level. Subscript \( 0 \) refers to the substitute.

Utility maximisation implies that consumers will purchase the product if

\[
\theta(q - q_0) \geq V_0 - p_0 - (V - p)
\] (2)
and the substitute otherwise. The distinction between positive and negative quality essentially relates to how consumers compare the product and the substitute. Suppose the substitute is a low-quality alternative, i.e. $q - q_0 > 0$. Then aggregate demand for the product is generated by consumers, for whom

$$\theta \geq \frac{V_0 - p_0 - (V - p)}{q - q_0}$$

(3)

i.e. the most quality conscious consumers.

Unless $V_0 > V - p$ the case would not be very interesting – the left-hand side of (3) would be negative implying that all consumers purchase the product and nobody the substitute. Obviously, if the product is of a higher quality than the substitute and all non-quality characteristics (incl. price) are also preferred nobody would ever choose the substitute.

Now suppose the substitute is a high-quality alternative, then $q - q_0 < 0$ and aggregate demand is formed by consumers for whom

$$\theta \leq \frac{V_0 - p_0 - (V - p)}{q - q_0}$$

(4)

the least quality conscious consumers. Since the numerator is negative, for the left-hand side to be positive, we require $V - p > V_0 - p_0$.

Now that I have established the concepts of positive and negative quality, I will simplify notation by normalising price and quality of the substitute to zero, $P_0 = q_0 = 0$. Also, in the positive quality case, $V_0 = V$, and in the negative quality case, $V_0 = 0$. These normalisations are sufficient for ruling out the trivial cases.

### 2.2 Producers

The domestic and the foreign firm are assumed to be identical, except for the fact that the foreign firm incurs transport costs, $t$. The interpretation of $t$ can be generalised to include other trade costs, such as specific tariffs, as well as any marginal cost 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. In the remainder of the paper, I will assume that $t > 0$ but small relative to total costs so that the foreign firm are always able to earn positive profits. Assuming $t < 0$ would not change the results qualitatively – it would be equivalent to switching the labels of domestic and foreign firm.

Raising quality is costly for the firms. I assume that marginal costs, $c(q) \geq 0$, are constant in quantity but convex in quality, i.e. $c'(q) \geq 0$ and
Let quality be defined over a given range, \( q \in [q_{\text{min}}, q_{\text{max}}] \). If quality is positive, the lower bound is given by the quality of the substitute, i.e. \( q_{\text{min}} = 0 \). In the case of negative quality, the substitute quality determines the upper bound, i.e. \( q_{\text{max}} = 0 \).

3 Positive Quality

In this section, I consider the positive quality case. The equilibrium is generated in three stages. In the first stage, the government sets the MQS. As argued above, because consumers are otherwise unable to observe product quality, the MQS effectively determines the firms’ choice of \( q \) and consumers’ consistent expectations. Thus, in the second stage, firms observe the MQS and determines output and in the third and final stage consumers observe prices and quality and determine demand. I derive the market equilibrium by backward induction.

Aggregate demand is generated by the most quality-conscious consumers, determined by (3). Given normalisation of the substitute product (\( V_0 = V \), \( P_0 = q_0 = 0 \)), aggregate demand can be written as

\[
X(p, q) = \frac{1}{\theta} 1 d\theta 
\]

(5)

\[
= 1 - \tilde{\theta} 
\]

(6)

where \( \tilde{\theta} \) is the marginal consumer, i.e. the consumer just indifferent between purchasing the product or the substitute given prices and quality, defined by

\[
\tilde{\theta}(p, q) = \frac{p}{q} 
\]

(7)

Hence, aggregate inverse demand can be written as

\[
p(X, q) = q(1 - X) 
\]

(8)

The domestic and the foreign firm maximise profits given respectively as

\[
\pi_d = (p(X, q) - c(q))x_d 
\]

(9)

and

\[
\pi_f = (p(X, q) - t - c(q))x_f 
\]

(10)

where \( x_d \) and \( x_f \) are output of the domestic and the foreign firm respectively, with \( X = x_d + x_f \).
As quality is determined by regulation, the only strategic variable is output, and with Cournot conjectures, equilibrium output of the two firms are given as

\[ x_d(q) = \frac{q - c(q) + t}{3q} \] (11)

\[ x_f(q) = \frac{q - c(q) - 2t}{3q} \] (12)

As long as transport costs are not too large \((t < (q - c)/2)\), the foreign firm will supply the domestic market, albeit taking a smaller market share than the domestic firm. This is the familiar result of Brander and Krugman (1983) – in a Cournot duopoly, a foreign firm may serve the domestic market in spite of transport cost disadvantages.

