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ECONOMIC INTEGRATION IN VERTICALLY DIFFERENTIATED MARKETS

By

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Abstract

We analyze trade liberalization in a vertically differentiated market with free entry. We consider two asymmetric countries each having a uniform income distribution of different width and density. Income distributions have common origin, so the "wider" country is also "richer", having higher average income.

In the short run integration increases prices in the smaller country while it lowers those in the larger country *(pure price effect).*

In the long run, when the fixed cost is *quality - specific,* the lower quality always increases in the smaller country while in the larger country it may increase or decrease. The price of the lower quality falls in both countries, despite quality improvements.

The price of the high quality, a) for high (low) levels of the fixed cost increases in the small (large) country while it decreases in the large (small) country, b) for intermediate levels of the fixed cost, falls in both countries (JEL Classification : L13, F12).

Key **Words:** Vertical Differentiation, International Trade, Asymmetric Countries.

1. Introduction

In the context of differentiated products, the impact of trade liberalization -or as in the EEC case economic integration- on welfare can be distilled into two questions:[1] supposing that two initially separated economies are joined via free trade, *a)* with unchanged product specifications (short run), how is the increased competition going to affect consumer welfare, and *b)* what

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will be the overall impact of changes in product specifications on consumer welfare? The second question addresses the long run impact of economic integration. Changes in the range of available products not only affect consumers directly, they also imply further changes in prices.

In this paper we analyze the impact of trade liberalization in a vertically differentiated market with free entry. We consider two asymmetric countries characterized by two different income distributions. Income distributions have common origin, so the "wider" country is also "richer", having higher average income. Our purpose is to characterize equilibrium price and quality changes due to the enactment of a free trade policy, relative to each country's autarkic situation. We use a model where the preference-marginal cost structure determines an upper bound to the number of firms, independent of the level of fixed cost *{finiteness property)}* In both markets in autarky, as well as in the integrated market, we consider this upper bound equal to two (natural duopolies). In our analysis, the nature of the fixed cost turns out to be of crucial importance.

Trade liberalization in the presence of the finiteness property is also examined in Shaked and Sutton (1984) where it is shown that when two countries which are joined via trade have income distributions of similar width, the number of firms in the integrated market will be reduced.[3] With product specifications unaffected (short run), free trade will induce no change in prices or consumer surplus.[4] The latter increases in the long run if fixed cost increases with quality. In this case, the larger number of consumers per firm in the integrated economy increases the returns to quality improvements, thus inducing firms in the integrated market to produce higher qualities than in autarky. Our work re-examines these issues assuming asymmetric countries with respect to the width of their income distribution.

Long run quality changes with asymmetric countries were first considered in Motta (1992). Central in that analysis lies the observation that, since the finiteness property implies a reduction to the number of firms, the nationality of the surviving firms is important in order to assess each country's gains from trade. However, in Motta's model, product differentiation is only a transitory phenomenon, all products being homogeneous in a long run equilibrium.[3] Moreover, absent quality changes, the prices in the integrated market would be the same as in autarky. As in Shaked and Sutton (1984), quality improvements are due to the larger size of the integrated economy which generates increasing returns to investments in quality. In a more recent contribution, Motta *et al.* (forthcoming), look at country asymmetries in order to identify the quality leader in the integrated market.

In our long run analysis we abstract from the above mechanism by assuming that the level of the fixed cost is independent of the quality produced. This assumption allows us to focus on quality changes that are due to strategic considerations of the lower quality *vis-a-vis* potential entrants. While in many cases the fixed cost may be sunk upon entry but unaffected by subsequent quality changes (e.g., general set-up costs), in other instances the start-up cost is *quality-specific,* in that it needs to be paid a new every time the firm decides to change its quality (e.g., product-specific advertising, R&D for a new product, or the cost of a patent). Hence, an incumbent can no longer respond to entry by altering his own quality. Unlike the previous case, at the moment a potential entrant decides entry, he knows not only how many firms are in the market, but also their (irreversibly chosen) quality level. Surprisingly, the *quality-specific* fixed cost, while sunk, has no commitment value for a lower quality firm. This is due to the natural duopoly assumption: in equilibrium, if a third firm introduces a product of better quality than that of the low quality incumbent, the latter's market share will be reduced to zero, no matter how aggressive his price response is. Hence, the incumbent has no threats that the sunkness of the fixed cost can make credible. Only producing a quality as close to the high quality as the nonnegative profit condition allows can protect one from further entry.

