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working papers

MARKET ACCESS AND MINIMUM QUALITY STANDARDS

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Keywords: Minimum Quality Standards, Market Access, Import Tariffs, Blocked Entry, Vertical Differentiation.

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Market Access and Minimum Quality Standards

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10th May 2004

Abstract

In this paper we analyze market access blocking properties of a Minimum Quality Standard (MQS). For an importing country that imports a high and low quality good, the welfare maximizing optimal MQS limits market access only to the high quality firm. This result is further confirmed for a uniform MQS imposed by a high quality producing country that imports a low quality good. The optimal MQS in this case always blocks entry to the low quality foreign firm. We then propose a Flexible Quality Standard (FQS). Under a FQS a good is taxed if it does not meet the standard. Otherwise, imports are exempt from the tariff. Both firms stay in the market under a FQS and discriminatory import tariff. Total welfare in this case is greater than under free trade and under the optimal MQS (for a pure importing country). With uniform conditional tariffs also both firms stay in the market, however, the welfare obtained is greater than under free trade and lower than under a MQS.

JEL Classification: F12, F13, L13.

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1 Introduction

Quality standards have become an integral part of industrial, and international trade policy. The role of quality standards in trade is highlighted by the debate on increasing globalization. The fear that standards may limit market access arises from the fact that they are strictly binding. Any good that does not meet a standard is not allowed to access a market[1]. The issue of market access is thus important in international trade. For example, in a recent survey by the OECD[2] several countries mention that quality standards work as entry barriers in developed markets either because they are too high, or non-uniform. Surprisingly, how the adoption of quality standards affects market access has not been studied in detail by trade economists.

Authors both in International Trade and Industrial Organization have studied Minimum Quality Standards (MQS). In International Trade MQS have been studied by Chiang and Mason (1988), Das and Donnenfeld (1989), and Boom (1995). Chiang and Masson (1988) show that an MQS above the equilibrium quality increases quality and equates domestic salaries to world levels. Domestic welfare increases in this case. Das and Donnenfeld (1989) show that a MQS can decrease domestic welfare of the country imposing it. Similarly, Boom (1995) argues that an importing country has incentives to impose a MQS slightly above the lowest quality produced in an unregulated market.

In Industrial Organization MQS have been studied by Ronnen (1991), Crampes and Hollander (1995), Ecchia and Lambertini (1997) and Valletti (2000). Ronnen (1991) shows that if the government sets a MQS in some determined range then an equilibrium exists in which both firms stay in the market and domestic welfare increases. This result, however, is shown not to be robust. First, the equilibrium of the entire game is not analyzed by Ronnen (1991) in the sense that he does not solve for the optimum MQS. The analysis is instead performed for an MQS slightly above the lowest quality in the market. Second, Valletti (2000) shows that if firms compete in quantity then total welfare can decrease. Finally, Ecchia and Lambertini (1997) (extending Crampes and Hollander (1995)) endogenously determine the optimal MQS in a model without sunk costs (of quality). The optimal MQS increases total welfare in their model.

In this paper we study the incentives of an importing country to adopt an optimal MQS in a vertical product differentiation model[3]. We first study the incentives to impose only a MQS. We look at the case of a *pure importing country* (with no domestic production) and the case of an *importing country* with domestic production. A pure importing country imports both the high and low quality good. The domestic firm for the importing country is high quality. This reflects the incentives for developed (higher quality) countries to impose standards that may work as entry barriers for imports from developing

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[1] This is specially true for trade between developed and underdeveloped countries.

[2] Annex 4, "Analysis of non-tariff measures: The case of export duties," Working paper of the trade committee, Trade Directorate-Trade Committee, 2003.

[3] Note, except Ecchia and Lambertini (2000) none of the papers above have studied the optimal MQS.

(lower quality) countries. Market access is blocked under any MQS for the low quality firm. Given the market access blocking property, we propose a Flexible Quality Standard (FQS) for the pure importing country case. A FQS allows imports of a good even if they do not meet the standard, however, any good that produces a quality below the standard pays an import tariff.

We show that domestic welfare increases over free trade for a pure importing country if the government were to only choose an *optimal* MQS. However, the market is then served by a monopoly[4]. This occurs as the optimal MQS is very high and forces the low quality firm out of the market. The optimal MQS increases domestic welfare[5] relative to free trade. For the case of an importing country with domestic production we show that the level of the MQS that maximizes total welfare depends upon the relative weight a government puts on its firm profits. However, regardless of the weight an optimal MQS *always* blocks entry for the low quality foreign firm. For low enough levels of the weight the government always chooses the highest MQS that gives the domestic firm zero profits. For high enough weights the MQS is decreasing in the weight and equals the quality level produced by a domestic monopolist for an infinitely large weight. Regardless, the optimal MQS is still high enough so as to block entry for the low quality foreign firm. Interestingly, if a government assigns equal weights to consumer surplus and domestic firm profits then the optimal MQS is high enough such that the domestic firm, a monopoly, does not make monopoly profits. This result is interesting as it points out that a high MQS may not be simply placed to grant monopoly rights to the domestic firm. In fact, the domestic firm obtains monopoly profits only if its profits are infinitely weighed by the domestic government.

Given the market access blocking property of a MQS we propose an ex-post tariff that is contingent upon some Flexible Quality Standard (FQS) set by the government. Unlike a MQS, a FQS is flexible in the sense that it allows imports even if the quality of the good lies below the standard. A firm that meets the FQS is exempt from the import tariff. Contrarily, a firm that does not meet the FQS pays an import tariff. In this sense the import tariff is contingent upon the quality and is time consistent. The advantage[6] of the tariff contingent FQS is that quality improvement is achieved and both the firms still serve the market. Further, the FQS improves welfare over free trade and a MQS for the pure importing country.

The government selects its trade policy instrument in two stages. In the first stage, the government announces the FQS that would exempt a firm from paying the tariff. The firms, knowing the FQS, then invest in quality. After firms select quality, the government then chooses its tariff level. The tariff level is defined by the FQS-tariff rule that the government announces in the first

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[4]Unlike Boom (1995) the importing country does have an incentive to set an MQS. However, it is high enough such that a monopoly is obtained.

[5]Contrary to Valleti (2000), in our model, total welfare goes up under a MQS and Cournot competition.

[6]Given that the optimal MQS results in a monopoly serving the market (clearly an unrealistic situation) and that the optimal tariff decreases quality thereby lowering welfare.

stage.[7] In this sense the import tariff is conditional on the quality chosen by the firms. Facing such an import tariff exporting firms have two options: invest in a quality level that is equal, greater, or less, than the minimum (knowing that it will then face a subsequent tariff). In such a scenario we analyze the effect of import tariffs chosen by an importing country when the imported good is of a high and low quality. We show that if the government were to set a conditional import tariff then domestic welfare goes up[8]. Conditional import tariffs increase consumer surplus, market coverage and total welfare of the importing country.