The MQS affects equilibrium output levels in two opposing ways. Firstly, increasing the level of quality raises marginal costs making the product more expensive. Secondly, a higher quality increases consumers’ willingness to pay for the product and induces new consumers to switch from the substitute to the product. The net effect on output can be derived by differentiating (11) and (12) with respect to \(q\):

\[ \frac{\partial x_d}{\partial q} = \frac{c - t}{3q} - \frac{c'}{3q} \] (13)

\[ \frac{\partial x_f}{\partial q} = \frac{c + 2t}{3q} - \frac{c'}{3q} \] (14)

It is clear that for positive \(t\), \(\frac{\partial x_d}{\partial q} < \frac{\partial x_f}{\partial q}\). Increasing the MQS induces the domestic firm to reduce output by more (or expand output by less) than the foreign firm. As the domestic firm market share is larger than that of the foreign firm, increasing the level of quality serves to narrow the output gap between the two firms.

Figure 1 illustrates the impacts on firm output caused by an increase in the MQS. Perceived demand \((D)\) is illustrated by the solid downward sloping lines and perceived marginal revenue \((MR)\) is given by the dashed lines. The foreign firm has higher marginal costs (represented by horizontal solid lines), inclusive of transport costs, \((MC_f)\) than the domestic firm \((MC_d)\) and equating marginal costs with perceived marginal revenue therefore results in a lower output of the foreign firm compared to the domestic firm\(^1\).

\(^1\)As figure 1 shows perceived demand and marginal revenue it would be more correct to illustrate the foreign firm’s output decision by shifting downward the perceived demand and marginal revenue lines of the domestic firm, instead of shifting upward the marginal
Increasing the MQS rotates outward (up and to the right) the perceived demand and marginal cost curves and shifts the marginal cost curves upward. The demand line can be interpreted as representing the distribution of consumers. The most quality conscious consumers are the ones that react the most to increases in product quality. In figure 1, these consumers reside at the top of the demand line and this part of the line therefore shifts the most.

A well known feature of an oligopoly characterised by Cournot strategic interaction is that the markup of price over marginal costs can be written as

\[
\frac{p}{c} = \frac{1}{1 - \epsilon}
\]

where \(\sigma\) is the market share of the firm and

\[
\epsilon \equiv -\frac{\partial X}{\partial p} \frac{p}{X}
\]

However, this would clutter the figure with even more lines and the picture would become less clear. I have therefore taken the artistic liberty to illustrating the point in this equivalent fashion.
is the (numerical value) of the elasticity of demand.

As illustrated in figure 1, demand becomes more inelastic as quality increases. With positive quality, the substitute is a low-quality alternative and expanding the quality gap between the two goods make consumers less inclined to switch back to the substitute as prices increase. This induces firms to raise markups by reducing output (or by expanding output by less than demand). As the domestic firm has a higher market share than the foreign firm, it will increase it's markup by more, and it's output by less. In the example depicted in figure 1, the foreign firm expands output whereas the domestic firm contracts output slightly in response to the change in regulation.

