Economic Integration and Quality Standards in a Duopoly Model with Horizontal and Vertical Product Differentiation

by

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Abstract:
This paper examines the effects of trade barriers on quality levels in a duopoly model for two countries with one producer in each country. The products are both vertically and horizontally differentiated. In absence of quality regulation, the two producers determine prices and quality levels in a two stage game. The firms choose the quality level in the first game, and their prices in the second game. The Nash equilibrium illustrates that the producer in the large country produces a higher quality than the producer in the small country. However, a reduction of the trade barrier twists the quality levels in favour of the small country. Furthermore, in case of implementation of a minimum quality standard, which forces the low quality producer from the small country to increase the quality level, the producer from the large country reacts strategically by lowering the quality level of his product. On the unregulated markets, integration increases welfare in both countries if they are almost of similar size. However, if the countries are very asymmetrical with respect to size, market integration may harm welfare in the large country. Welfare effects by introduction of minimum quality standards are also ambiguous depending on the parameters of the model.

Keywords: Vertical product differentiation; horizontal product differentiation; market integration; duopoly; minimum quality standard.
JEL: F12, F13, F14.

1. Introduction

On markets for differentiated products, product quality is a strategic variable for firms. In the pioneering work of Gabszewicz and Thisse (1979), product quality has been analyzed formally in a duopoly model based on vertical product differentiation. This analysis has been followed by a large number of analyses of determination of product quality in duopoly models, where quality is used as a strategic parameter. Basically, market equilibrium in these models is determined in a two stage game between the two companies, where product qualities are determined in the first game leaving prices or output to be determined in the second game.

Several of these analyses focus on the impacts of implementation of minimum quality standards. The quality level of each producer's product influences the choice of quality of the other producer's product. The implementation of a minimum quality standard therefore changes the quality of the products not only for the producer, who is obliged to raise his product quality level, but also for the producer, who has a quality level of his product above the required level. In a seminal paper on this issue by Ronnen (1991), it is shown that a minimum quality standard, which effectively forces the low quality producer in a duopoly to raise his product quality, will induce the high quality producer to raise his product quality too. The model of Ronnen is based on pure vertical product differentiation, Bertrand competition on prices and quality dependent fixed costs. This result was corroborated by Crampes and Hollander (1995), who show in a duopoly model very similar to that of Ronnen that the effect on the high quality producer of a minimum standard also holds in the case, where variable production costs depend on the level of quality. The positive impact on the quality level for the high quality producer of a minimum quality standard effective for a low quality producer also appears, if the producers compete over quantities instead of prices i.e. in case of Cournot instead of Bertrand competition; see Valetti (2000) for this result. The models referred to above diverge strongly in conclusions about welfare and profits of the two producers, but they do not diverge as to the positive impact on quality that a minimum quality standard has on the high quality producer.

However, these results hinge on the assumption of pure vertical product differentiation. When a low quality producer is forced to raise product quality because of a minimum quality standard the immediate effect is an increased competition on the market. To mitigate this effect, the high quality producer therefore reacts by raising the quality level of his product. For more generalized models, which include both vertically and horizontally differentiated products, quality levels might be substitutes i.e. when one company raises its quality level, the other is induced to lower its quality level. Recently, this is shown formally in a model by Garella (2003), who also shows that the implementation of a minimum quality level induces the high quality producer to lower his quality level, if the consumers show strong horizontal preferences. The intuition behind this result is that the horizontal differentiation weakens the need for vertical differentiation in order to mitigate the pressure of competition.

Duopoly models with vertical product differentiation have also been analysed in a two country case. Boom (1995) examines the effects of implementation of asymmetric minimum quality standards for two countries i.e. the minimum quality standard differs across countries. It is assumed that each producer cannot customize more than one variant. If one of the countries therefore keeps its minimum standard above the standard of the other country, the low quality producer might be obliged to raise its quality on both markets, if the producer wants to market his product on both markets. Whether or not minimum quality standards are uniform across countries, international spill-overs are unavoidable. The trade aspect is only rudimentary dealt with in this analysis. Trade costs are neglected and the location of the two producers is therefore without importance for prices, quantities and qualities. In a more detailed analysis, welfare is of course sensitive to the location of the producers as the companies have non-negative profits. Recently, a similar two country model has been developed by Lutz (2000). Also in his model, markets are completely segmented, so there is no arbitrage between countries.

The purpose of this paper is to extend the above analyses to include trade costs i.e. to address specifically the question of quality in a duopoly on partially integrated markets which might or might not be regulated by a minimum quality standard. To examine this question, a model is developed which bears close affinity to the model by Garella (2003). The model includes horizontal as well as vertical product differentiation and is basically based on the same specifications of utility and technology (costs) as the model of Garella. However, the analysis is extended by introducing two countries with one producer located in each country. The markets in the two countries are partially integrated as trade costs prevail i.e. the producer in each country has a competitive advantage on the domestic market.

Two main findings follow from this extension of Garellas model. First, the relative size of the markets plays a role for the ranking of qualities between the two producers. If the producers are equally cost effective in production and developing quality, the high quality producer will appear in the country, where the domestic market is largest. In previous analyses, the ranking of producers with respect to quality is either described as a first mover advantage (see e.g. Ronnen, 1991) or as a result of cost efficiency asymmetries (see e.g. Garella, 2003). In the model developed in the following, a large domestic market stimulates quality development involving fixed costs, which might be spread over more units on the large market. Economic integration i.e. a decrease of trade costs weakens the importance of a big domestic market and hence, quality increases for the producer on the small market, but decreases for the producer on the big market. These market changes, triggered by a decrease in trade costs, in general influence welfare, since welfare may increase in the small country and decrease in the large country. Secondly, implementation of a minimum quality standard common for the two countries might induce the producer in the small country to raise his quality level and the producer located in the large country to reduce his quality level, if the consumers have strong horizontal preferences. This basic result is identical with the model of Garella, but an additional point appears, if trade costs are reduced. In that case the small country's producer maintains his quality level at the required minimum standard, but the big country's producer will reduce his quality level. The overall effect of economic integration is thus a decrease of the quality level in the industry, while the welfare implications are ambiguous, dependent on the parameters of the model.

