Abstract

Regulatory standards that control the quality of vertically differentiated products are becoming increasingly important for industrial production and international trade. There is considerable debate surrounding the possible effects of standards on international trade and social welfare. This paper examines the implications of minimum quality standards (MQSs) in a free trade environment with two countries and two firms competing in prices in an industry characterised by vertical product differentiation. Mild minimum quality standards are shown to raise welfare by increasing the quality, lowering the (quality-adjusted) price of traded goods and increasing market coverage. Nevertheless, cross-country externalities result in governments choosing MQSs above or below the world optimum thereby reducing welfare by inducing exit and reducing competition. The model suggests that international organisations, such as the International Organization for Standardization (ISO), may be better positioned to improve welfare outcomes through the development of product standards.

Keywords: International Trade,
JEL Classification Numbers:
1 Introduction

Regulatory standards that control the quality of vertically differentiated products are becoming increasingly important for industrial production and international trade. The last thirty to forty years have witnessed a shift in the approach of industry from vigorous resistance to mandatory regulations for safety and protection of the environment to pro-active management of these issues.

The aim of this paper is to examine the impact of mandatory quality standards on trade volume, prices and quality as well as to explore theoretically whether these standards are chosen optimally by governmental standard-setting bodies.

Much of the body of literature focuses on the impact of minimum quality standards on welfare in a single economy with a duopoly in the vertically differentiated sector. The welfare implications of these models depend critically on the nature competition among firms and the way in which quality development contributes to cost. In Ronnen’s (1991) renowned paper firms compete in prices and face fixed quality-development costs. Minimum quality standards unambiguously improves welfare by intensifying price competition among firms. Similar results are obtained by Crampe and Hollander (1995) assuming that quality improvements increase variable rather than fixed costs. Other papers explore the effects of firms competing in quantities rather than prices e.g. Motta (1997). The broad picture is one where minimum quality standards improve welfare under price competition among vertically differentiated firms, and lower welfare when firms compete in quantities.

In this paper I extend the economic environment to include two economies that trade freely in vertically differentiated goods. Once the unregulated equilibrium is determined I examine the effects of minimum quality standards on trade flows. The two-country framework allows me to analyse how standard-setting incentives differ across governments due to cross-country externalities.

The rest of the paper is structured as follows. The two country model of a vertically differentiated industry is presented in Section 2. The unregulated and regulated market equilibria are examined. Section 3 discusses some avenues for further research and Section 4 concludes.

2 The Model

Consider an economic environment with two segmented markets, which I call countries 1 and 2. There is a single firm $i$ located in each country, where $i \in \{1, 2\}$. There is no potential entry, although exit of the incumbent firms may occur. These firms compete in quality and prices in a free trade environment, producing a single vertically differentiated good. Firms can only supply a market with goods of a single quality level, though they can choose to differentiate the quality of exported goods from domestic sales. Let $q_{ij}$ be the quality level of the good produced in country $i$ (by firm $i$) and consumed in country $j$, where $q_{ij} \in [0, \infty)$ and $i, j \in \{1, 2\}$.
There are no fixed costs of quality development; rather, there are quality-dependent variable costs. Let the marginal cost of firm $i$ when producing quality $q_{ij}$ be $c_i(q_{ij})$, where $c'_i(q_{ij}) > 0$, $c''_i(q_{ij}) \leq 0$ and $c_i(0) = c'_i(0) = 0$. That is, marginal cost is linear or concave in quality level $q_{ij}$. In addition, assume that $c_2(q) > c_1(q)$ $\forall q$; that is, for any given quality level firm 2 is less efficient than firm 1. This asymmetry in the cost structure across firms is introduced to reflect the different levels of country development. Country 1 is the developed economy while country 2 represents a developing economy.

The firms interact in a two-stage game. In the first stage, firms 1 and 2 commit to quality levels $q_{11}, q_{12}$ and $q_{21}, q_{22}$ respectively, then in the second stage they compete in prices given the quality levels chosen in stage 1. Note that in the absence of fixed quality-development costs incurred in the first stage, this implies there is some commitment mechanism for firms. The solution concept that will be employed for the two-stage game is the subgame perfect equilibrium (SPE), which excludes any non-credible threats or promises made by firms.