4 Negative Quality

Consider now what I refer to as negative quality, i.e. the situation in which the substitute is the higher quality alternative. In this case, aggregate demand is formed by the least quality conscious consumers – consumers that are more concerned about product quality choose the higher quality substitute. Given normalisation of the substitute product ($V_0 = p_0 = q_0 = 0$), aggregate demand is given by

\[ X(p, q) = \int_0^\theta 1d\theta \]
\[ = \theta \] (17)

where the marginal consumer is given by

\[ \hat{\theta}(p, q) = -\frac{V - p}{q} \] (18)

which is positive as $q < 0$. Combining (19) with (18) gives us aggregate inverse demand

\[ p(X, q) = V + qX \] (20)

Maximising profits of the two firms ((9) and (10)) using inverse demand (20) given Cournot conjectures yields equilibrium output levels

\[ x_d(q) = -\frac{V + t - c(q)}{3q} \] (21)

\[ x_f(q) = -\frac{V - 2t - c(q)}{3q} \] (22)
The output decisions of the two firms with negative quality are very similar to the situation with positive quality, except that $q$ is replaced by $V$ in the numerator. However, this small difference has significant implications. To see how the firms react to changes in the MQS, differentiate (21) and (22) with respect to $q$ and rearrange to obtain

$$\frac{\partial x_d}{\partial q} = \frac{V + t - c}{q} + c'$$

(23)

$$\frac{\partial x_f}{\partial q} = \frac{V - 2t - c}{q} + c'$$

(24)

The second term in the numerator is positive, whereas the first term is negative and numerically larger for the domestic firm than for the foreign for $t > 0$. As the denominator is negative for negative quality, we see that $\frac{\partial x_d}{\partial q} > \frac{\partial x_f}{\partial q}$, 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. This is the exact opposite result compared to what we found in the case of positive quality.
Figure 2 illustrates the output decisions of the two firms in the case of negative quality. Again, the downward sloping solid lines represent demand, the dashed lines are marginal revenues, and the horizontal lines illustrating marginal costs lie higher for the foreign firm than for the domestic firms due to transport costs. As before, raising the level of quality has two effects, marginal costs increase and the demand (and marginal revenue) lines rotate outward as consumers are willing to pay more for the higher quality product.

However, the mode of rotation is different from the positive quality case. With negative quality, the most quality conscious consumers are situated at the bottom part of the demand line as consumers of the substitute. The top of the demand line represents the more indifferent consumers, who do not respond much to changes in quality.

The interpretation of output decisions of the two firms is the exact converse of what was discussed in the positive quality case. Increasing negative quality reduces the quality gap between the product and the substitute, making demand more elastic. This forces both firms to lower their markups by expanding output by more (or lowering by less) than demand. With a higher market share, the domestic firm reduces its markup by more than foreign firm.

5 Choice of standard

Having established how the markets will react to a product standard, we can now look closer at the governments’ choice of optimal standard. It is common to assume that governments act to maximise national welfare, given in this partial equilibrium framework as the sum of profit and consumer welfare. It is easy to show that with linear demand curves, profits of the two firms and domestic consumer surplus can be written as, respectively

\[
\pi_g(q) = \delta q x_g(q)^2
\]

\[
CS(q) = \frac{1}{2} \delta q X(q)^2
\]

where \( g \in (d,f) \) and \( \delta \) 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 with respect to \( q \) shows us how changing quality affects the different actors

\[
\frac{\partial \pi_g}{\partial q} = \delta x_g (x_g + 2q \frac{\partial x_g}{\partial q})
\]
Consider first negative quality. Suppose \( q_d \) denotes the level of MQS that maximises domestic profit. This is implicitly defined as

\[
\frac{\partial x_d(q_d)}{\partial q} = \frac{x_d(q_d)}{2q_d}
\]  

(29)

At this level of quality, we can see that the foreign firm would benefit from a lowering of the MQS, as

\[
\frac{\partial \pi_f(q_d)}{\partial q} = x_f(q_d) \left( x_f(q_d) + 2q_d \frac{\partial x_f(q_d)}{\partial q} \right) < x_f(q_d) \left( x_f(q_d) + 2q_d \frac{\partial x_d(q_d)}{\partial q} \right) = x_f(q_d) (x_f(q_d) - x_d(q_d)) < 0
\]  

(30)