The paper is organized as follows. Section 2 presents the basic assumptions and notation of the model. Section 3 derives the price and quality equilibrium on the two partially segmented markets. The effects of market integration are analyzed by comparing the equilibrium for alternative sizes of trade costs. Section 4 introduces a minimum quality standard and analyses for this case of regulation the effects of alternative trade costs. Section 5 analyses the welfare implications of market integration and minimum quality standards. Section 6 concludes.

2. The model

The world consists of two countries, 1 and 2, with one producer of a differentiated product in each. The products are differentiated both vertically and horizontally. Vertically, the quality of the product is characterised by a quality indicator θ (θ≥0). In the horizontal dimension, each consumer has an address or ideal variant characterised by *x,* where *x* = [0,1]. Each consumer is assumed to consume one unit only of the differentiated good and the consumer chooses the variant, which offers the largest utility gain, given by the gross utility of consuming the good minus the costs of acquiring it. These costs consist of the price at the gate of the producer plus trade costs, in case the consumer prefers the foreign good. The consumers in each country are identically distributed with respect to *x* in the interval 0 to 1. However, the two countries might be asymmetrical in size. The number of consumers is normalized to 1 in country 1 and to σ in country 2, and throughout in the following analysis, it is assumed that σ ≥ 1.

The producer's horizontal position is exogenously given contrary to the vertical position, where the quality level is a strategic variable. Horizontally, the producers are assumed to have extreme locations, so a producer is located at 0 in country 1 and at 1 in country 2[1]. Hence, for a consumer at the address *x*, the horizontal distance to the producer in country 1 is *x* and (*1-x*) in country 2, respectively. However, if the consumer demands the foreign good, he incurs the trade costs at *g* per unit. Although the markets are partially segmented by trade costs, it is assumed impossible for the producer to distinguish between domestic and foreign buyers. Each producer therefore charges a uniform price i.e. price discrimination is neglected.

For the consumer in country 1, the utility of consuming one unit of the good produced by the domestic or by the foreign producer is given by the additive separable specification of the vertical and horizontal dimensions[2]:

$$u_{11} = v + \theta_1 - tx - p_1 \qquad (1a)$$

and

$$u_{12} = v + \theta_2 - t(1-x) - p_2 - g \qquad (1b)$$

For a consumer in country 2, the utility of consuming one unit of the foreign good or alternatively the domestic good is given by:

$$u_{2,1} = v + \theta_1 - tx - p_1 - g \qquad (1c)$$

and

$$u_{2,2} = v + \theta_2 - t(1-x) - p_2 \qquad (1d)$$

where *v* is an exogenously given parameter, *t* a parameter for utility loss per unit increase in the horizontal distance between a consumer and a producer, *p* prices for producers and *g* trade cost[3].

[1] D'Aspremont et al. (1979) have shown that two producers choose maximal horizontal distance at the market, if the transport cost or utility loss is a quadratic function of distance. However, in the following we use linear distance costs.

[2] The additive specification of quality in the utility function has been suggested by Mussa and Rosen (1979) and has later been used in several analyses e.g. Tirole (1988). Another specification of quality in the utility function is to use a multiplicative specification, where basic utility depends on consumption of other (non-differentiated) goods, which varies proportionately with the quality indicator of the differentiated good. This alternative specification has been introduced by Gabszewicz and Thisse (1979) and later used by Shaked and Sutton (1982) and Boom (1995), among others.

[3] The specification of the utility function disregards diversity of tastes with respect to quality. In most other papers in this tradition, the effect on utility of quality in the individual utility function is assumed to depend both on a good

We assume that the consumer's attachment to the preferred variant measured by the size of the parameter t is strong (see footnote 5). As appears from the following formal analysis, this assumption secures not only positive solutions for qualities, but also that qualities are strategic substitutes for the two companies.

The producers are assumed to share the same technology and hence, to be symmetrical with respect to cost effectiveness. The variable unit costs are assumed to be independent of quality and constant with respect to quantity produced. Quality is output from the firm's R&D activity. To develop quality the firm incurs sunk costs. The flow equivalent fixed costs to the sunk costs for the firm is assumed to be a quadric function of quality, i.e. the costs functions for the two producers are specified by (2):

$$C_i = cQ_i + \tfrac{1}{2}\theta_i^2; \quad i = 1,2 \qquad (2)$$

where Q_i (i=1,2) is the quantity of the good produced by the two producers and c, variable unit costs.

The model specified above is similar to that of Garella (2003), but extended by including two partially segmented markets.

3. Equilibrium in unregulated markets

This section deals with unregulated markets, defined as markets without a minimum quality standard. The producers use the quality level and price as strategic variables. It is assumed that each producer in a first game chooses his quality level and subsequently chooses price in the second game. The Nash equilibrium is derived by backward induction i.e. by deriving the prices for given qualities, and then determination of qualities.

To simplify, we assume that the two markets are fully covered i.e. each consumer in both countries buys one unit of the good. This is only the case if each consumer gets a positive utility of consuming the good irrespective of the size of the trade barrier, the level of quality and the horizontal address. If the prices are too high, some consumers might find it unattractive to buy. The most unfavourable condition arises, if the trade costs are so high that the markets are completely segmented into two monopoly markets. However, also in this case the horizontally most distant consumer will buy one unit of the domestically produced good of quality zero, if v exceeds $c + 2t$. On a given market, a competitive edge exists between the two producers defined as the location of a marginal consumer, who is indifferent whether to buy the variant from one or the other producer.