Setting a FQS the government is able to influence quality investment in a positive manner benefitting domestic consumers. Due to greater commitment power of the government (relative to that of the firm) it is able to positively influence quality investment by the firms. This is the strategic advantage that the government loses if were to choose tariffs that were not conditional on the FQS. The firm is able to counteract the effectiveness of a single instrument, i.e. tariff, by strategically decreasing its quality investment. However, under the conditional tariff the government is able to counteract this negative effect on quality through the FQS.

We show that outcomes depend upon whether the government is able to set a discriminative, or uniform, conditional tariffs for the, high and low quality, imported goods. If the government were to discriminate and set a different conditional import tariff for the high and low quality firm it would obtain a higher level of welfare. In this case the FQS would be set high enough such that the low quality firm would pay the import tariff thus increasing government revenues. The high quality firm on the other hand produces a quality just equal to the FQS and evades paying the tariff. If the government were to only charge a uniform conditional tariff then it only directly influences quality investment by the low quality firm. The high quality firm prefers the situation where both the firms pay the import tariff. The uniform tariff is high enough for the low quality firm and relatively low for the high quality firm. A high FQS-tariff seriously undermines the competitiveness of the low quality firm. As a result, paying the tariff the high quality firm increases its profits taking advantage of the negative effect it has on its rival. Total welfare achieved under a conditional discriminative, and uniform, tariff is greater than under free trade. Note that, our results show that including variables such as quality (that positively impact consumer surplus) can have an important effect on results.[9]

The paper is organized as follows. In Section 2 we present the model under free trade. Section 3 studies the optimal and market access blocking MQS. Section 4 studies Flexible Quality Standards (import tariffs conditional on qualities). Section 5 concludes.

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[7]The issue of intervention as a strategic choice has been analysed by several authors. Cooper and Riezman (1989), Arvan (1991), Shivakumar (1993) and Hwang and Shulman (1994) model government policy in two stages . In these papers the government first announces the trade policy instrument and later decides on its level.

[8]Unlike the effect of a specific import tariff (Hernán and Kujal, 2003).

[9]In our model quality investment is a long run variable that allows firms to commit before governments fix their tariff levels. See Grossman (1988), Sutton (1991) and Herguera, Kujal and Petrakis (2000,2002) for a discussion on long and short run competition variables.

2 The model

We study a vertically differentiated industry where a high and low quality firm export to a third market. There is no domestic consumption in the exporting countries. The third country is a pure consumer of the imported goods and has no domestic production[10]. Consumers are uniformly distributed in the importing country and are identified by their taste parameter θ, which is distributed uniformly over the interval $\left[0, \overline{\theta}\right]$, with $\overline{\theta} > 0$. Each consumer has unitary demand for the good. A consumer with parameter θ obtains utility $U = \theta s - p$, if he purchases one unit of the good at price p and quality s, $s_1 > s_2$. Utility is zero if a consumer does not purchase the good. Note that θ can also be interpreted as the marginal rate of substitution between income and quality ratio (Tirole, 1989, p. 97).

The high and low quality firm compete in quantities. In the first stage firms invest in quality which is then taken as given in the quantity competition stage. In this sense quality is a long run decision variable. Firms first choose quality and then compete in quantities. The marginal cost of production, c, is constant and is independent of costs of quality. The marginal cost of production is set equal to zero without loss of generality. Quality costs are fixed and costs of quality improvement are increasing. This specification captures the characteristics of a (pure) vertical product differentiation model. Shaked and Sutton (1983) define a purely vertically differentiated industry as one in which the costs of quality improvement fall primarily into fixed costs and involve only a modest, or no, increase in unit variable costs. Quality costs borne in the first stage are treated as sunk in the market competition stage. For reasons of tractability we assume that quality costs are quadratic, $s^2/2$. We solve the game using subgame perfection.

2.1 Quantity competition

We first determine the demand function faced by the firms. Let θ_{12} be the taste parameter of the consumer that is indifferent between purchasing the high, or low, quality good. Setting, $\theta_{12}s_1 - p_1 = \theta_{12}s_2 - p_2$, we can then write $\theta_{12} = \frac{p_1 - p_2}{s_1 - s_2}$. Similarly, we define θ_{02} as the taste parameter of the consumer that is indifferent between purchasing the low quality good and not purchasing at all. Setting, $\theta_{02}s_2 - p_2 = 0$, we then get $\theta_{02} = \frac{p_2}{s_2}$. Given θ_{12} and θ_{02} we can now determine the demand that each firm faces.

$$D_1(p_1, p_2, s_1, s_2) = \overline{\theta} - \frac{p_1 - p_2}{s_1 - s_2}$$

$$D_2(p_1, p_2, s_1, s_2) = \frac{p_1 - p_2}{s_1 - s_2} - \frac{p_2}{s_2}$$

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[10]Later we relax this assumption to allow for domestic production in the importing country. Under free trade the equilibrium qualities are unchanged for both models.
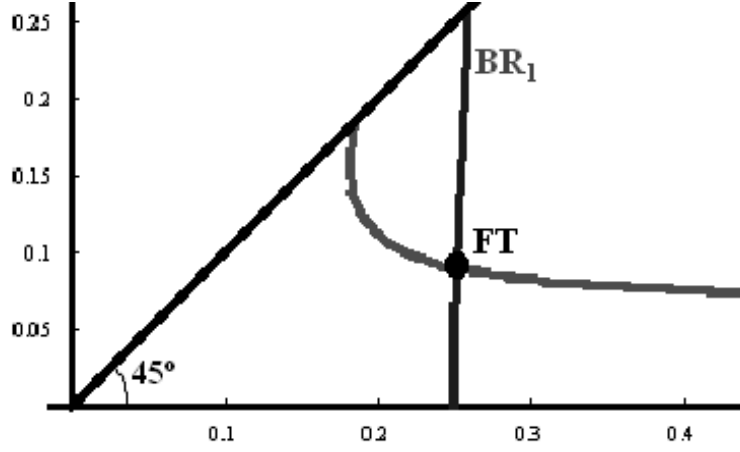
Figure 1: Quality reaction functions under free trade.