Size effects -absent in the case of *entry-specific* cost- enter the determination of the lower quality, since higher revenues raise the zero profit level of the lower quality. This result is reminiscent of the "endogenous sunk cost" mechanism in Shaked and Sutton (1987), where increases in the size of the economy result in higher equilibrium qualities by increasing the returns to quality improvements.[6] Here, however, improvements of the lower quality product are due to increased entry threats which, because of higher firm revenues in the integrated market, reduce differentiation between the top two qualities. Thus, the choice of the lower quality depends on income distribution parameters even if the fixed cost is not increasing in quality.

We show that with *quality-specific* fixed cost, free trade always increases the lower quality in the smaller country while its corresponding effect on the larger country is ambiguous: it may reduce the low quality when both

We consider only two goods: a differentiated product and a homogeneous commodity which plays the role of a Hicksian numéraire. On the demand side we assume two separate economies E^j, $j=L,S$, each of them composed of a continuum of consumers with identical preferences but differing incomes. Consumers in any of the two countries are uniformly distributed with respect to their income over the support $[a_j,b_j]$ with density d_j, where $j=L,S$. We assume that $a_L=a_S=a$ and $b_L>b_S$, so country E^L(E^S) can be termed the "large" ("small") country.[8] Greek letters denote normalized values of income distribution parameters, so $\beta_j=b_j/a$ and $\delta_j=d_j/(d_S+d_L)$.

Preferences are identical not only within each country but also between countries. Each consumer has a perfectly inelastic demand, so they can buy either one unit of the differentiated product or none at all; the remainder of their income is spent on the numéraire. The utility function of a typical consumer with income y assumes the following form

$U=u_i(y-p_i)$ or $U=u_R.y$ (1)

The first expression in (1) holds if the consumer buys one unit of quality u_i, $i=1,2,...,n$, at price p_i, where u_i, is a decreasing index of quality, *i.e.*, $u_1>u_2>...u_i...>u_n$; the second holds in the case of no purchase. The quality levell $u_R<u_i$ represents the *reservation quality*, i.e., a quality level below which the consumer does not buy the product even if it is available for free.

On the supply side, we assume that all the firms have access to an identical technology described by the feasible quality range $[u,\bar{u}]$, a fixed cost F independent of quality, and zero variable cost.

The model at hand is one of *vertical differentiation* in that, if any two qualities are available at prices reflecting their average variable costs (here taken to be zero), consumers' choice over these qualities is unanimous. In this context, Gabszewicz and Thisse [1979] and Shaked and Sutton [1982], [1983] have shown the presence of the *finiteness property*, according to which there exists an upper bound to the number of products that can obtain a positive market share in a Bertrand-Nash equilibrium.[9] The finiteness property allows the characterization of markets as *natural oligopolies* according to the width of the income distribution. In this study we assume that $2a<b_j<4a, j=L,S$, which according to Lemma 2 in Shaked and Sutton [1982] implies that, unless fixed costs are too high, exactly two firms can enter in each of the national markets; the shares of these firms will cover the entire market.[10]

Demands are chain linked so they an be represented as $M_{1j}=d_j(b_j-t_j)$, and $M_{2j}=d_j(t_j-a)$, where t_j represents the income of the consumer in country j who is just indifferent between u_{1j} and u_{2j}. Thus, t_j is defined by the expression $u_{1j}(t_j-p_{1j})=u_{2j}(t_j-p_{2j})$,

which yields:

$t_j=r_jp_{1j}+(1-r_j)p_{2j}$ (2)

where $r_j=u_{1j}/(u_{1j}-u_{2j})$, $j=L,S$.