In country 1, the competitive edge $\tilde{x}_1$ is determined by:

$$v + \theta_1 - tx - p_1 = v + \theta_2 - t(1-x) - p_2 - g$$

which gives

$$\tilde{x}_1 = \frac{1}{2t}\left[t + (p_2 - p_1 + g) + (\theta_1 - \theta_2)\right] \qquad (3a)$$

Similarly, the competitive edge in country 2 is given by

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specific indicator of quality and a consumer specific parameter related to the weight the consumer puts on quality, see e.g. Tirole (1988).

$$\tilde{x}_2 = \frac{1}{2t}\left[t + \left(p_2 - p_1 - g\right) + \left(\theta_1 - \theta_2\right)\right] \tag{3b}$$

Total demand for product 1 and 2, Q_1 and Q_2, respectively, is given by:

$$\begin{aligned} Q_1 &= \tilde{x}_1 + \sigma\tilde{x}_2 \\ &= \frac{1}{2t}\left[\left(1+\sigma\right)t + \left(1+\sigma\right)\left(p_2 - p_1\right) - \left(\sigma - 1\right)g + \left(1+\sigma\right)\left(\theta_1 - \theta_2\right)\right] \end{aligned} \tag{4a}$$

and:

$$\begin{aligned} Q_2 &= (1-\tilde{x}_1) + \sigma(1-\tilde{x}_2) \\ &= \frac{1}{2t}\left[\left(1+\sigma\right)t - \left(1+\sigma\right)\left(p_2 - p_1\right) + \left(\sigma - 1\right)g - \left(1+\sigma\right)\left(\theta_1 - \theta_2\right)\right] \end{aligned} \tag{4b}$$

Profits, π_i, for the two producers are given by:

$$\pi_i = \left(p_i - c\right)Q_i - ½\theta_i^2 \quad ; i = 1,2 \tag{5}$$

The producers are assumed to play Bertrand, maximizing profit with respect to the price of the producer's own product, given the price of the competitor's product. Inserting (4a) and (4b) in (5) and maximizing each producer's profit with respect to his own price, gives the following *price reaction functions* for the producer in country 1 and 2, respectively:

$$p_1 = \frac{1}{2}\left[p_2 - \frac{\left(\sigma - 1\right)g}{(1+\sigma)} + \left(\theta_1 - \theta_2\right) + \left(t + c\right)\right] \tag{6a}$$

$$p_2 = \frac{1}{2}\left[p_1 + \frac{\left(\sigma - 1\right)g}{(1+\sigma)} - \left(\theta_1 - \theta_2\right) + \left(t + c\right)\right] \tag{6b}$$

Solving (6a) and (6b) with respect to prices gives Bertrand equilibrium:

$$p_1 = \frac{1}{3}\left[-\frac{\left(\sigma - 1\right)g}{(1+\sigma)} + \left(\theta_1 - \theta_2\right) + 3\left(t + c\right)\right] \tag{7a}$$

and

$$p_2 = \frac{1}{3}\left[\frac{\left(\sigma - 1\right)g}{(1+\sigma)} - \left(\theta_1 - \theta_2\right) + 3\left(t + c\right)\right] \tag{7b}$$

Using (7a) and (7b) in (4a) and (4b) gives the quantity demanded or output in equilibrium:

$$Q_1 = \frac{1}{6t}\left[3\left(1+\sigma\right)t - \left(\sigma - 1\right)g + \left(1+\sigma\right)\left(\theta_1 - \theta_2\right)\right] \tag{8a}$$

and

$$Q_2 = \frac{1}{6t}\left[3\left(1+\sigma\right)t + \left(\sigma - 1\right)g - \left(1+\sigma\right)\left(\theta_1 - \theta_2\right)\right] \tag{8b}$$

The results (7a), (7b), (8a) and (8b) allow us to deal with the first game: determination of quality levels. Profits in the Bertrand equilibrium are given by (5). Maximizing π_1 with respect to θ_1 and π_2 with respect to θ_2 by using (7a), (7b), (8a) and (8b) gives the *quality reaction function* for the producer in country 1 (R_1):

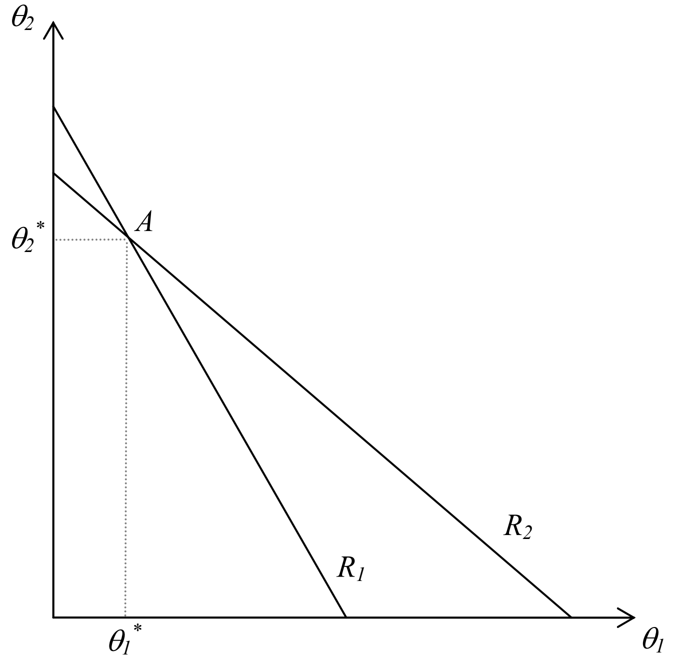
$$\theta_1 = \frac{1}{(9t-(1+\sigma))}\left[-(1+\sigma)\theta_2-(\sigma-1)g+3(1+\sigma)t\right] \quad (9a)$$

and the quality reaction function for the producer in country 2 (R_2):

$$\theta_2 = \frac{1}{(9t-(1+\sigma))}\left[-(1+\sigma)\theta_1+(\sigma-1)g+3(1+\sigma)t\right] \quad (9b)$$

Figure 1 illustrates the quality reaction function R_1 and R_2 and the resulting Nash equilibrium A.