Where, $D_1(p_1, p_2, s_1, s_2)$ is the demand faced by the high quality firm and $D_2(p_1, p_2, s_1, s_2)$ is the demand faced by the low quality firm. These then give us the indirect demands:

$$p_1 = s_1\overline{\theta} - s_1 q_1 - s_2 q_2 \tag{1a}$$

$$p_2 = s_2\overline{\theta} - s_2 q_1 - s_2 q_2 \tag{1b}$$

Firms maximize profits. The equilibrium quantities in this stage are given by:

$$q_1 = \frac{(2s_1 - s_2)\overline{\theta}}{4s_1 - s_2} \tag{2a}$$

$$q_2 = \frac{s_1\overline{\theta}}{4s_1 - s_2} \tag{2b}$$

Given quantities [2a] and [2b] firms choose qualities in the first stage. Maximizing profits $\pi_i = p_i \cdot q_i - \frac{s_i^2}{2}$, with respect to qualities gives us the first order conditions:

$$\frac{\partial \Pi_1}{\partial s_1} = 0; s_1 = \overline{\theta}^2 \frac{16s_1^3 - 12s_1^2 s_2 + 4s_1 s_2^2 - s_2^3}{(4s_1 - s_2)^3} \tag{3a}$$

$$\frac{\partial \Pi_2}{\partial s_2} = 0; s_2 = \overline{\theta}^2 \frac{s_1^2 (4s_1 + s_2)}{(4s_1 - s_2)^3} \tag{3b}$$

The quality reaction functions [3a] and [3b] are described in the *figure 1*. The intersection of the reaction function correspond to the Nash equilibrium in

quality choices:

$$s_1^* = 0.2519\overline{\theta}^2$$
$$s_2^* = 0.0902\overline{\theta}^2$$

Given qualities one can then write the prices, quantities and profits[11]:

$s_1^{FT} = 0.251942\overline{\theta}^2$	$s_2^{FT} = 0.090223\overline{\theta}^2$	$q_1^{FT} = 0.450834\overline{\theta}$	$q_2^{FT} = 0.274583\overline{\theta}$
$p_1^{FT} = 0.1133584\overline{\theta}^3$	$p_2^{FT} = 0.024774\overline{\theta}^3$	$\Pi_1^{FT} = 0.01947\overline{\theta}^4$	$\Pi_2^{FT} = 0.002732\overline{\theta}^4$

Table 1: Equilibrium values under free trade.

Consumer surplus is defined by the following expression:

$$CS = \int_{\theta_{02}}^{\theta_{12}} (\theta s_2^{FT} - p_2^{FT})d\theta + \int_{\theta_{12}}^{\overline{\theta}} (\theta s_1^{FT} - p_1^{FT})d\theta$$

Total welfare in this case is defined by the sum of the consumer surplus of the high and low quality consumers, and is given by:

$$CS^{FT} = 0.040174\overline{\theta}^4 \quad SW^{FT} = 0.040174\overline{\theta}^4$$

3   Minimum quality standards (MQS)

The main debate relating to market access is that the imposition of a MQS blocks access to the market for the lower quality firms. This is in fact one of the concerns of developing countries regarding market access in developed economies. We show that a MQS imposed by a pure importing country, with no domestic production, or by an importing country that has a high quality domestic firm, always results in blocked access for the low quality firm. Our results confirm that quality standards may in fact work as entry blocking devices towards low quality goods. To our knowledge this is the first theoretical treatment that has shown the market entry blocking property of quality standards.

We first study an MQS for a pure importing country (that has no domestic production). We show that in this case the importing country sets a MQS such that only the high quality firm supplies the market making zero profits. The rationale behind imposing the MQS may be to benefit the local firm. We extend the model to allow for this possibility. We study the incentives to impose a MQS for the case of an importing country with domestic production, where the domestic firm produces high quality. We also allow for the possibility that the government assigns different weights (m) to domestic profits (relative to consumer surplus).

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[11]These are the values that one obtains in the free trade model (see Motta, (1993)).

3.1 Pure Importing Country

We first present the results for an optimal MQS. Note that a MQS below the free trade level of low quality is ineffective as it does not affect quality investments. The government thus always sets the MQS above the free trade level of low quality. This makes it always binding for the low quality firm. It is easy to see that if an importing country imposes an MQS then only the high quality firm supplies the market. The reason behind this is simple. Domestic welfare, $SW = CS = \int_{\theta_{02}}^{\theta_{12}}(\theta s_2 - p_2)d\theta + \int_{\theta_{12}}^{\overline{\theta}}(\theta s_1 - p_1)d\theta$, is increasing in quality[12]. As the MQS increases the low quality firm no longer finds it profitable to increase its quality. For a MQS of $0.1867\overline{\theta}^2$ it stops selling in the foreign market (see *figure 2*). Beyond this point the domestic market is supplied by a foreign monopoly. In this case social welfare is simply the consumer surplus from consuming the high quality good.

It is interesting to see how the choice of the MQS alters Social Welfare (SW) for the importing country. In *figure 2* one can see that Social Welfare is increasing as the low quality firm, in response to the MQS, increases its quality beyond the free trade level (s_2^{FT}). However, at the quality level of $0.1867\overline{\theta}^2$ it exits the market. At this point the SW drops as the market is served only by the high quality foreign firm selling at the free trade level of quality (s_1^{FT}). Beyond this point SW is increasing in the MQS and reaches its maximum at a quality level of $0.5\overline{\theta}^2$. At this point the foreign monopolist makes zero profits. Note, however, that SW for the importing country is same at points A and B. This implies that the importing country would either choose an MQS low enough such that both the firms stay in the market, this point would then lie to the left of A, or it would choose a MQS in the range BC, where a monopolist would serve the market. As stated earlier SW is maximized at C. The results are summarized in the proposition below.

Proposition 1 *In equilibrium the market is supplied by a monopolist. Under the optimal MQS $(= 0.5\overline{\theta}^2)$ the foreign monopolist makes zero profits. Social welfare under the optimal MQS $(0.0625\overline{\theta}^4)$ is greater than under free trade$(0.040174\overline{\theta}^4)$.*

3.2 Importing Country High Quality

We now study the incentives for an importing country with domestic production to impose a MQS on the low quality imported good. The domestic market is served by the high quality firm. This scenario reflects the market access problem raised by developing economies. The claim is that high quality standards work as entry barriers, thus making entry difficult for firms from developed markets. In this section we study the case of a high quality country that imports a low quality good. We analyze two cases. In the first case, we look at the MQS that blocks entry for the low quality foreign firm. We call this the prohibitive MQS. Note, however, that a prohibitive MQS need not be optimal and as a result may

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[12]Note that an importing country does not bear sunk costs of quality.

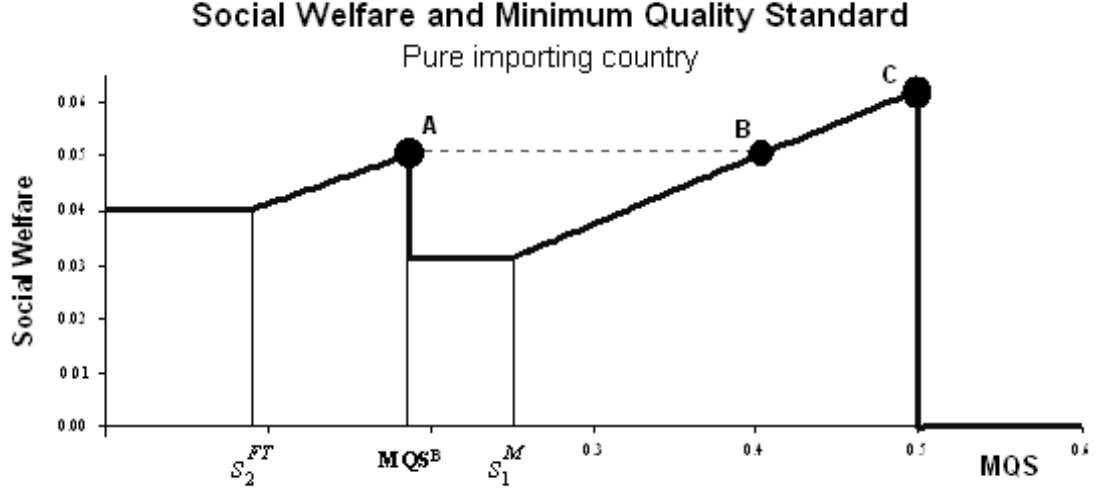## Social Welfare and Minimum Quality Standard
Pure importing country