The situation is modeled as a three-stage game. In the first stage all the firms simultaneously announce their quality level. In the second stage they decide simultaneously on whether to sink the fixed cost and produce the previously selected quality, having observed the quality choice of all their rivals. In the last stage active firms compete in prices. A player's strategy $s_i=\{u_i,w_i,q_i\}$, $i=1,2,e$ consists of choosing a $u_i \in [u_R, \overline{u}]$, a function w_i: $[u_R, \overline{u}]^3$-({0,1} and a function p_i: $[u_R, \overline{u}]^3$ x $\{0,1\}^3$-R_+. His payoff function is $\pi_i=R_i(u_i,p_i)-F$.

$$R_{ij}=p_{ij}M_{ij},\ i=1,2,\ j=L,S. \tag{3}$$

Differentiating the four expressions in (3) and solving for the optimal prices obtains

$$p_{1j} = \frac{2b_j-a}{3}.\frac{1}{r_j}, \qquad p_{2j} = \frac{b_j-2a}{3}.\frac{1}{r_j-1} \tag{4}$$

$j=L,S.$[11] Substituting these prices into expression (2) yields the equilibrium value for t

$$t_j = \frac{b_j+a}{3},\ j=L,S. \tag{5}$$

Lemma 1: *Economic integration is allocationally equivalent to a single economy where consumers are distributed uniformly over* $[a,b_I]$ *with density* $d_I=(d_L+d_S)$, *where* $b_I=(\delta_L b_L+\delta_S b_S)$.

Proof: In Constantatos [1999] it is shown that the expressions for the equilibrium values of p_{1I}, p_{2I} and t_I are similar to those in (4) and (5) with the subscript j replaced by I for the integrated market.

The implication of Lemma 1 is that for given qualities, firms choose their prices in the integrated economy as if they were serving an *average* economy. The price ratio between free trade and autarky can be written as

$$W_{ij} \equiv p_{iI}/p_{ij}=A_{ij}B_{ij},\ i=1,2,\ j=S,L, \tag{6}$$

where $A_{1j} \equiv (2\beta_I-1)/(2\beta_j-1)$, $A_{2j} \equiv (\beta_I-2)/(\beta_j-2)$, $B_{1j} \equiv (r_j/r_i)$, and $B_{2j} \equiv (r_j-1)/(r_I-1)$. The A terms represent a *pure price effect*, which is present even when free trade does not affect quality specifications. They are due to the introduction of asymmetries in the width of the income distribution of the two countries:if $\beta_S=\beta_L=\beta_I$ then all the A's are equal to one. The B terms increase with product differentiation in the integrated market. If trade reduces *product differentiation* the B terms are less than one tending to lower W's.

$$R^j_1{}^*(u^j_1,u^j_2) = \frac{d_j(2b_j-a)^2}{9}.\frac{1}{r^j} \tag{7}$$

and

$$R^j_2{}^*(u^j_1,u^j_2) = \frac{d_j(b_j-2a)^2}{9}.\frac{1}{r^j-1}, \tag{8}$$

$j=L,S,I$, which relate the revenue of each firm to its quality choice as well as its rival's quality. Note that with two firms in the market, $\forall\ u_{2j} \in [\underline{u}, \bar{u}]$, $\partial R_{1j}(\cdot)/\partial u_{1j}>0$, and $\forall u_{2j} \in [\underline{u}, \bar{u}]$, $\partial R_{2j}(\cdot)/\partial u_{2j}<0$. Hence, $u_{1j}^{*}=\bar{u}$, and $u_{2j}=\underline{u}$, $j=S,L,I$.

In this section we consider Game 2 in which firms cannot costlessly change their quality level in response to rival entry. More formally, in the first stage firms simultaneously choose their quality from the set $Q=\{u_R, [\underline{u}, \bar{u}]\}$, u_R representing the non-entry option.[13] This case differs from Constantatos (1999) in that quality choices are no longer conditional on the observed entry decision of the other firms.