Figure 1: Quality reaction functions and Nash equilibrium



Solving (9a) and (9b) gives the quality levels in Nash equilibrium:[4]

$$\theta_1^* = \frac{1+\sigma}{3} - \frac{(\sigma-1)}{\left(9t-2(1+\sigma)\right)}g \quad (10a)$$

$$\theta_2^* = \frac{(1+\sigma)}{3} + \frac{(\sigma-1)}{\left(9t-2(1+\sigma)\right)}g \quad (10b)$$

The prices and output in Nash equilibrium are derived by inserting (10a) and (10b) into (7a) - (8b). This gives:

$$p_1^* = t + c - \frac{3(\sigma-1)t}{(1+\sigma)\left(9t-2(1+\sigma)\right)}g \quad (11a)$$

[4] We only look at cases of strong preferences for the consumers' preferred variant. Specifically, t is assumed to exceed $\frac{2}{9}(1+\sigma)+\frac{1}{3}(\sigma-1)g$. This condition secures negatively sloped reaction functions as well as solutions with positive quality levels.

$$p_2^* = t + c + \frac{3(\sigma - 1)t}{(1+\sigma)(9t - 2(1+\sigma))} g \tag{11b}$$

$$\begin{aligned} Q_1^* &= \frac{1}{2}\left[(1+\sigma) - \frac{3(\sigma-1)}{(9t-2(1+\sigma))} g\right] \\ &= \frac{3}{2}\theta_1^* \end{aligned} \tag{12a}$$

and:

$$\begin{aligned} Q_2^* &= \frac{1}{2}\left[(1+\sigma) + \frac{3(\sigma-1)}{(9t-2(1+\sigma))} g\right] \\ &= \frac{3}{2}\theta_2^* \end{aligned} \tag{12b}$$

Using these results, the profits in Nash equilibrium for the two companies are given by:

$$\begin{aligned} \pi_1^* &= (p_1^* - c)Q_1^* - \frac{\theta_1^{*2}}{2} \\ &= \frac{9t - (1+\sigma)}{18(1+\sigma)}\left[-\frac{3(\sigma-1)}{(9t-2(1+\sigma))} g + (1+\sigma)\right]^2 \\ &= \frac{(9t-(1+\sigma))}{2(1+\sigma)}\theta_1^{*2} \end{aligned} \tag{13a}$$

$$\begin{aligned} \pi_2^* &= (p_2^* - c)Q_2^* - \frac{\theta_2^{*2}}{2} \\ &= \frac{9t - (1+\sigma)}{18(1+\sigma)}\left[-\frac{3(\sigma-1)}{(9t-2(1+\sigma))} g + (1+\sigma)\right]^2 \\ &= \frac{(9t-(1+\sigma))}{2(1+\sigma)}\theta_2^{*2} \end{aligned} \tag{13b}$$

Given the restricted values of t (see footnote 5), both firms earn positive profits and the *rank* of profits coincides with the rank of qualities.

The producer on the large market delivers the variant with the highest quality. Quality requires fixed costs, and easy access to the large market therefore gives this producer a competitive advantage in quality development relative to the producer located on the small market. For the same reason, price and output are also larger for the producer at the large market compared with the producer on the small market. Since the two countries are exchanging products within the same industry, we observe in equilibrium intra-industry trade in vertically differentiated products, but at the same time also an exchange of products that are differentiated horizontally, for which reason disentangling intra-industry trade into a horizontal and a vertical part is impossible.[5] The unregulated scenario described above implicitly assumes a system of mutual recognition of national standards, meaning that the two government set standards for their national industries only, while recognizing the adequacy of foreign standards on imported products.

Market integration

The model allows for an examination of the effects on qualities, prices and output levels of economic integration i.e. a decrease of trade costs, g. For σ>1 it follows from (10a)-(13b) that:

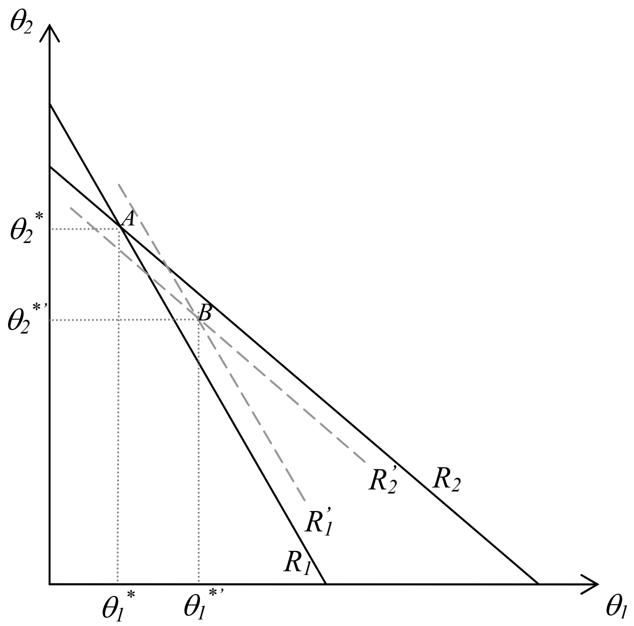
$$\frac{\partial \theta_1^*}{\partial g}, \frac{\partial p_1^*}{\partial g}, \frac{\partial Q_1^*}{\partial g}, \frac{\partial \pi_1^*}{\partial g} < 0$$

where as:

$$\frac{\partial \theta_2^*}{\partial g}, \frac{\partial p_2^*}{\partial g}, \frac{\partial Q_2^*}{\partial g}, \frac{\partial \pi_2^*}{\partial g} > 0$$

Figure 2 illustrates the effect on quality of a decrease in trade costs.

Figure 2: Market integration and product qualities on the unregulated markets



[5] In empirical trade studies on intra-industry trade disentangling trade in horizontally and vertically differentiated products, the dominant methodology has been to divide a given product group into *either* horizontal *or* vertical intra-industry trade by comparing unit values for exports and imports, see e.g. Greenaway et al. (1994). Within many product groups (or industries) there may at the same time be trade in horizontally as well as vertically differentiated goods between countries. Look e.g. at trade in cars between Germany and South Korea. On average, it is reasonable to assume that German cars are of a higher quality than Korean cars. But at the same time, there may be a number of Korean producers producing car models at a similar quality level from which German consumers may choose depending on their preferences (ideal variants in Lancaster terms). There seems therefore to be a good reason in trade theory to combine the horizontal and vertical dimension in product differentiation as is done in our model. This may open up for better empirical studies on intra-industry trade.