Figure 2: Social welfare and MQS in a pure importing country

not be welfare maximizing. As a result we also analyze the MQS that maximizes Total Welfare for the importing country. We call this the optimal MQS. Notice that a prohibitive MQS may be simply motivated to block entry and directly benefit the domestic firm. While an optimal MQS is set keeping in mind the total welfare of the economy.

3.2.1 The Prohibitive MQS

The MQS that impedes the entry of the low quality firm is the one that gives the low quality firm zero profits, and with the domestic firm maximizing on its best response. This can be written as:

$$\max_{s_2} \pi_2(s_2; s_1) = 0$$

such that,

$$
\begin{aligned}
s_2 &\geq MQS \\
s_1 &= BR_1(s_2)
\end{aligned}
$$

Where $BR_1(s_2)$ is the reaction function for firm 1 (see 3a). The solution to the above gives us the MQS that results in zero profits for the low quality firm, i.e. $MQS^B = 0.18667\overline{\theta}^2$. At this MQS the firms produce qualities $s_1 = 0.25685\overline{\theta}^2$ and $s_2 = 0.18667\overline{\theta}^2$. Note that if the low quality firm were to decide to stay out of the market then the high quality firm becomes a monopolist. The

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quality produced by the monopolist is, $s_1^M = 0.25\overline{\theta}^2$. This then implies that the MQS that gives a domestic monopoly is prohibitive[13].

Under a prohibitive MQS the monopolist offers a single quality of the good. The consumer who is indifferent between buying and not buying the good has the taste parameter $\theta_M = \frac{p_M}{s_M}$ (the subscript M stands for the domestic monopolist case). All the consumers with $\overline{\theta} < \theta < \theta_M$ purchase the good with quality s_M. The monopolist thus faces the demand curve

$$x(p_M, s_M) = \overline{\theta} - \frac{p_M}{s_M}$$

and its profits are $\pi_M = s_M(\overline{\theta} - x_M)x_M - \frac{s_M^2}{2}$. Maximizing first with respect to s_M and then with x_M, we obtain $x_M^* = 0.5\overline{\theta}$ and $s_M^* = 0.25\overline{\theta}^2$. Then the equilibrium outcome under the prohibitive MQS is:

$s_M^* = 0.25\overline{\theta}^2$	
$x_M^* = 0.5\overline{\theta}$	$\pi_M^* = 0.03125\overline{\theta}^4$
$CS_M^* = 0.03125\overline{\theta}^4$	$TW_M^* = 0.03125\overline{\theta}^4(1+m)$

Table 2: Equilibrium values under a monopoly.

The domestic monopolist serves half the market and offers a quality level that is (slightly) lower than the high quality produced under free trade ($s_1^{FT} = 0.25194\overline{\theta}^2$). The total output sold in the market is substantially lower than with free trade ($x_M^* = 0.5\overline{\theta} < x_1^{FT} + x_2^{FT} = .7254\overline{\theta}$).

Note, however, that prohibiting entry is only beneficial for the domestic government for sufficiently high m. It is easy to see that social welfare is always greater than free trade for $m > 0.75756$. The results are summarized in the proposition below.

Proposition 2 *Under a prohibitive MQS the market is supplied by a monopolist. The minimum quality that results in zero profits for the low quality firm and results in blocked entry is $MQS^B = 0.18667\overline{\theta}^2$. For sufficiently large m, $m > 0.75756$, total welfare with a prohibitive MQS ($0.03125\overline{\theta}^4(1+m)$) is greater than under free trade ($0.040174\overline{\theta}^4 + m0.01947\overline{\theta}^4$).*

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[13]The size of the MQS depends upon how the domestic firm reacts to entry. If the domestic firm cannot optimally adjusts its quality, the MQS which block access is defined by

$$\max_{s_2} \pi_2(s_2; s_1) = 0$$

such that,

$$s_2 \geq MQS$$
$$s_1 = 0.25\overline{\theta}^2$$

The MQS that solves the condition above is $MQS^{\tilde{B}} = 0.19098\overline{\theta}^2$.
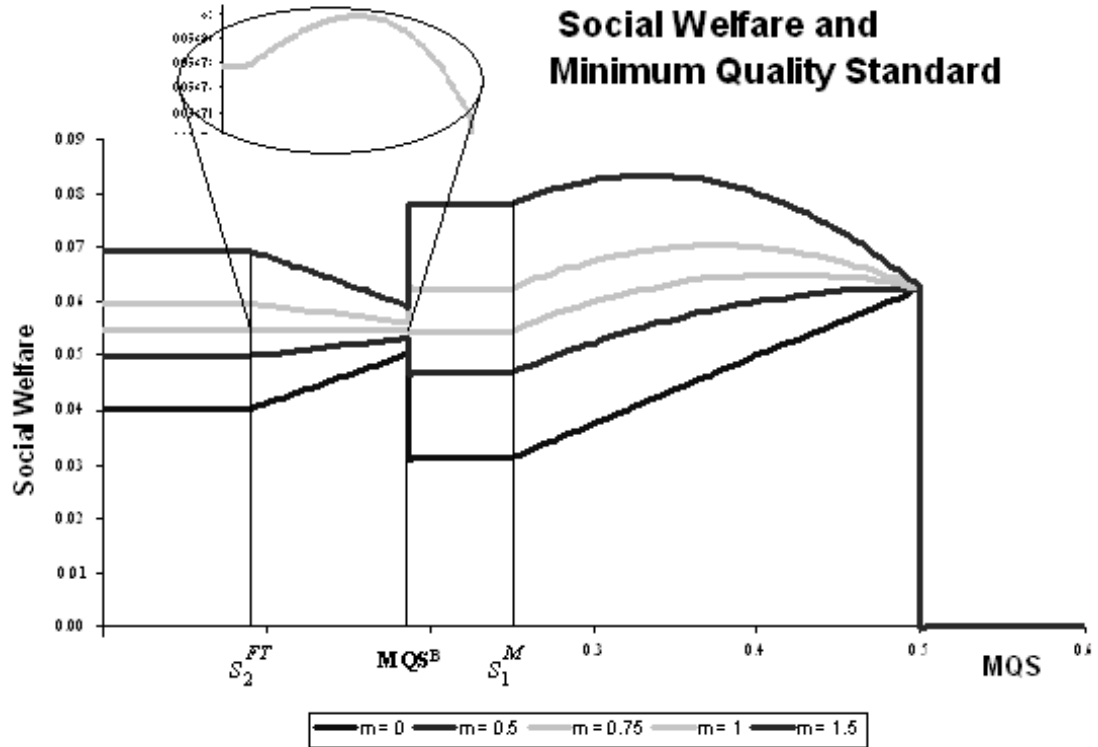
Figure 3: Social Welfare and MQS with domestic production

3.2.2 The optimal MQS

The optimal MQS is the one that maximizes total welfare for the country. As before, a MQS below, or equal, to the free trade level of low quality does not affect total welfare. The level of the MQS that maximizes total welfare depends on the weight one sets on domestic firm profits.