Following the standard modeling features used in quality differentiation models [e.g. Shaked and Sutton (1982)] we assume the demand side consists of a continuum of consumers in each market with a varying taste parameter, $\theta$, distributed uniformly over the interval $[0, 1]$. Consumers derive utility from the first unit of purchase only, so that each consumer chooses to consume one unit of the good or makes no purchase. The utility function of each consumer purchasing a unit of a good with quality $q$ and price $p$ is described by $U = \theta q - p$.

In this simple model, consumers can costlessly observe the quality levels available in the market. Hence, the implications of minimum quality standards (MQS) on trade flows and welfare are analysed without the introduction of an adverse selection problem, commonly found in traditional analysis e.g Leland (1979). The notion that consumers can perfectly identify the quality level of goods, without any need for costly labelling or certification, is far from realistic. In practice, minimum quality standards go hand in hand with third party certification by certification authorities, whether these are governmental bodies or licensed private organisations. Nevertheless, I seek to uncover the key mechanisms in the full-information case through a simple model. The effect of modifications to incorporate the certification process and ensuing implications for trade will be discussed in more detail in Section 3.

The consumers in each market are price and quality takers. Given firms’

1 As will become clear further on, this assumption regarding the non-convexity of marginal costs is crucial to our results. When the quality level rises as a result of the imposition of a minimum quality standard, there are two conflicting effects on (quality deflated) prices. First, the price competition effect works to lower prices. Second, the variable cost effect works to raise prices through the impact of a higher level of quality on marginal cost. By assuming marginal cost is linear or concave in the level of quality we ensure the price competition effect dominates the variable cost effect.

2 Chipty and Witte (1997) carry out an empirical investigation of firms’ responses to minimum quality standards. They study the effects of minimum standards on the behaviour of child care centers in the US. They find that when minimum standards do no lead to exit, minimum standards can increase the average and maximum quality of products in the market. This evidence supports the assumption that firms compete in prices and adjust their quality levels in order to alleviate price competition through quality differentiation.
decisions \((q_{ij}, p_{ij})\), consumers in each market choose between (i) purchasing a unit of the good from firm 1 (ii) purchasing a unit of the good from firm 2, or (iii) making no purchase.

### 2.1 The Unregulated World Market Equilibrium

Solving for the subgame perfect equilibrium involves two steps. First, I determine the (unique) second-stage price equilibrium and define firms’ payoffs in terms of first-stage quality decision. Second, I determine the optimal first stage quality decisions of firms. Since there are no transport costs or trade barriers between markets and the distribution of consumers is identical, the unregulated (without minimum quality standards) equilibrium quality levels and prices chosen by firms for exports and domestic sales are identical. The market share of firm \(i\) will be same in each market. This allows me to focus on a single market for the purposes of solving for equilibrium.

In the event that only one firm produces in equilibrium, the active firm operates as a monopolist in both markets. Consider a monopolist with quality \(q\) and price \(p\). Defining \(\theta \in [0, 1]\) as the individual indifferent between buying a unit of the good from the monopolist and making no purchase, it follows from the utility function that \(\theta = \frac{pq}{c}\). Hence the market share of the monopolist in each market is \((1 - \frac{pc}{c})\). Using the simplifying assumption of linear marginal cost \(c_i(q_i) = cq_i\), where \(c\) is constant between 0 and 1, it is straightforward to show that the monopolistic quality-deflated price is \(\frac{pq}{cq} = 1 + \frac{c}{q}\), and the monopolist sells to consumers within the interval \([\frac{1}{2}, \frac{c}{q}, 1]\).  

Now consider the case where both firms are active in equilibrium. If firms choose identical quality levels, the degree of price competition is maximised.

Hence, firms have an incentive to diminish the degree of price competition between them by differentiating themselves; One of the firms emerges as the high-quality producer (\(H\)) and the other as the low-quality producer (\(L\)). It is common practice in the literature to arbitrarily assign one firms as firm \(H\) and the other as \(L\), e.g. Ronnen (1991). In this model, the asymmetry in the cost structure across firms determines which will be the high- and which the low-quality producer. For simplicity, let the marginal cost of each firm be a linear function of quality, such that \(c_1(q_{1j}) = aq_{1j}\) and \(c_2(q_{2j}) = bq_{2j}\), where \(1 > b > a > 0\) and so \(q_{1j} > q_{2j}\). In the Appendix the reaction functions of the firms are calculated, from which it follows that when both firms are active there is a unique equilibrium to the second-stage price-setting subgame.