The relative advantage of being located on the large market weakens, when trade costs decrease. Qualities, prices and output levels therefore converge between the two countries, when market integration is deepened.

4. Minimum quality standards

We now assume that the two countries introduce a common minimum quality standard $\overline{\theta}$ [6]. It is assumed that $\theta_1^* < \overline{\theta} < \theta_2^*$ i.e. the minimum quality standard will force the low quality producer to raise the quality of his product. However, the compulsory change of the product quality of the low quality producer will induce the high quality producer to change his quality. As qualities are strategic substitutes, the high quality producer will be induced to *reduce* his quality. Formally, this follows from inserting $\theta_1 = \overline{\theta} > \theta_1^*$ into (9b) which gives:

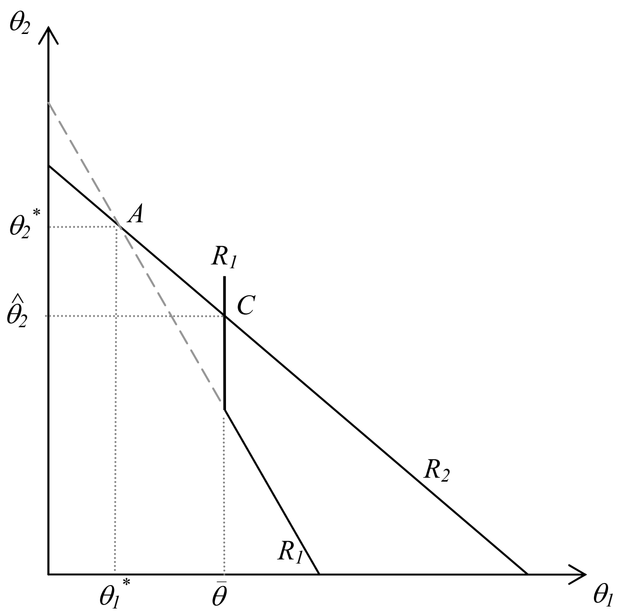
$$\hat{\theta}_2 = \frac{1}{(9t-(1+\sigma))}\left[-(1+\sigma)\overline{\theta} + (\sigma-1)g + 3(1+\sigma)t\right] \qquad (14)$$

This can be compared with the quality level in Nash equilibrium in the unregulated market given by (9b) for $\theta_1 = \theta_1^*$, i.e.:

$$\hat{\theta}_2 = (1+\sigma)(\overline{\theta} - \theta_1^*) + \theta_2^* < \theta_2^* \qquad (15)$$

Graphically, the impacts of implementation of a minimum quality standard on quality levels are illustrated in *Figure 3*.

Figure 3: Impacts of a minimum quality standard



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[6] A minimum standard may be interpreted as "full harmonization", where a common minimum standard is introduced in the two countries that are members of a community, like e.g. the EU. The reason for introducing the minimum standard may be a common belief in the countries that producing a product below a given level of "quality" creates unnecessary health and/or environmental risk for consumers.

The Nash Equilibrium is illustrated by the set of qualities in A. Implementation of a minimum quality standard changes equilibrium to C. The minimum quality standard can be perceived as a Stackelberg game, where the low quality producers (involuntarily) become Stackelberg leader, leaving the role of Stackelberg follower to the high quality producer.

Prices, output levels and profits follow from inserting $\theta_1 = \bar{\theta}$ and $\theta_2 = \hat{\theta}_2$ into (7a), (7b), (8a), (8b) and (5). Inspection of the results reproduced in appendix A shows that:

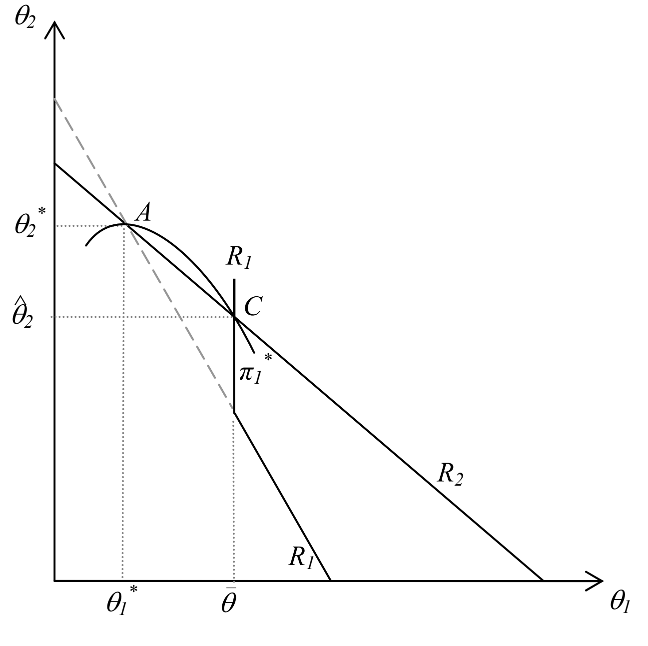
$$\frac{\partial \hat{p}_1}{\partial \bar{\theta}}, \frac{\partial \hat{Q}_1}{\partial \bar{\theta}} > 0$$

and

$$\frac{\partial \hat{p}_2}{\partial \bar{\theta}}, \frac{\partial \hat{Q}_2}{\partial \bar{\theta}} < 0$$

The compulsory increase of the quality level for the low quality producer raises his price and output level, but lowers the price and output level of the high quality producer. The effects on profits are more complicated to analyze, but may easily be captured by a graphical analysis of the iso-profit curves in quality space, see *Figure 4*.

Figure 4: Minimum quality standards and profits



The figure illustrates the special case, where the size of the minimum quality standard results in the regulated equilibrium C, which also contains the iso-profit curve in Nash equilibrium for the low quality producer (π_1^*). The profit of the low quality producer is thus in this case unaffected by the implementation of the minimum quality standard $(\pi_1^* = \hat{\pi}_1)$. It follows straight forward that $\hat{\pi}_1$ (profit with minimum quality standard) exceeds π_1^* (profit without) for all iso-profit curves for producer 1, which cut or are tangent to R_2 in the interval between θ_1^* and $\bar{\theta}$. A mild minimum quality standard close to the unregulated quality level of the low quality producer thus raises his profit, contrary to a severe minimum quality standard, which will harm the profit of the low quality producer. The high quality producer will unambiguously loose profit from an implementation of a minimum standard.