As can be seen from *figure 3* a MQS is effective only above the free trade level of low quality. For a MQS above this level of quality, total welfare can increase, or decrease, depending upon the size of m. For $m > 0.7601$ total welfare first declines. The decline continues till the low quality firm exits the market (*figure 3*). For $m < 0.723$ total welfare first increases. The increase in total welfare continues till the low quality firm exits the market. In the range $0.7601 > m > 0.723$, however, for low values of MQS total welfare first increases and then declines. These results hold for MQS below the prohibitive level. Our results add to the literature where a MQS slightly above the low quality is shown to increase welfare (Ronnen (1991), Boom (1995), Valletti (2000)). We

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show that this may not always be the case.

Further note that once the government sets the MQS$> 0.25\bar{\theta}^2$ the optimal one depends on the value taken by m (see *figure 3*). Given that the domestic firm always meets the MQS one can write total welfare as,

$$SW = \frac{s\bar{\theta}^2}{8} + m(\frac{s\bar{\theta}^2}{4} - \frac{s^2}{2})$$

The quality level that maximizes total welfare in this case will be the following.

$$s = \frac{\bar{\theta}^2}{8m}(1+2m)$$

Keeping in mind that π_1 is not positive if $s_1 > \frac{\bar{\theta}^2}{2}$, then the optimal value of s will be:

$$MQS^* = \left\{ \begin{array}{ll} \frac{\bar{\theta}^2(1+2m)}{8m} & m > \frac{1}{2} \\ \frac{\bar{\theta}^2}{2} & m \leq \frac{1}{2} \end{array} \right\}$$

Total welfare then is:

$$SW^* = \left\{ \begin{array}{ll} \frac{\bar{\theta}^4(1+2m)^2}{128m} & m > \frac{1}{2} \\ \frac{(1+m)\bar{\theta}^4}{32} & m \leq \frac{1}{2} \end{array} \right\}.$$

The first thing that one sees is that for $m \leq \frac{1}{2}$ the MQS is independent of m. For values of $m > \frac{1}{2}$ the optimal MQS is decreasing in m. It can be easily seen that as m becomes large enough the optimal MQS tends to $0.25\bar{\theta}^2$. This is the level of quality produced by a domestic monopoly. This insight is interesting as this shows that the MQS is smaller as the weight given to industry profits increases. However, regardless of the size of m any resulting MQS blocks entry for the low quality firm. This result thus confirms the market access blocking property of a MQS. The results are summarized in the following proposition.

Proposition 3 *The optimal MQS is decreasing in the weight placed on domestic firm profits. Regardless of the weight placed on domestic firm profits a MQS always results in total welfare greater than under free trade and the low quality firm is excluded from the market even for the lowest MQS.*

4   Flexible quality standards and import tariffs

How trade policy instruments may affect long run variables in markets was pointed out by Grossman (1988). In our model the government has two target variable, namely, quality and output. Hence, a more appropriate government policy may be one that uses two instruments on (its) two target variables, i.e. quality and output. We argue that such policy instruments are more appropriate for industries characterized by the presence of both long, and short, run

variables. In fact one observes that at any point of time any industry faces a combination of (multiple) industrial policy instruments such as MQS, tariffs and Voluntary Export Restraints etc.

Keeping this in mind we propose a non-linear policy instrument that can be used by governments in such industries. We propose the use of Flexible Quality Standards (FQS). If a firm invests above the flexible FQS it is exempt from paying the import tariff, otherwise, it pays the tariff. In our structure a FQS and import tariffs are a pair of possible policy instruments[14] at the governments disposal. FQS's are less restrictive than Minimum Quality Standards as they permit the sale of the good if the quality of the good is below the limit set by the standard. Most industries have quality standards as an integral part of a governments industrial policy. Our use of flexible QS's is motivated by the fact that a government valuing consumer welfare finds in its interest to promote quality investment by firms due to their welfare improving effects. In fact a FQS achieves improvement in average quality a motivation behind the use of, much more restrictive, MQS's.

The tariff depends upon the quality level chosen by the firm and in this sense is conditional on it. We analyze two types of conditional tariffs. In the first case the government sets a uniform quality conditional tariff (applied to both the firms) on its imports. In the second case the government is allowed to discriminate between the firms when setting the conditional tariff. The government in this case can set a different conditional tariff for the high, and low, quality firm. The sequence of moves that we study is the following (see *figure 4*). The government first sets the QS. Given the FQS firms then invest in quality. A firm may, or may not, choose to meet the QS. If the firms meet, or exceed, the FQS they pay no tariffs on their exports. The quality chosen by the firms is of course decided by the trade-off between the profits gained by the marginal quality increment and the increase in quality costs such that the firm does not pay the import tariff[15].
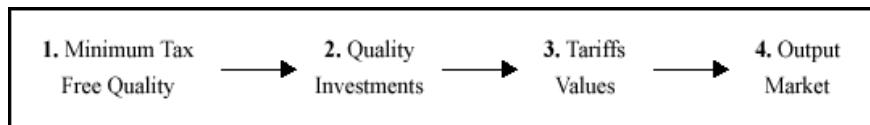

Figure 4: The Conditional Tariff Game.

The government is interested in such a policy as the cost of quality improvement falls only on the exporting countries. An increase in quality in this case

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[14]We only consider these two policy instruments in this paper.

[15]Such a separation of government policy has been studied before by several authors in a different context. Cooper and Riezman (1989) study a model in which the government first studies what trade policy instrument to use (subsidies or quotas on exports) and in a later stage decide on the levels. Arvan (1991) and Shivakumar (1993) extend this model and study the effect of choosing its policy before (assuming commitment), or after (assuming no commitment), the firms get to know their true demands.

implies an increase in the importing countries welfare through the increase in consumer surplus. Looking at it this way the conditional tariff can be interpreted as a mechanism to increase firm investment in quality above the levels observed under free trade. Of course, by choosing its quality investment the firm decides whether it is in its benefit to choose a quality that exempts it from paying the tariff, or not.

In the following section we study such conditional tariffs. First we study a uniform conditional tariff that is the same for both the low and high quality firm. This is followed by the analysis of the discriminative conditional tariff.