Defining the quality-deflated prices of the low- and high quality producers as

\[ P_{1i} = \frac{p_{1i}}{q_{1i}}, \quad P_{2i} = \frac{p_{2i}}{q_{2i}} \]

\[ \Pi_i = (1 - \frac{pc}{c}) (p_{1i} - c_{1i}) \]

Maximising with respect to price, given \(q_i\), and rearranging the first order condition, we can find the monopolist’s quality-deflated price and market share.

\[ \theta = \frac{pq}{c} \]

\[ q_{1i} = q_{2i} \quad c_1(q_{1j}) = c_2(q_{2j}) = 0 \]

results.
\[ x_{1j} = \frac{p_{1j}}{q_{1j}} \text{ and } x_{2j} = \frac{p_{2j}}{q_{2j}} \text{ respectively, as well as the marginal consumer in market } j \text{ indifferent between } q_{1j} \text{ at price } p_{1j} \text{ and } q_{2j} \text{ at price } p_{2j} \text{ as } z_j = \frac{p_{1j} - p_{2j}}{q_{1j} - q_{2j}}. \]

\[ x_{1j}^* = \frac{2(r_j - 1)}{4r_j - 1} + \frac{2r_j}{4r_j - 1} \frac{c_1(q_{1j})}{q_{1j}} + \frac{1}{4r_j - 1} \frac{c_2(q_{2j})}{q_{2j}} \quad (1) \]

\[ x_{2j}^* = \frac{r_j - 1}{4r_j - 1} + \frac{r_j}{4r_j - 1} \frac{c_1(q_{1j})}{q_{1j}} + \frac{2r_j}{4r_j - 1} \frac{c_2(q_{2j})}{q_{2j}} \quad (2) \]

where \( r_j = \frac{q_{1j}}{q_{2j}} \). Substituting for linear marginal costs yields equations (3) and (4).

\[ x_{1j}^* = \frac{2(r_j - 1)}{4r_j - 1} + \frac{2r_j}{4r_j - 1} q + \frac{1}{4r_j - 1} b \quad (3) \]

\[ x_{2j}^* = \frac{r_j - 1}{4r_j - 1} + \frac{r_j}{4r_j - 1} a + \frac{2r_j}{4r_j - 1} b \quad (4) \]

The equilibrium quality-deflated prices are determined solely by \( r_j \), that is, by the qualities chosen in the first stage. In both countries, the equilibrium market share of firm 1, the high quality firm, is \([z_j, 1]\) while that of firm 2, the low quality firm, is \([x_{2j}, z_j]\). Hence, in the unregulated equilibrium, country 1 exports high quality goods to country 2 and imports low quality goods at a low quality-adjusted price from country 2 the developing country. In each economy, firm 1 captures the top end of market. Note that given a uniform distribution of consumers over the interval \([0, 1]\) the market is never covered completely by the available qualities.

Firm profits can be obtained as a function of qualities by multiplying market share with equilibrium price and subtracting cost. Firm 1 and 2 profits in each market are described by equations (5) and (6) respectively.

\[ \Pi_{1j}(q_{1j}, q_{2j}) = q_{1j}(x_{1j} - a)(1 - z_j) \quad (5) \]

\[ \Pi_{2j}(q_{1j}, q_{2j}) = q_{2j}(x_{2j} - b)(z_j - x_{2j}) \quad (6) \]

Maximising these payoffs with respect to qualities yields the unique qualities chosen in stage 1, where \( q_{1j}^* > q_{2j}^* \). Figure 1 illustrates the equilibrium for economy \( j \), with each firm \( i \) setting marginal cost \((MC_{ij})\) equal to marginal revenue \((MR_{ij})\).

The next section considers the impact on trade and welfare of minimum quality standards (MQS) imposed by the governments in the two economies, and addresses whether or not MQS should be harmonised across countries.