Let us start by examining the equilibrium level of the lower quality for a given level of high quality. Since the discussion around Lemma 4 is identical for $j=S,L,I$ the index j will appear only when necessary. For any given $u_I=\hat{u}$, we define a low quality level as feasible if its producer makes nonnegative profits; it is *sustainable* if there is no $u_3>u_2$ such that $R_2(u_3;\hat{u}) \geq F$.

Lemma 2: *a)* $\forall\ u_1 = \hat{u}$, *if* $R_2(\underline{u}, \hat{u}_1)>F$ *there exists a feasible and sustainable low quality level* $u_2(\hat{u}_1)$ *characterized by the following relation*

$$\frac{1}{\hat{r}_j-1}=\frac{9}{(b_j-2a)^2}\cdot\frac{F}{d_j} \quad j=S,L,I \qquad (9)$$

where $\hat{r}=\hat{u}/(\hat{u}-u_z)$. *Moreover, b) the triplet* $(\bar{u}, u_2(\bar{u}), u_R)$ *is a Nash equilibrium of the quality stage*

Proof: The revenue function of the lower quality is represented by (8) which is monotonically decreasing in u_2. Recall that $R_2(\hat{u}, \hat{u}_1)=0$ due to Bertrand competition. If $R_2(\underline{u}, \hat{u})>F$, then there must be a quality level $u_2(\hat{u})$ such that $R_2(u_2(\hat{u}), \hat{u})=F$; $\forall\ u_2 \in (u_2, \hat{u})$, $R_2(u_2, \hat{u})<F$ (non feasibility) while $\forall\ u_2 \in (\underline{u}, \hat{u}]$, $R_2(u_2, \hat{u})>F$. On the other hand, when $R_2(\underline{u}, \hat{u})<F$, the set of feasible qualities is empty and the lower quality disappears from the market. Expression (10) is obtained by setting (8) equal to F.

Part *b*) of the lemma is proven in Constantatos and Perrakis (1998). Q.E.D.

Hereafter, the term u_2 refers to the zero profit level of the lower quality and the subscript Z is omitted. We consider cases where $R_2(\underline{u}, \hat{u})>F$ ruling out the trivial case of natural monopoly due to high fixed cost relative to demand.

The fundamental implication of the quality - specific fixed cost assumption is that the degree of differentiation depends on a) the fixed cost level, and b) income distribution parameters. The equilibrium level of the low quality depends positively on the density d_j and the relative width of the income distribution β_j, $j=S,L,I$. We term the first influence *size effect* and the second *income distribution effect.* If $d_S>d_L$ and the size effect is substantial relative to the income distribution effect, in autarky consumers in the poor country may enjoy a better low quality product than the one available in the rich country.

Equilibrium prices depend on the pure price effect identified in the price stage of the game and the level of the lower quality. The higher the latter is, the **lower** both prices will be, because of reduced differentiation and more intense competition. Two things must be noted here. First, prices may depend on the level of the fixed cost and more precisely on its relation to market density (F/d_i, $i=L,S,I$). Second, the width of the income distribution no longer has an unambiguous positive effect on prices, as in Game 1. While a wider distribution still tends to increase prices through the *pure price effect*, it also implies, *ceteris paribus*, higher revenues for any given pair of qualities. This pushes the zero profit quality upwards and tends to reduce equilibrium prices.

The following proposition investigates the impact of integration on the lower quality available in each country.

Proposition 2: The lower quality in the integrated market a) is always higher relative to its autarky level in the poor country; b) if $x \equiv (b_L-b_S)/(b_L-2a)<1/2$ it is higher relative to its autarky level in the rich country; and c) if $x \equiv (b_L-b_S)/(b_L-2a)>1/2$, $\forall x$ there exists a $\delta'_L(x)$ such that if $\delta_L<(>)\delta'_L(x)$ it is higher (lower) relative to its autarky level in the rich country.