4.1 Discriminatory conditional tariff

In this section we look at the possibility that the government sets a different conditional import tariff for both the exporting firms. The advantage of the discriminative conditional tariff is that it allows the government to influence the quality investment of the high quality firm. Knowing that welfare is increasing in high quality, the government chooses a high enough FQS that results in the high quality firm meeting the standard and not paying the tax. In the case of the discriminatory tariff the high quality firm does not have the incentive to lower its quality investment and pay the import tariff. The incentives for the high quality firm are just the opposite in this case. Under a discriminatory conditional tariff the government chooses a high QS. In equilibrium the high quality firm invests exactly equal to the FQS and earns less than it would if it were to pay an import tariff. The low quality firm, meanwhile, selects a substantially lower quality (relative to the uniform conditional tariff), selling less and makes less profits. A discriminatory conditional tariff works to the detriment of both the firms.

This is seen in the *figure 5* where, π_1^{LT} indicates profits for the high quality firm when only the low quality firm pays the tariff. $\pi_1^{\tilde{B}}$, on the other hand, indicates profits for the high quality firm when both the firms pay the conditional import tariff. It is thus clear that if the government were to choose the FQS below s_1^L then it will be non-binding on the high quality firm as it will always choose s_1^L maximizing profits at L. The area to the right of L is thus the region in which the government can increase total welfare (with the high quality firm increasing its quality investment). Noticing that total welfare is increasing in s_1 the government wants the high quality firm to moves down its profit curve (π_1^{LT}). The highest FQS the government will choose is $\widetilde{MCH}$ that leaves the high quality firm indifferent between paying the tariff making $\pi_1^{\tilde{B}}$ (point $\tilde{B}$), or not paying the tariff and staying at point $\widetilde{MCH}(=\tilde{s}^*)$. Under a discriminative tariff the government thus chooses a FQS that coincides with $\tilde{s}^*(=0.450403\bar{\theta}^2)$ maximizing total welfare.

Note, however, if both the firms pay the tariff then the welfare obtained by the government is much lower ($SW^{\tilde{B}} = 0.02355\bar{\theta}^4$ at $\tilde{s}_1^{\tilde{B}}$) than if only the low quality firm pays the tariff. Any FQS slightly below $\widetilde{MCH}$ gives the government
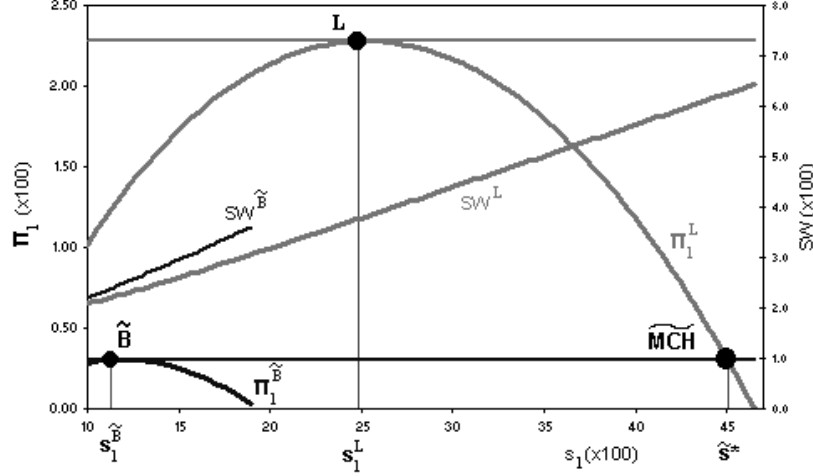
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Figure 5: Profits high-quality firm and total welfare under a discriminative conditional tariff.

welfare greater than the case where the high quality firm chooses quality $\widetilde{s}_1^{\widetilde{B}}$.

Proposition 4 *The importing country, setting discriminatory tariffs, increases welfare over free trade (and uniform the conditional tariff) setting a MQL$\geqslant s_1^L$. The welfare maximizing MQL is $\widetilde{s}^* = 0.450403\overline{\theta}^2$ and each firm pays tariff: $t_1 = \frac{s_1(3s_1 - s_2)\overline{\theta}}{9s_1 - s_2}$ and $t_2 = \frac{2s_1 s_2 \overline{\theta}}{9s_1 - s_2}$. Welfare under the discriminatory conditional tariff equals $SW = 0.062528\overline{\theta}^4$.*

The equilibrium values obtained under the discriminatory tariff are summarized in the table below.

$s_1^{\widetilde{s}} = 0.450403\overline{\theta}^2$	$s_2^{\widetilde{s}} = 0.06562\overline{\theta}^2$	$q_1^{\widetilde{s}} = 0.481565\overline{\theta}$	$q_2^{\widetilde{s}} = 0.253073\overline{\theta}$
$p_1^{\widetilde{s}} = 0.216898\overline{\theta}^3$	$p_2^{\widetilde{s}} = 0.017413\overline{\theta}^3$	$\Pi_1^{\widetilde{s}} = 0.003019\overline{\theta}^4$	$\Pi_2^{\widetilde{s}} = 0.00205\overline{\theta}^4$

Table 3: Equilibrium values under the discriminative conditional tariff.

As can be seen, only the low quality firm pays the import tariff $t_2 = 0.000806\overline{\theta}^3$. Tariff revenues obtained by the government are $R = 0.000204\overline{\theta}^4$ and consumer surplus for the high and low quality consumers, respectively, is $CS_1 = 0.060222\overline{\theta}^4$ and $CS_2 = 0.0021011\overline{\theta}^4$.

The discriminative conditional tariff has important effects on the strategic choice of quality by both the low, and high, quality firm. Both firms earn less profits. The low quality firm decreases quality investment and the high quality

firm increases quality investment. Consumer surplus and total welfare under a discriminatory conditional tariff is greater than under any other tariff policy. Under a discriminatory tariff the government is able to affect quality investment by the high quality firm. This ability to affect quality investment of the high quality firm, is not present under the uniform tariff.

4.2   Uniform conditional tariff

The government first announces the FQS. The FQS informs the firms on the minimum quality that exempts their exports from the tariff. Following this announcement firms decide on their quality investment. The quality chosen by the firms determines whether they will be subject to the import tariff, or not. After the firms decide on their qualities, the government (observing the qualities) announces the tariff. Finally, the firms compete in quantities.