---

\( 6 \) If \( z_j \) is the consumer in market \( j \) indifferent between \( q_{1j} \) at price \( p_{1j} \) and \( q_{2j} \) at price \( p_{2j} \), then it follows from the utility function that \( z_j q_{1j} - p_{1j} = z_j q_{2j} - p_{2j} \). Hence, \( z_j = \frac{p_{1j} - p_{2j}}{q_{1j} - q_{2j}} \).
Figure 1: The unregulated equilibrium
2.2 The Regulated World Market Equilibrium

In this section I consider the impact of a MQS, \( q_{\text{min}} \), being imposed in each market by a paternalistic government wishing to raise minimum quality in the market, for example, to improve health and safety. In particular, \( q_{1j} > q_{\text{min}} > q_{2j} \), such that the MQS is binding for the low-quality firm (2), but not for the high-quality firm (1).

Following Ronnen (1991) I consider a 'mild' MQS, where the latter is defined as a standard lax enough such that both firms remain active in the equilibrium of the regulated world market. A 'severe' MQS is one that induces exit of one of the firms and hence results in an unambiguously welfare-reducing monopolistic outcome.

The analysis aims to answer two key questions, (i) how do 'mild' MQS imposed in each country affect the volume, quality and price of traded goods? Are MQS barriers to trade?, and (ii) in an economic environment, à la Ronnen (1991), in which MQS are welfare improving, is it optimal for countries to harmonise their regulatory standards?

The answer to the first of these questions depends crucially on the nature of competition in the second stage of the game as well as on the way quality affects firms' costs. It can be shown that with price competition among firms facing non-convex marginal costs, quality levels are strategic complements so the imposition of a mild MQS has a positive welfare effect [e.g. Ronnen (1991)]. Conversely, if marginal costs rise particularly steeply with quality, or firms compete in quantities in the second stage rather than prices, a MQS can be shown to be welfare reducing [e.g. Motta (1993)].

In economic environments in which mild MQS lower welfare by raising quality adjusted prices and reducing market coverage, endogenising the MQS yields an optimum standard of \( q_{\text{min}} = 0 \). Such economic environments are not conclusive to analysing the issue of the optimality (or otherwise) of harmonising standards in vertically differentiated markets, since these regulatory interventions are never optimal. It is for this reason that I restrict the analysis to an economic environment in which mild MQS are welfare improving.

Consider the imposition of a mild MQS by the government of country \( j \). The low quality firm in the market is forced to raise its quality level to meet the standard. When \( q_{2j} \) rises to meet the standard, \( r_j = \frac{q_{2j}}{q_{1j}} \) falls. This narrows the disparity between the quality levels of the two firms, thereby intensifying the degree of price competition in the second stage and exerting downward pressure on quality-deflated prices \( x_{1j} \) and \( x_{2j} \). This is the price competition effect. The optimal reply of firm 1 to the higher quality level of goods produced by firm 2 is to raise its own quality level\(^7\). This widens the disparity between quality

\[^7\]Consider the revenue function of each firm:

\[ R_{1j} = q_{1j}(x_{1j})(1 - z_j) \] and \[ R_{2j} = q_{2j}(x_{2j})(z_j - x_{2j}) \]. From these one can derive marginal revenue functions \( MR_{1j} \) and \( MR_{2j} \) for which the following properties follow:

\[ \frac{\partial MR_{1j}}{\partial q_{1j}} < 0 \quad \forall q_{2j} > 0 \]

and

\[ \frac{\partial MR_{2j}}{\partial q_{2j}} < 0 \quad \forall q_{1j} > 0 \]
levels once again assisting to weaken price competition. Despite the rise in the
quality level of firm 1, price competition is tougher than in the unregulated world
market since the MQS restricts the range of qualities from \([0, \infty)\) to \([q_{\text{min}}, \infty)\).

Counteracting the price competition effect is the \textit{variable cost effect}. The
rise in the quality levels chosen by both firms exerts an upward pressure on
quality-deflated prices through the impact of higher quality on marginal costs.
The net effect on \(x_{1j}\) and \(x_{2j}\) depends on the relative size of the two effects.
When marginal costs are linear or concave in quality, the price competition
effect dominates the variable cost effect giving rise to an overall reduction in
quality adjusted prices. Conversely, convexity of marginal cost would raise
\(x_{1j}\) and \(x_{2j}\) overall.