Proof: A decrease in the lower quality after integration, $u_j>u_I$, implies $B_{2j}>I$ which by use of (10) yields

$$\frac{9F}{(b_j-2a)^2 d_j} < \frac{9F}{(b_I-2a)^2(d_L+d_S)} \Leftrightarrow \delta_j > \frac{(b_I-2a)^2}{(b_j-2a)^2},\ j=S \tag{10}$$

For part *a*) of the proposition substitute *S* for *j* and notice that the inequality in (11) can never hold since its LHS<1 while its RHS>1 because of $b_I>b_S$. Hence, $u_{zs}<u_{zI}$. For parts *b*) and *c*) substitute *L* for *j* and $b_I=\delta_L b_L+(1-\delta_L)b_s$ from Lemma 1. After the necessary simplifications (see appendix B) inequality (11) turns out to be equivalent to

$$X=-(1-\delta_L)x^2+2x-1>0 \tag{11}$$

which has two roots $x'=(1-\delta^{1/2}_L)/(1-\delta_L)$ and $x''=(1+\delta^{1/2}_L)/(1-\delta_L)$, with $0<x'<1<x''$. From the definition of *x* and the natural duopoly assumption $2a<b_j<4a$ we conclude that $x\in(0,1)$, therefore, the only admissible root is x'. Since *X* is positive between its roots the inequality in (11) holds for values of $x\in(x',1)$ and is reversed for $x\in(0,x')$. Moreover, it is shown in appendix C that $\forall\ \delta_L\in[0,1)\ x'(\delta_L)$ is continuous monotonically decreasing in δ_L approaching ½ as δ_L approaches 1. Thus, for any $x<1/2$, $X<0$ in (11) independently of the value of δ_L, which proves part *b*). For part *c*) notice simply that the continuity and monotonicity of $x'(\delta_L)$ guarantee that $\forall\ x\in(1/2,\ 1)$ there is a δ'_L such that $X(x,\delta'_L)=0$; $\forall\ \delta_L,\ <(>)\ \delta'_L\ X(x,\delta)<(>)0$, so quality increases (decreases)in the rich country after integration, Q.E.D. The situation is depicted in the following figure

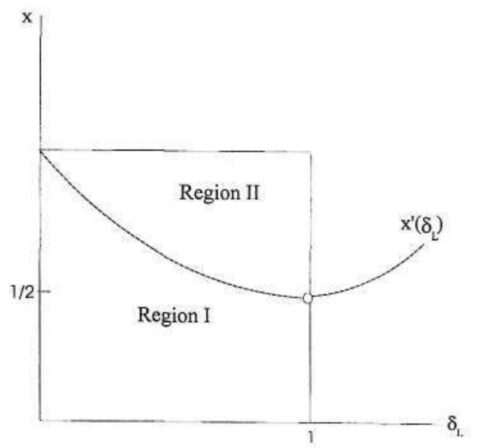

FIGURE 1

The area below (above) the $x'(\delta_L)$ curve-region I(II) - contains combinations of x and δ_L for which quality increases (decreases) in the rich country after integration.

Part a) of Proposition 2 should not come as a surprise since both the size and income distribution effects n the poor country work in the same direction increasing the lower quality. In the rich country, however, the two effects work in opposite directions: while the size effect tends to increase the lower quality after integration, the income distribution effect tends to lower it since $b_I<b_L$. Variable x reflects the relative difference in the width of the income distributions in autarky. Recalling that b_I is a weighted average between b_L and b_S notice that low values of x imply, *ceteris paribus*, a small income distribution effect and vice versa. The role of δ_L -the density of the rich country relative to the total density- is more complex. A higher δ_L mitigates the income distribution effect since, for given b_L, b_S, it increases b_I. At the same time though, a high δ_L implies that the density in the integrated market will be close to that of country L, therefore the size effect will not be substantial for that country. As it turns out, the latter effect is more important so high values of δ_L tend to reduce the lower quality in L.

Finally, simple inspection of (10) reveals that $B_{Ij} = (\bar{u}-u_{2j})/(\bar{u}-u_{2I})$, a relative measure of product differentiation between autarky and the integrated market, is independent of F. Thus, although the level of F affects the lower quality, it has no impact on changes in the degree of product differentiation between autarky and the integrated market.