It is easy to see that if the FQS is at, or less than, the low quality chosen under free trade it has no impact upon the qualities chosen by the firms. Further, if the FQS equals the quality chosen by the low quality firm under free trade tariff revenues are zero. Thus the government is only able to change the qualities and generate tariff revenues if the FQS exceeds the (low) quality chosen under free trade, $s_2^{FT} = 0.090223\bar{\theta}$. If the FQS is slightly above s_2^{FT} the low quality firm has two options. The first is to invest below s_2^{FT} paying the import tariff and the other is to invest above it. If the firm decides to pay the import tariff once more it chooses s_2^{FT}. In the case that the firm invests above s_2^{FT} then it will always choose the FQS set by the government. Given that total welfare is increasing in quality the government is interested in setting a FQS above s_2^{FT}.
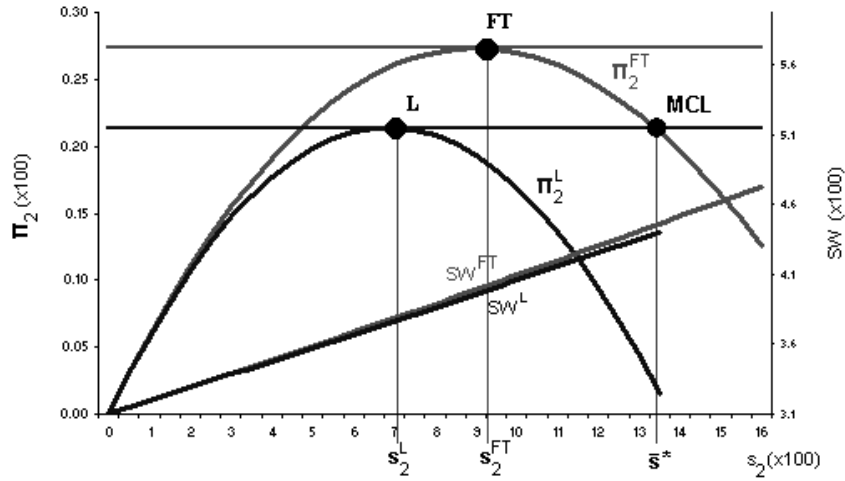

Figure 6: Total welfare and profits under conditional tariff: Low Quality Firm

In *figure 6* we see the maximum profits of the low quality firm given the best response of the high quality firm (see [3a] paying no tariff) for quality s_2^{FT}. Beyond s_2^{FT} profits in equilibrium will be smaller if the firm invests more in quality. Contrarily, total welfare (SW^{FT}) increases in low quality (given that no firm pays the tariff and the rival best responding). The low quality firm always sets its quality equal to the FQS (given that it earns greater than setting a lower quality and paying the import tariff). That is,

$$s_2 = \overline{s} \quad if \quad \Pi_2\left(fr_1(\overline{s}; t_1 = t_2 = 0), \overline{s}\right) \geqslant \Pi_2^L$$
$$s_2 = s_2^L \quad otherwise$$

It is interesting to see how the choice of the uniform conditional tariff influences quality choice by the two firms. Looking at the figure we see that any $QS \leqq s_2^{FT}$ does not affect quality investment for either firm. Further, as neither firms pay the tariff the government does not change the equilibrium from free trade. Thus the government only gains if it sets a FQS above s_2^{FT}. For a FQS above s_2^{FT} we see that the low quality firm still makes greater profits than paying the tariff and staying at point L (on Π_2^{LT}). The low quality firm always chooses the FQS till the point MCL where its profits exactly equal the profits at point L. If the FQS were to be greater than MCL it always chooses point L. The government thus knows that it can only increase low quality in the range $(s_2^{FT}, \overline{s}^*]$.

In *figure 6* we can observe that the profits for the low quality firm that meets the FQS and pays the import tariff are represented by the point MCL. This point corresponds to a quality level , $s_2 = \overline{s}^* = 0.133885\overline{\theta}^2$, for the low quality firm. In the case that the government sets $\overline{s}^*$ as the FQS the equilibrium values are the following:

$s_1^{\overline{s}} = 0.254011\overline{\theta}^2$	$s_2^{\overline{s}} = 0.133885\overline{\theta}^2$	$q_1^{\overline{s}} = 0.424115\overline{\theta}$	$q_2^{\overline{s}} = 0.287942\overline{\theta}$
$p_1^{\overline{s}} = 0.10773\overline{\theta}^3$	$p_2^{\overline{s}} = 0.038551\overline{\theta}^3$	$\Pi_1^{\overline{s}} = 0.013429\overline{\theta}^4$	$\Pi_2^{\overline{s}} = 0.002138\overline{\theta}^4$

Table 4: Equilibrium values: Uniform conditional tariff.

Given that both the firms invest above the required minimum, neither pays the import tariff. The government thus earns zero tariff revenues. Total consumer (total) surplus in this case is $CS^{\overline{s}} = SW^{\overline{s}} = 0.044745\overline{\theta}^4$. Total welfare obtained under a uniform tariff is greater than under free trade, $SW^{FT} = 0.040174\overline{\theta}^4$.

Lemma 1 *Total welfare under a uniform conditional tariff, $SW^{\overline{s}} = 0.044745\overline{\theta}^4$, is greater than under free trade, $SW^{FT} = 0.040174\overline{\theta}^4$. Neither firm pays the import tariff producing quality at, or above, the MQL.*

Quality investment by both the firms is greater than under free trade. As a result profits for both the firms decline. The government is able to increase quality investment and achieves a higher level of welfare. Even though prices

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increase and total output declines the increase in quality more than compensates for the increase in the price and the fall in output. Consumer surplus for both, the low and high, quality consumers is greater than under free trade.

If the government sets the FQS above $\overline{s}^*$ the low quality firm prefers to produce the quality s_2^{LT}, paying the import tariff and making greater profits. On the other hand the government has no incentive to set the FQS above $\overline{s}^*$ as it decreases total welfare.

It now interesting to look at the incentives of the high quality firm given that the QS$>\overline{s}^*$. Profits for the high quality firm are denoted by π_1^{LT} when the low quality firm pays the tariff. Profits for the high quality firm are much higher (π_1^B) if both firms pay the tariff. In any range between B and MCH the high quality firm will always choose a quality slightly below the QS. Further, knowing that a high tariff works to the detriment of the low quality firm the high quality firm always invests below the FQS in the range $(B, MCH]$ making greater profits. The government, however, never wants both the firms to pay the tariff as its welfare is lower in this case ($SW^B < SW^{LT}$). Knowing that it cannot increase quality investment of the high quality firm above s_1^B, the government, always prefers a FQS in the range $(s_2^{FT}, \overline{s}^*]$.
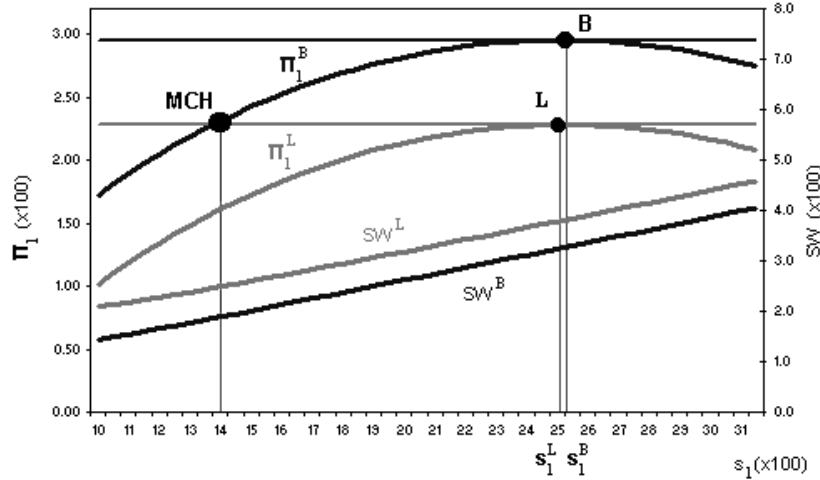

Figure 7: Total welfare and profits for the high quality firm: Uniform conditional tariff.