To see the two effects consider equations (1) and (2). The price competition
effect is captured by the first term in each of these equations, while the variable
cost effect is captured by the last two terms. If variable costs are assumed to be
zero, as in Ronnen’s model, the last two terms of equations (1) and (2) drop out,
eliminating the variable cost effect completely. Once the linear cost assumptions
are imposed, the ambiguity is resolved in equations (3) and (4) and \(x_{1j}\) and \(x_{2j}\)
unambiguously fall with the decline in \(r\), as is depicted in figure 2.

The reaction functions of firms 1 and 2 can be simplified to equations
(7) and (8).

\[
x_{1j} = \frac{1}{2} [a + 1 - \frac{1}{r_j} + \frac{x_{2j}}{r_j}]
\]

(7)

\[
x_{2j} = \frac{1}{2} [b + x_{1j}]
\]

(8)

Figure 2 depicts these reaction functions and the impact of a decline in \(r\)
on equilibrium quality-adjusted prices. The mild MQS succeeds in raising the
quality levels of both firms while lowering \(x_{1j}\) and \(x_{2j}\) to \(x_{1j}^{MQS}\) and \(x_{2j}^{MQS}\), the
combined effect of which is greater market coverage. More consumers purchase
a unit of the good and each consumer consumes a higher quality than in the
unregulated equilibrium. In their effort to minimise the intensity of price com-
petition in the second stage, firms excessively widen the quality disparity in
the market. The MQS corrects this effect and increases social welfare overall

The implications for trade are (i) the quality of traded goods increases (ii)
goods are traded at lower quality-deflated prices and (iii) the volume of trade
increases, giving rise to greater market coverage. Hence, contrary to popular

\[
(3) \quad \frac{\partial R_{1j}}{\partial q_{2j}} > 0 \quad \forall q_{1j} > q_{2j}
\]

\[
(4) \quad \frac{\partial R_{2j}}{\partial q_{1j}} > 0 \quad \forall q_{2j} > 0
\]

\[
(5) \quad \frac{\partial R_{1j}}{\partial q_{1j}} < 0 \quad \forall q_{1j} > q_{2j}
\]

\[
(6) \quad \frac{\partial R_{2j}}{\partial q_{2j}} > 0 \quad \forall q_{2j} > 0
\]

It follows that quality levels are strategic complements. The stronger price competition
following a narrowing of quality disparities follows from (5) and (6), and (3) indicates the
incentive for firm 1 to raise quality when the lower quality level rises.
Figure 2: Quality-deflated prices under a ‘mild’ MQS
belief, moderate minimum standards can potentially stimulate trade rather than create barriers to trade.

Now let $q_{1\text{min}}^j$ and $q_{2\text{min}}^j$ be the MQS imposed by the governments of countries 1 and 2 respectively. To address the issue of cross-country harmonisation of MQS I define social welfare in each economy and consider the incentives of the independent regulatory authorities. The welfare of economy $j$, $W_j$, is the sum of consumer and producer surplus (a MQS does not generate any revenue for the government). Hence,

$$W_1 = CS_1 + \Pi_{11} + \Pi_{12}$$

and

$$W_2 = CS_2 + \Pi_{22} + \Pi_{21}$$

where $CS_j$ is consumer surplus in $j$ and $\Pi_{ij}$ is the profit generated by firm $i$ from sales in market $j$. The government of each country will choose $q_{\text{min}}^j$ to maximise $W_j$. Consumer surplus can be found by integrating over the distribution of consumers, such that

$$CS_1 = \int_z^1 (\theta q_{11} - p_{11}) \, d\theta + \int_{x_{21}}^z (\theta q_{21} - p_{21}) \, d\theta$$

$$= \frac{1}{2} \left[ q_{11}(1 - z_1)(1 + z_1 - 2x_{21}) + q_{21}(z_1 - x_{21})^2 \right]$$

and

$$CS_2 = \int_z^1 (\theta q_{12} - p_{12}) \, d\theta + \int_{x_{22}}^z (\theta q_{22} - p_{22}) \, d\theta$$

$$= \frac{1}{2} \left[ q_{12}(1 - z_2)(1 + z_2 - 2x_{22}) + q_{22}(z_2 - x_{22})^2 \right]$$