The first inequality is due to the fact that with negative quality, \( \frac{\partial x_d}{\partial q} > \frac{\partial x_f}{\partial q} \), and the second reflects the larger market share of the domestic firm. Hence, the MQS maximising foreign firm profits, denoted by \( q_f \) is always lower than \( q_d \) with negative quality. As the derivative of consumer surplus is basically (one half) the weighted sum of the derivatives of the two firm profits, the MQS maximising consumer surplus, \( q_{CS} \), lies somewhere in between the standards preferred by the foreign and domestic firm. Thus, with negative quality, we can establish the relation

\[ q_d > q_{CS} > q_f \]

Unfortunately, the ordering of preferred standards in the positive quality case takes a bit more effort to establish. Using the same approach as before, it is easy to show that

\[
\frac{\partial \pi_f(q_d)}{\partial q} > x_f(q_d) (x_f(q_d) - x_d(q_d))
\]  

(34)

\[ < 0 \]  

(35)

but that does not tell us very much. However, by using expressions of \( x_d(q_d) \), \( x_f(q_d) \) given by (11) and (12) as well as \( \frac{\partial x_d(q_d)}{\partial q} \), \( \frac{\partial x_f(q_d)}{\partial q} \) determined by (13) and (14), straight-forward (but tedious) algebraic derivation leads to the following simple expression

\[
\frac{\partial \pi_f(q_d)}{\partial q} = 3tx_f(q_d) > 0
\]  

(36)
Thus, at the standard maximising domestic profits, the foreign firm would prefer to raise the MQS further. For positive quality, we can therefore establish the relation

\[ q_d < q_{CS} < q_f \]

So we have the exact opposite ordering depending on the quality of the product relative to its substitute. If the substitute is the higher quality alternative, the domestic firm will favour a more restrictive MQS than would consumers (on average) and the foreign firm. On the other hand, if the substitute is of lower quality, the foreign firm would benefit more from a higher standard.

This conclusion makes it relevant to also consider characteristics of close substitutes, when a policy maker contemplates regulating the quality of a product. If the product can be characterised as a negative quality good the potential for international trade disputes arise. Assuming the government chooses a MQS to maximise national welfare defined as the (possibly weighted) sum of consumer surplus and domestic profit, the optimal standard, \( q_g \) would lie somewhere between \( q_d \) and \( q_{CS} \). With negative quality, \( q_g > q_f \), and the foreign firm could accuse the government of protectionism by imposing a more restrictive than necessary product standard for the benefit of domestic firms. With positive quality, claims of protectionism would probably be less relevant. In this case, \( q_g < q_f \), and we do not usually encounter accusations from foreign firms that domestic governments are too lax in their regulation (though maybe examples could be found).

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 standard. The standard not only raises product quality but also raises prices. The net utility effect is positive for the most quality conscious consumers, but consumers that are indifferent to quality tend to lose from such regulation. With positive quality, however, this is not a problem as the least quality conscious consumers purchase the substitute anyway. But a range of consumers around the marginal consumer lose from an increase in the MQS as the price increases by more than their willingness to pay and they are forced to switch to the lower quality substitute (recall that positive quality induces firms to increase their markups). With negative quality, the least quality conscious consumers lose from regulation, as the price increases by more than their limited willingness to pay for quality, and a range of consumers around the marginal consumer will tend to win as they enter the market.
6 Conclusion

In this paper I have shown that the impacts of product standards on international trade and the relative ordering of the interests of domestic producers, foreign producers and consumers depend on the quality characteristics of the product in question relative to close substitutes. If the substitute is a higher quality alternative (what I refer to as a negative quality case), domestic firms would lobby for a more restrictive product standard than would domestic consumers and foreign firms, thus generating the potential for international trade dispute. On the other hand, if the substitute is a lower quality alternative (the positive quality case), the ordering is reversed and the foreign firm would prefer the higher standard. In the latter case, international trade dispute is more unlikely.

The results are based on a very simple example of an international Cournot duopoly (with no entry/exit), consumer heterogeneity with respect to quality, 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 have different impacts on demand elasticities, which in turn affects firm markups proportionately to market shares. When the substitute is the lower quality alternative, increasing the product standard expands the quality gap between the product and the substitute and makes consumers less inclined to switch between the two. Vice versa, when the substitute is of higher quality. But these relationships should not be limited to this simple example. Generalising the results could be an interesting topic for future research.

References