The results under a uniform conditional tariff are summarized in the following proposition:

Proposition 5 *The government maximizes total welfare choosing a MQL of $\overline{s}^* = 0.133885\overline{\theta}^2$. In equilibrium no firm pays the import tariff. The low quality firm sets its quality (s_2^*) exactly equal to the MQL and the high quality firm*

produces quality $s_1^{\bar{s}} = 0.254011\bar{\theta}^2$.

5   Conclusion

We have shown that optimal MQS limit access to markets. A country choosing a MQS will maximize welfare for a high enough MQS so that the market is only served by a foreign monopolist. The domestic market is served by a monopoly both for the case of a pure importing and an importing country with domestic production. This confirms the general perception that quality standards work towards limiting access to markets, especially from countries that sell lower quality goods. To our knowledge this is the first theoretical treatment of this issue. It is easy to see that this outcome is achieved due to the binding constraints that an MQS imposes upon imports.

In this paper we first study the incentives to impose a MQS for a pure importing country. The results in this case are clear. The domestic government maximizes total welfare, in this case the total consumer surplus, and sets a high enough MQS so that the high quality firm makes zero profits. The motivation for a high MQS is borne more out of the effect of an increase in quality on consumer surplus. However, the end outcome is that the domestic market is served by a monopoly[16]. The optimal MQS increases domestic welfare relative to free trade under such a MQS.

For the case of an importing country with domestic production we show that the level of the MQS that maximizes total welfare depends upon the relative weight a government puts on its firm profits. However, regardless of the weight there always exists a MQS which blocks entry for the low quality foreign firm. For low enough levels of the weight the government always chooses the highest MQS that gives the domestic firm zero profits. For high enough weights the MQS is decreasing in the weight and equals the quality level produced by a domestic monopolist when the weight is infinitely large. However, the optimal MQS is still high enough so as to block entry for the low quality foreign firm. Interestingly, if a government assigns equal weights to consumer surplus and domestic firm profits then the optimal MQS is high enough such that the domestic firm does not make monopoly profits. This result is interesting as it points out that high MQS may not be placed to grant monopoly rights to the domestic firm. This would occur at low levels of MQS. In fact, the MQS that gives monopoly profits occurs in the limit when the government assigns an infinitely high weight (with respect to consumer surplus) to its profits. This outcome, however, seems extremely unlikely.

Given the market access blocking property of a MQS we propose a Flexible Quality Standard as an alternative to the existing use of quality standards. We propose a conditional import tariff as an alternative trade policy instrument. The conditional import tariff depends on a certain FQS whereby, any firm failing to meet it pays an import tariff. In this sense, the FQS is a generalized version

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[16]Unlike Boom (1995) the importing country does have an incentive to set an MQS. However, it is high enough such that a monopoly is obtained.

of the Minimum Quality Standard as it allows sale of a good below a certain minimum threshold (under a MQS this tariff is prohibitive). A firm unable to meet the threshold simply pays the tariff. We show that if the government has at its disposal two instruments (a FQS and a conditional import tariff) and two targets (output and quality) then the conditional import tariff can be a welfare improving policy tool in the hands of an importing government.

If a firm does not meet this minimum it pays an import tariff, otherwise it is exempt. In this manner the government has an instrument for quality (a FQS) and an instrument for output (a tariff). With such a two-part instrument a government obtains greater domestic welfare than under a MQS or under free trade. We analyze two different conditional tariffs. First, we study a discriminative tariff. Subsequently we study a uniform conditional tariff that is the same for both, high and low quality, firms. We show that highest welfare is obtained by an importing country under a discriminative conditional tariff. Welfare under a discriminative tariff is higher than under free trade, a MQS, or a uniform conditional tariff. The incentives for governments to use discriminatory instruments are high in our model.

The effect on quality chosen by the firms is different under a uniform and a discriminative conditional tariff. A uniform conditional tariff has a detrimental effect on the low quality firm. The high quality firm in this case can lower quality investment thus increasing the competitive pressure on the low quality firm. This clearly works to the detriment of the low quality firm that makes lower profits. The government, however, is unable to affect quality investment by the high quality firm under the uniform conditional tariff. The FQS chosen in equilibrium is such that neither the low, nor the high, quality firm pay the conditional import tariff. The low quality firm chooses a substantially higher level of quality than under free trade. Even though in equilibrium neither firm pays the conditional import tariff total welfare increases due to the increase in consumer surplus (average quality increases).

The FQS set by the government lies in the intermediate range of the qualities chosen by the firms under free trade. The reason is that the high quality firm will never produce a quality greater than it does under free trade. In fact, for a high enough FQS, it is in the interest of the high quality firm to choose a quality level slightly below the FQS provoking a higher tax[17] on the low quality firm[18]. The high import tariff decreases the competitiveness of the low quality firm. This works to the advantage of the high quality firm and it earns greater profits than it would earn otherwise. However, it is not to the advantage of the government to set a high FQS. A high FQS lowers quality investment by both the firms resulting in lower total welfare. The government, as a result, selects an FQS that is somewhere between the qualities chosen by the two firms under free trade.

The story under the discriminative conditional tariff is different. The gov-

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[17] The import tariff paid by both the firms is greater than when only the low quality firm pays it.

[18] The strategy of reducing its quality investment and paying the tariff is optimal for the high quality firm for a MQL greater than $0.137533\overline{\theta}^2$.

ernment is able to affect quality investment by both the firms under the discriminative tariff. Each firm pays a separate tariff, the FQS is high enough such that the quality chosen by the high quality firm is substantially higher than under free trade. The low quality firm, however, invests less in quality. Total domestic welfare of the importing country is greater than under both free trade and the uniform conditional tariff. The low quality firm pays an import tariff while the high quality firm produces at the FQS (not paying the import tariff). Output sold in the market is higher. Firm profits are, however, much lower than under free trade.

In this paper we have shown that a MQS always blocks entry for the low quality firm. An interesting result obtained in the importing country case is that the domestic firm being a monopolist never earns monopoly profits. Clearly this occurs as the MQS is imposed uniformly across the domestic and the foreign firm. The domestic firm would obtain monopoly profits only in the case when the MQS applies to the foreign firm. Domestic welfare in this case is, however, lower than in the case where the MQS is imposed upon both the firms. Given that the MQS blocks entry we propose a new policy instrument. Here we flexibilize the MQS making it nonbinding if the qualities below it are taxed. We show that in this case a discriminative FQS results in greater welfare than under free trade or any other MQS.

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