With an identical distribution of consumers in each country, the positive impact of $q_{\text{min}}^j$ on $CS_j$ is the same in all countries. Hence, starting from the unregulated equilibrium, $\frac{\partial CS_j}{\partial q_{\text{min}}}$ is identical for both countries. The key difference in the incentives of the two governments lies in the impact of $q_{\text{min}}^j$ on firm profits. The profits generated by firms 1 and 2 in each market are given by equations (5) and (6), respectively. When choosing the MQS to maximise welfare, each government only considers the profit of the domestic firm. Since the profits generated by the high-quality firm (1) and low-quality firm (2) are different, government incentives do not coincide, even though the unregulated equilibrium in the two countries is identical. Each government’s MQS decision affects foreign profits. The resulting externality causes governments 1 and 2 to choose MQS levels $q_{\text{min}}^1$ and $q_{\text{min}}^2$ that are above and below the world social optimum, respectively. This policy inefficiency arises since countries differ in their level of development and quality-characteristics of domestically produced goods.

Harmonisation of MQS across countries to either level is inefficient (though in practice, developing countries are more likely to be pressured to harmonise
up to the severe standards of developed economies. Imposing an overly severe MQS may induce exit and thus lower welfare, while an overly lax MQS does not fully correct the firms’ incentive to widen the inter-firm quality gap.

The first-best MQS for both economies is determined by maximising world welfare \( W_1 + W_2 \), thereby internalising the cross-country externalities. The practical policy implication is that product standards should not be determined by government agencies but rather by international standard-developing organisations comprising of market participants from all countries, similar to the International Standards Organisation (ISO)\(^8\).

3 The Way Forward

The model developed in Section 2 is very stylized and can only capture certain aspects of the controversy surrounding product standards. The model can be extended to include numerous firms and greater complexity in the strategic interaction. For example, if high quality firms (whose quality level exceeds the minimum standard) can commit to a particular quality level prior to government regulation\(^9\), then the regulator may be induced to weaken the regulatory standard. Lutz et al (2000) examine the implications of such 'quality leadership strategies'.

An important aspect of the controversy over standards is the cost of complying to national systems for testing, certification and laboratory accreditation. In my model, firms respond to MQS by changing their quality level, which has cost implications, but there is no fixed cost of certification. In practice, product standards and certification go hand in hand. Final products and production processes need to be inspected on a regular basis and either a label is attached to the product to indicate quality or a certification of conformity is issued to the firm. For many vertically differentiated products, quality levels are not observable to consumers (e.g. whether goods are organic, child-labour free or animal friendly). Without an appropriate signal to consumers, buyers are unable to distinguish between high and low quality goods and so sellers cannot command a higher price for higher quality levels. Severe information asymmetries of this kind create an adverse selection problem. To reduce the 'market for lemons' problem, third party certification organisations (e.g. testing laboratories) are paid by producers to signal quality to consumers via a label or certificate.

The cost of gaining certification can be very steep. In 1993 Deloitte and Touche Management Consulting estimated the average cost of registration to ISO 9000 for firms operating in North America to be about $245,000 per firm, while the initial certifying costs for IBM are estimated at $100m [Wilson (1997)].

Mandatory minimum standards are developed by regulatory agencies and are based on national technical regulations. Most of these regulatory standards

---

\(^8\) Note that ISO develops voluntary consensus standards. The ISO 9000 series on product quality is an example.

\(^9\) In my model the government imposes the minimum quality standard and subsequently the firms respond to the standard by adjusting their quality levels and prices.
relate to public health, safety or the environment, and outline the technical specifications that products must meet. Once again, costly 3rd party certification is required to ensure products satisfy minimum standards.

Typically, minimum quality standards vary across countries. These cross-country differences act as a barrier to trade when exporting to several markets involves multiple certification. Wilson (1997) argues that even where standards vary little across countries, firms are required to certify their products multiple times since national authorities only recognise specific accreditation agencies.