Having characterized the equilibrium qualities let us now try to assess the overall impact of integration on product prices. From Section 3 we know that integration causes a pure price effect which tends to increase prices in the poor country and lower them in the rich country. From (4) and (A.3) in the appendix it is obvious that increases in the lower quality will, *ceteris paribus*, depress both product prices due to increased competition. Thus, in the poor country the pure price and total quality (size plus income distribution) effects work in opposite directions. In the rich country, they both tend to decrease prices as long as the combination (x,δ_L) belongs to region I (see Figure 1). If it belongs to region II the result it again ambiguous. The following proposition determines the effect of economic integration on the price of low quality in both countries, while Proposition 4 examines the same issue relative to the high quality product.

Proposition 3: *Economic integration reduces the price of the low quality in both countries.*

Proof: From (4), (A.3) and (10) follows that in order to have $p_{2I}<p_{2j}$, $j=S,L$, we must have

$$\frac{b_1-2a}{3}\cdot\frac{9F}{(b_I-2a)^2(d_S+d_L)}<\frac{b_j-2a}{3}\cdot\frac{9F}{(b_j-2a)^2d_j}, \qquad j=S,L,$$

which reduces to

$$\delta_j < \frac{(b_I-2a)}{b_j-2a)} \; j=S,L \tag{12}$$

Substituting S for j it is obvious that the above inequality always holds since $\delta_S<1$ and the RHS of (13) is greater than 1. Turning to country L, replace j by L and substitute b_I by its equivalent from Lemma 1 to obtain $\delta_L<[\delta_L b_L+(1-\delta_L)b_S-1]/(\delta_L b_L-1]$ which holds if $x<1$ which is always true, Q.E.D.

With respect to the changes in p_2 after integration, Proposition 3 implies that in the poor country the quality effect dominates the pure price efect while in the rich country the opposite holds true (when of course the two effects do not work in the same direction). Note than, again because B_{Ij} is independent of F, the latter leaves the price ratios of the lower qualities (W_{2j}) between the integrated market and autarky unaffected. Let us now turn to changes in p_I.

Proposition 4: *Define $\Phi \equiv 9F/[a^2(d_2+d_s)]$. There exist two critical values for Φ, $\Phi^s_c(x,\delta_L) > \Phi^L_c(x,\delta_L)$ with $\Phi^s_c>0$, $\partial\Phi^L_c<3$, $\partial\Phi^S_c/\partial x<0$, $\partial\Phi^L_c/\partial x>0$, and $\Phi^i_c/\partial\delta_L>0, i=L,S$, such that i) if $\Phi>(=)\Phi^s_c$ then $P_{IL}>p_{II}>(=)p_{IS}$, ii) if max $\{\Phi^L_c, 0\}<\Phi<\Phi^S_c$ then p_I falls in both countries, and iii) if $0<\Phi^L_c$ and $0<\Phi<(=)\Phi^L_c$ then $p_{IS}>p_{II}>(=)p_L$.*

Proof: See the appendix.

The situation is depicted in Figure 2, drawn for a given value of β_L. For any value of $\Phi=\tilde{\Phi}$ we can trace the loci SS/($\tilde{\Phi}$) and LL($\tilde{\Phi}$) representing (δ_L,x) combinations such that $\Phi^S_c(\delta_L, x)=\tilde{\Phi}$ and $\Phi^L_c(\delta_L, x)=\tilde{\Phi}$ respectively.

These loci meet at $x=1$ since the RHS of (D.9) equals zero when $x=1$. Therefore, they separate the $(\delta L, x)$ space in three regions, A, B, and C. According to the signs of the derivatives stated in the proposition, region A represents values of the parameters for which $\tilde{\Phi}\Phi^S_c > \Phi^L_c$ therefore free trade increases p_I in S while it falls in L; in region B, $\Phi^S_c > \tilde{\Phi}\Phi^L_c$ therefore the price of the high quality falls in both countries; in region C, $\Phi^S c > \Phi^L_c > \tilde{\Phi}$ which implies $p_{1L} < p_{1I} < p_{1S}$. Let us also trace the $x/(\delta_L)$ locus from Figure 1. It can be shown easily that $LL'(0)$ lies entirely above $x/(\delta_L)$, which is normal since a fall in u_{2L} is a necessary condition for a fall in p_{IL}. It follows that $\forall\ \Phi$, $LL'(\Phi)$ lies above the $x/(\delta_L)$ locus which divides only regions A and B. Region $B1$ (see Figure 2) represents parameter configurations for which trade is beneficial to **all** consumers: lower quality increases in both countries and all the prices fall. In all other areas, it has a negative impact on at least one consumer group while its impact on the well being of some other groups may be ambiguous. For instance, in area $A2$ high quality consumers in the S country pay a higher price for the same quality and the low quality purchasers in country L enjoy a higher quality but at a higher price.