Market integration

The model also allows for an analysis of the effects of market integration, i.e. a decrease of g, in case of an existing minimum quality standard. From (14) and the results in the Appendix A, we have for modest changes in the trade barrier (*g*):

$$\frac{\partial \hat{\theta}_1}{\partial g} = 0; \frac{\partial \hat{p}_1}{\partial g}, \frac{\partial \hat{Q}_1}{\partial g} < 0$$

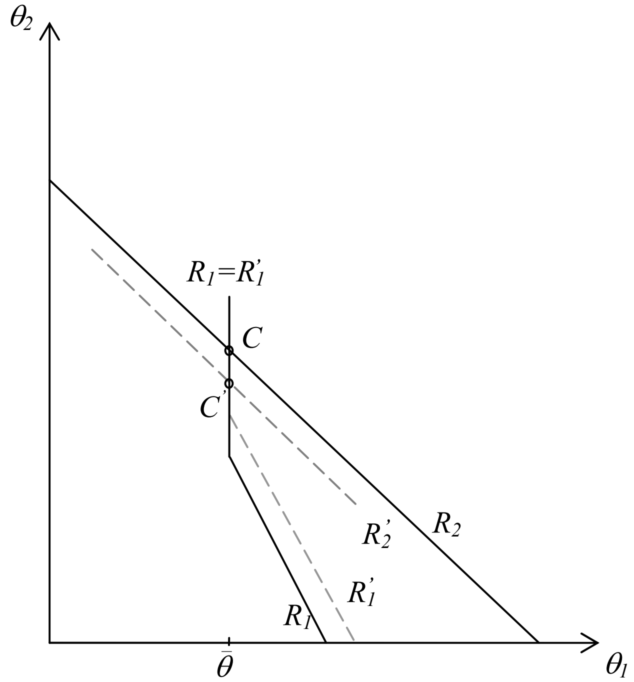
and:

$$\frac{\partial \hat{\theta}_2}{\partial g}, \frac{\partial \hat{p}_2}{\partial g}, \frac{\partial \hat{Q}_2}{\partial g} > 0$$

Market integration will reduce the quality of the product of the high quality producer, but leave quality unchanged for the low quality producer, as he is forced to produce to the minimum standard. The overall effect is thus a decrease of average product quality on the market.

Figure 5 illustrates the effects of integration, when markets are initially regulated. The decrease of the trade barrier moves the reaction curve of the high quality producer inwards from R_2 to R_2' and the segment of the reaction curve of the low quality producer outwards from R_1 to R_1'. If the decline of trade costs is relatively modest, the minimum quality standard will still be binding for the low quality producer and equilibrium changes from C to C'.

Figure 5: Market integration and minimum quality standard



The decline of the trade barrier and the induced effects of this on the quality of the high quality producer will increase the price and output level of the low quality producer, but lead to a decrease of the price and output level of the high quality producer.

It is interesting to notice that introduction of a minimum quality standard and market integration through a decrease of trade costs (g) changes the qualities of the two products in the same direction. Thus liberalisation in trade restrictions reduces the need for minimum standards and in that sense trade liberalisation and minimum quality standards are policy substitutes. However, the two policies differ in relative impacts on qualities. If the policy maker has the goal to raise quality of the low quality producer to $\overline{\theta}$, see figure 3, trade policy liberalisation results in a lower quality level of the high quality good than a minimum quality standard does.

5. Welfare implications

This section deals with the welfare implications of market integration and minimum quality standards. The expressions for welfare in each of the two countries, with and without minimum quality standards, are complex without specific assumptions, and the following analysis is therefore restricted to special cases.[7]

a. No quality regulation

Market integration increases welfare in both countries if the countries are of nearly the same size. If the countries are very asymmetrical in size, market integration increases welfare in the small country, but if the trade barrier is high there might be cases, where welfare in the large country decreases. The two cases will be analysed more closely in the following.

Welfare in country 1, W_1, consists of producer surplus, π_1, and consumer surplus, CS_1, i.e. consumer surplus of consumption of domestically produced goods, CS_{11}, and of foreign produced goods CS_{12}. Hence, we have

$$\begin{aligned} W_1 &= CS_1 + \pi_1 \\ &= CS_{11} + CS_{12} + \pi_1 \end{aligned} \qquad (16)$$

Producer surplus is given by (13a). Consumer surplus can be calculated from:

$$\begin{aligned} &CS_{11} + CS_{12} \\ &= (v + \theta_1^* - ½t\tilde{x}_1 - p_1^*)\tilde{x}_1 + (v + \theta_2^* - ½t(1 - \tilde{x}_1) - ½g - p_2^*)(1 - \tilde{x}_1) \end{aligned}$$

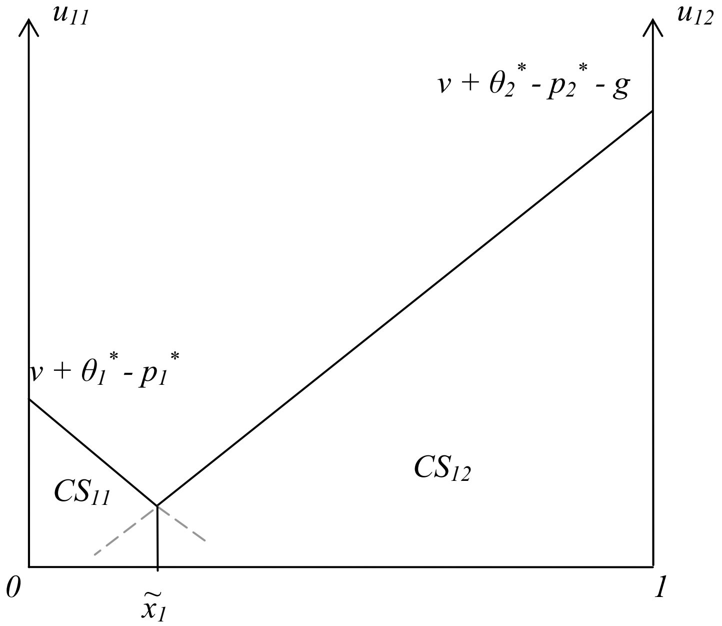
where $\tilde{x}_1$ *is* given by (3a) for $\theta_i = \theta_i^*$ (i=1,2), i.e.: (17)

$$\tilde{x}_1 = \frac{1}{2t}\left[t + \left(p_2^* - p_1^* + g\right) + \theta_1^* - \theta_2^*\right]$$

Figure 6 illustrates consumer surplus by the areas of the two trapeziums (CS_{11} and CS_{12}).