Where trading with countries with different mandatory standards involves duplicating fixed certification costs, the arguments for MQS harmonisation are more compelling. One interesting way forward in this line of research is to introduce information asymmetries in the model. This will allow analysis regarding the role of intermediaries in international trade and the implications of costly certification by intermediaries for the quality of traded goods and MQS harmonization.

4 Conclusion

Regulatory standards that control the quality of vertically differentiated products are becoming increasingly important for industrial production and international trade. There is considerable debate surrounding the possible effects of standards on international trade and social welfare. The paper examines the implications of minimum quality standards in a free trade environment. I construct a model with two countries and two firms in an industry characterised by vertical product differentiation. In the first stage of the game product qualities for export and domestic sales are chosen by the firms, while in the second stage firms compete in prices. Rather than creating barriers to trade, appropriate minimum quality standards intensify price competition among firms through the narrowing of quality disparities, thereby lowering (quality-deflated) prices, raising qualities and expanding trade and market coverage. These results depend crucially on the price competition assumption for which there is some empirical evidence (Chipty and Witte, 1997).

Further, I examine the incentives faced by governments setting minimum quality standards. Cross-country externalities result in governments choosing minimum quality standards that are either above or below the world welfare maximising level. An inefficient choice of MQS may reduce welfare inducing exit and reducing competition in the market. The model questions how appropriate it is for governments to set country-specific standards. It suggests that international organisations, such as the ISO, may be in a better position to improve welfare outcomes through the development of product standards.
5 References


8. Lutz, S, T. P. Lyon and J. W. Maxwell (2000), "Quality leadership when regulatory standards are forthcoming"


6 Appendix

Solving for the second-stage price equilibrium requires the calculation of the reaction functions of firms 1 and 2. There is a unique equilibrium at their intersection. Consumer $\theta$ purchases from firm 1 in market $j$ if and only if two conditions hold:

1. $\theta \geq \frac{p_{1j}}{q_{1j}} \equiv x_{1j}$ (the consumer derives a positive surplus from consumption)
(2) \( \theta \geq \frac{p_{1j} - p_{2j}}{q_{1j} - q_{2j}} \equiv z_j \) (the consumer’s surplus from consumption of the high quality good exceeds that derived from consumption of the low quality good).

Let:

\[
x_{1j} \equiv \frac{p_{1j}}{q_{1j}} \\
x_{2j} \equiv \frac{p_{2j}}{q_{2j}} \\
z_j \equiv \frac{p_{1j} - p_{2j}}{q_{1j} - q_{2j}} \\
r_j \equiv \frac{q_{1j}}{q_{2j}}
\]

Then, if \( x_{1j} \leq x_{2j} \), the \( \max \{x_{1j}, z_j\} = x_{1j} \). If \( x_{1j} \geq x_{2j} \), the \( \max \{x_{1j}, z_j\} = z_j \). Hence, given the uniform distribution of consumers over \([0, 1]\), firm 1’s market share is \([x_{1j}, 1]\) if \( x_{1j} \leq \min \{x_{2j}, 1\} \); \([z_j, 1]\) if \( 1 \geq x_{1j} \geq x_{2j} \) and \( z_j \leq 1 \), and \( \emptyset \) otherwise.

Hence, given linear marginal cost in quality, if \( x_{2j} \geq \frac{1}{2} + \frac{a}{2} \), the optimal reply of firm 1 is to set the monopoly quality deflated price. If \( x_{2j} \leq \frac{1}{2} + \frac{a}{2} \), the optimal reply of firm 1 is obtained by choosing \( x_{1j} \) to maximise the profits of firm 1 in market \( j \): \( \max \Pi_{1j} = (1 - z_j)(x_{1j} - a) \). Setting \( \frac{\partial \Pi_{1j}}{\partial x_{1j}} = 0 \) yields equation (7).

Hence, firm 1’s reaction function is:

\[
x_{1j}(x_{2j}) = x_{2j} \text{ for } \frac{1}{2} + \frac{a}{2} \geq x_{2j} \geq \frac{(r_j - 1) + ar_j}{2r_j - 1}
\]

Following a similar procedure, one can find the reaction function of firm 2. The two reaction functions intersect uniquely to give equilibrium quality-deflated prices \( x_{1j}^* \) and \( x_{2j}^* \) as described by equations (3) and (4).