The role of the fixed cost is particularly important in this game. First, F affects prices through the determination of equilibrium qualities, like in Shaked and Sutton (1984) and Motta (1992). Unlike in those papers, however, the impact of F on quality levels does not come from increased returns to quality but rathe from more intense entry threats due to the higher size of the integrated market. Second, the level of F determines not only the magnitude of changes in the price of the high quality but also the **direction** of these changes: high levels of F increase p_I in the country S and reduce it in country L $(p_{IL} < p_{1I} < p_{IS})$, the opposite occurs for low values of F (provided $\Phi^L_c > 0$), and for intermediate values of F, free trade lowers p_I in both countries.

To elucidate the role of F on W_{Ij}, let us write B_{Ij} as a weighted average between I and B_{2j}:

$$B_{1j} = (r_j/r_I) = 1/r_I + [(r_I - 1)/r_I]B_{2j}, \quad j = S, L. \tag{13}$$

B_{2j} is independent of F or quality choices, so F affects ony the weights in (14): an increase in F reduces u_{ZI} as well as r_{ZI}, tilting B_{Ij} closer to 1 than to B_{2j}.

For all values of F integration increases the lower quality in S, so $B_{2S}<l$. Hence, as F increases, B_{IS} increases, implying that free trade does little to reduce product differentiation. Similar arguments apply to country L except that now B_{2L} can be either <1 ($u_{2l}>u_{2L}$-Region I in Figure 1) or >1 ($u_{2I}<U_{2L}$-Region II in Figure 1). In the former case, pure price and product differentiation effects work in the same direction so $WIL<1$, VF. The level of F in this case only affects (negatively) the magnitude of the price ratio. When $B_{2L}>1$, an increase in F reduces the price ratio by reducing the importance of the product differentiation effect.

5. Conclusions

In a model of pure vertical differentiation we examined the consequences of bringing together two countries with consumer income distributions differing with respect to their width and densities. The unequal densities imply that the joint distribution in the integrated economy is not uniform. However, assuming the two separate income distributions have a common lower end point, Constantatos (1999) shows that the equilibrium in the integrated market is equivalent to having a uniform distribution and identifies a *pure price effect:* even if neither market structure not product specifications is affected by trade, the latter will affect product prices. This is so because after trade opening, firms will choose their price as if operating in an integrated market in which the income distribution has a width equal to the weighted average of the widths of the joined countries.

While size effects were absent in the case discussed in that paper, when quality commitment takes place prior to entry (or qualities cannot be changed without the repayment of a substantial part of the fixed cost), they play an important role, even if the *level* of the fixed cost is not a function of the quality chosen. In this case, the lower quality must be selected so as to avoid the entry of an intermediate quality and the resulting displacement (zero profit quality). Under these conditions, trade always increases the lower quality in the poor country. It may have the opposite effect in the large country if the joined countries are sufficiently different with respect to the width of their income distribution and the large country has a substantially greater density.