[7] The welfare effects analysed in the following are concentrated on consumer and producer welfare, implicitly assuming absence of different types of externalities. This may conflict with the idea of introducing a minimum quality level, typically motivated by health and safety reasons related to production and consumption.

Figure 6: Consumer surplus in country 1



For country 2 producer surplus is given by (13b) and for consumer surplus similar expressions to (17) i.e.:

$$CS_{21} + CS_{22}$$
$$= \sigma\left[(v+\theta_1^* - ½t\tilde{x}_2 - ½g - p_1^*)\tilde{x}_2 + (v+\theta_2^* - ½t(1-\tilde{x}_2) - p_2^*)(1-\tilde{x}_2)\right] \quad (18)$$
where $\tilde{x}_2$
$$\tilde{x}_2 = \frac{1}{2t}\left[t + \left(p_2^* - p_1^* - g\right) + \theta_1^* - \theta_2^*\right]$$

Inserting the Nash equilibrium for quality and prices, i.e. (10a)-(11b), determines consumer surplus in each of the two countries as functions of the parameters in the model. However, the resulting expressions are complex, and hence only special cases will be analysed in the following.

Case 1: Nearly symmetric countries (σ≈1)
In case of symmetry, qualities, prices, output levels and profits are equal and independent of the trade barrier in Nash equilibrium, see (10a) - (13b) for $\sigma = 1$, which imply $\theta_1^* = \theta_2^* = 2/3$ and $p_1^* = p_2^*$. Inserting this into (17) - (18) determines consumer surplus in each of the two countries, i.e.:

$$CS_1 = CS_2$$
$$= (v + \frac{2}{3} - \frac{5}{4}t - c) - \frac{g}{4} \quad . \quad (19)$$

i.e. market integration increases consumer surplus in both countries. As profit in the symmetrical case is constant and independent of the size of the trade barrier, the overall welfare effect of market integration is positive for both countries. In other words, the consumers are able to turn the whole cost saving from a decline of trade costs into more consumer surplus leaving profit unchanged for both companies.

Case 2: Asymmetric countries and large initial trade barriers
In the general case of different sizes of the countries, market integration will raise the profit for the producer in the small country, but lower the profit for the producer in the large country, see (13a) and (13b). The consumers are affected by the effects on quality, price and for the foreign produced good, also by the decrease of trade costs.

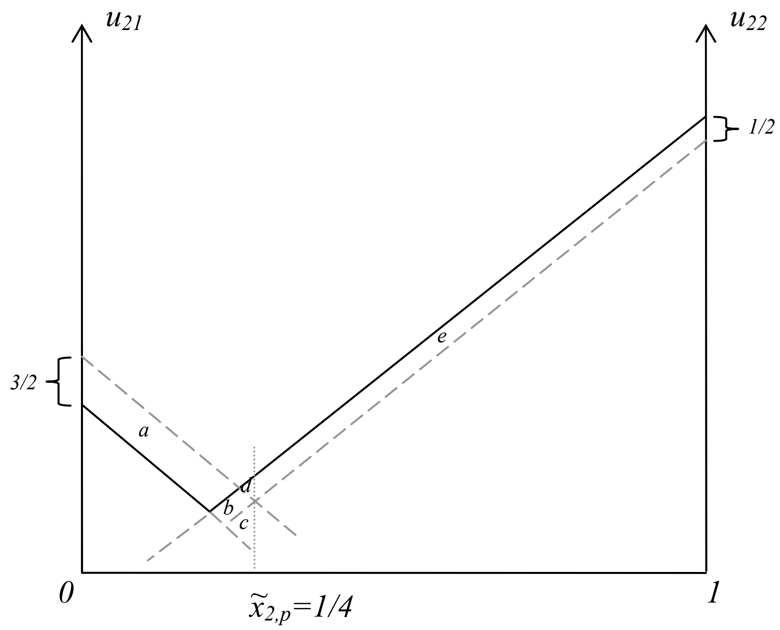
In, admittedly, rare cases of very high trade costs, consumer surplus in the large country might also decrease and hence, the net welfare effect in this country is negative. To illustrate this point the effects on consumer surplus in country 2, CS_2, of a decrease of the trade costs are illustrated in *Figure 7* for $t = 1$ and $\sigma = 3$, which imply:

$\delta\theta_1^* / \delta g = -2, \quad \delta p_1^* / \delta g = -3/2, \quad \delta\theta_2^* / \delta g = 2,$ and $\delta p_2^* / \delta g = 3/2,$ confer (12a)-(13b).

Market integration therefore has the following effect on the two groups of consumers:

$-\delta u_{21}/\delta g = -\delta\theta_1{}^*/\delta g + \delta p_1{}^{*}/\delta g + 1 = 3/2$ and $-\delta u_{22}/\delta g = -\delta\theta_2{}^*/\delta g + \delta p_2{}^{*}/\delta g = -½.$

Figure 7: Market integration and consumer surplus in country 2



Assume that the trade barrier, *g,* decreases from the relatively high level to ¼. i.e. the competitive edges in the two countries *after* the decrease of the trade barrier are given by:

$$\tilde{x}_{1,p} = \frac{1}{2t}\left[t + (p_2^* - p_1^* + g) + (\theta_1^* - \theta_2^*)\right] = \frac{1}{2}$$

$$\tilde{x}_{2,p} = \frac{1}{2t}\left[t + (p_2^* - p_1^* - g) + (\theta_1^* - \theta_2^*)\right] = \frac{1}{4}$$

In the illustrated case, the winners among the consumers gain the area *a,* and the losers face the loss (*d* +*e*) i.e. the net change in consumer surplus is (*a* – *d* – *e*). This is definitely negative as (*a* + *b* +

c) = e = 1/8. Both consumer surplus and profit therefore decrease in country 2 and so does welfare. Using the same parameters for country 1, it is easily demonstrated that all consumers in country 1 benefit from a decrease in trade costs and as profit, welfare also increases unambiguously.

b. Minimum quality standards

The conclusions about the welfare effects of minimum quality standards are ambiguous for both countries. In the following, we only look at a mild quality standard i.e[8].

$\theta_1^* < \overline{\theta}$ but $(\overline{\theta} - \theta_1^*)$ is small.

It follows from the analysis related to Figure 4 that

$\frac{\delta\hat{\pi}_1}{\delta\overline{\theta}} > 0$ and $\frac{\delta\hat{\pi}_2}{\delta\overline{\theta}} < 0$

Using (1a) – (1b), (15) and (A.1a) and (A.1.b) in appendix A, the effects on consumer surplus for consumers buying the good produced in country 1 and country 2 respectively of a marginal increase of the minimum quality standard, are given by:

$$\frac{\delta CS_{11}}{\delta\overline{\theta}} = \frac{\delta CS_{21}}{\delta\overline{\theta}} = 1 - \frac{\delta\hat{p}_1}{\delta\overline{\theta}} = \frac{6t-(1+\sigma)}{(9t-(1+\sigma)}$$
$$\frac{\delta CS_{12}}{\delta\overline{\theta}} = \frac{\delta CS_{22}}{\delta\overline{\theta}} = \frac{\delta\hat{\theta}_2}{\delta\overline{\theta}} - \frac{\delta\hat{p}_2}{\delta\overline{\theta}} = \frac{3t-(1+\sigma)}{(9t-(1+\sigma)} \qquad (20)$$

Note that the effects for each consumer are the same across countries.

If the difference of size of the countries is not too large (σ less than 2) and for t=1, $\delta CS_{ij} / \delta\overline{\theta}$ (i,j =1,2) are all positive, i.e. the small country will definitely experience a positive welfare effect as both profit and consumer surplus increases. For country, 2 the welfare effect is ambiguous, as profit decreases, but consumer surplus increases.

If large differences in size of countries exist (σ larger than 2) and t=1, the effects for consumers, who prefer the good from country 2 are negative as the quality deterioration is only partially matched by a lower price. If the trade barrier is high, most of the consumers in country 2 buy their locally produced good. In that case, total consumer surplus and hence, total welfare might decrease in this country.

6. Conclusions

This paper has analyzed the effects of market integration on the level of quality of products and welfare of countries, both in cases with no regulation of quality, and regulation through a minimum

[8] To be more precise, the profit for the low quality producer is maximized for a minimum quality standard $\overline{\theta}_{\max}$,where the iso-profit curve of the producer in the small country is tangent to the quality reaction function for the producer from country 2, i.e. $\overline{\theta}_{\max}$ is larger than θ_1^*, but less than the indicated minimum quality standard corresponding to the point C in Figure 4. A mild regulation characterizes in the following, a minimum quality standard in the interval $\theta_1^* < \overline{\theta} < \overline{\theta}_{\max}$.

standard. The theoretical framework is an international trade model with imperfect competition (duopoly), where products are both vertically and horizontally differentiated, and where international markets are segmented through real trade barriers. Because of scale economies related to quality, country size matters, so the large country will develop and produce high quality products relative to the products from the small country. Welfare will also be higher in the large country. Market integration will weaken this advantage of the large country, as a decrease of trade costs twists the quality levels and welfare in favour of the small country. Furthermore, it is shown that in case of implementation of a minimum quality standard, which forces the low quality producer from the small country to increase the quality level, the producer from the large country reacts strategically by lowering the quality level of his product, but the welfare effects by introduction of minimum quality standards are ambiguous depending on the parameters of the model.

It is shown that market integration affects the structure of qualities similar to implementation of a minimum quality standard. In this, sense market integration and implementation of a minimum quality standard are policy substitutes. The model also sheds some light on effect on quality of discriminatory trade liberalization. Creating a large internal market free of trade barriers between a subset of small countries will transform these small markets to one big market. This will stimulate quality development for firms located here. In contrast, firms located in third party countries react by lowering the qualities of their products.

However, before firm policy conclusions can be drawn, future research has to clarify the sensitivity of the results to other reasonable specifications of the model. The market structure, the competitive game between the producers and the entry barriers for producers might be specified differently with important implications for the conclusions. This paper therefore only claims to present the results of a specific modelling of this issue.

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Appendix A: Minimum quality standards, prices and output levels

Inserting $\theta_1 = \overline{\theta}$ and $\theta_2 = \hat{\theta}$ given by (14) into (7a) and (7b) gives the prices on the regulated market:

$$\hat{p}_1 = -\frac{(\sigma-1)}{3(1+\sigma)}g + \frac{(\overline{\theta}-\hat{\theta}_2)}{3} + t + c$$
$$= \frac{1}{(9\text{t-}(1+\sigma))}\left[3t\overline{\theta} - \frac{3t}{(1+\sigma)}g + (9t-2(1+\sigma))t\right] + c \qquad \text{(A1a)}$$

$$\hat{p}_1 = \frac{(\sigma-1)}{3(1+\sigma)}g + \frac{\overline{\theta}-\hat{\theta}_2}{3} + t + c$$
$$= \frac{1}{(9\text{t-}(1+\sigma))}\left[-3t\overline{\theta} + \frac{3t}{(1+\sigma)}g - 9t^2\right] + c \qquad \text{(A1b)}$$

Note that $\hat{p}_1 > p_1^*$ and $\hat{p}_2 < p_2^*$ as $\theta_1^* < \overline{\theta} < \theta_2^*$, see (7a) and 7(b).