An increase in the lower quality implies, *ceteris paribus,* a fall in both prices due to increased competition.[14] Thus, a *product differentiation* effect is added to the pure price effect. In the small country the two effects work

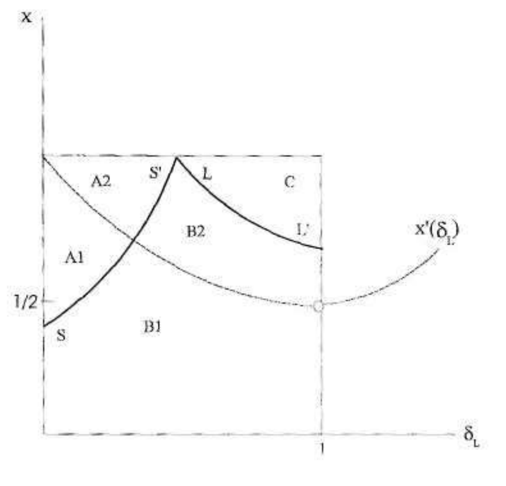

FIGURE 2

large, many of the price and quality movements we unravelled in this work might have been totally obscured. Second, absent a technological upper bound on quality (no $\overline{u}$), the high quality producer would face a threat of leapfrogging which would affect his choice of quality. In the integrated market, this threat would become more important due to increased revenues, thus leading to a *ceteris paribus* increase in the higher quality. This also would result in a level effect since the lower quality is chosen *after* the high quality has been decided. Moreover, continuity arguments convince us that our results do not change substantially if the cost function is steep enough around $\overline{u}$.

Concerning demand, it is important to relax the assumption of common origin in the income distribution of the two countries. If this assumption is replaced by that of common and in the distributions ($b_L = b_S$) the narrow country would also be the rich country and most probably the one enjoying the price reduction. However, at this stage we cannot say much on how Game 2 would be altered by this assumption. More importantly, the analysis must encompass all cases where $a_L \leq a_S < b_S \leq \beta_L$. This generalization figures in our research agenda.

Finally, note that we did not allow Firm 1 to play strategically in Game 2. Considering strategic positioning of the high quality would result in a proliferation of subcases: Firm 1 could either impede the entry of Firm 2 and monopolize the market, or try to manipulate the choice of the lower quality to its advantage.[15] To determine when entry is impeded and under what circumstances free trade can make entry easier, is a substantial topic on its own and should be examined separately. At this stage we hope that our analysis - together with that contained in Constantatos and Perrakis (1996) - will provide a first step in that direction.

Notes

1. See Snaked and Sutton (1984).

2. This happens when consumer's marginal willingness to pay for quality increases faster with quality than marginal cost. In such case, if any set of products were available at prices reflecting marginal cost, consumers would be unanimous over product ranking. The presence of the finiteness property calls for special care in the evaluation of trade liberalization policies, since the usual argument of increased variety due to Sower fixed cost *per capita* in the integrated market does not hold. In fact, the integrated market may support *fewer* firms than the autarkic equilibrium.

3. A similar conclusion had been reached by Gabszewicz *et αl.,* (1981) using a specific example of asymmetric countries.

4. Provided we exclude the extreme case where the top two qualities survive and engage in Bertrand competition with homogeneous products. This outcome can be easily ruled out if firms have to pay an ε fixed cost in order to enter the integrated market.

5. Motta's analysis relies on a utility function (borrowed from Sutton's book (1991, c. 3) for which the quantity purchased of the differentiated product is a substitute for its quality (although an imperfect one). Even if consumers are not allowed to mix two types of product, the fact that they can substitute quantity for quality and vice versa reduces the importance of product specification, thus bringing the Motta model closer in spirit to the characteristics approach [see Lancaster (1979)]. This specification, together with the assumptions of quantity rather than price competition and of identical consumers, result in product differentiation being an only short run phenomenon.

6. Shaked and Sutton (1987) focus on conditions that maintain market structure fragmented despite increases in the size of the economy. Quality increases in the aforementioned papers of Shaked and Sutton (1984) and Motta (1992) are due to the same mechanism.

7. Recall that we abstract from quality improvements due to increased market size by assuming the existence of a top quality, already produced in the autarkic equilibrium.

8. Note that the terms large and small are defined with respect to the *width* of the distribution rather than in terms of total population. It may thus be that !he *S* country is bigger in terms of population than the *L* country if its density is much higher. Note, further, that country *L* has higher average income so it could be equivalently termed the *rich* country.

9. This is so because price competition between rival firms forces the prices of the set of surviving products to a level sufficiently low for even the poorest consumer to prefer one of the surviving products rather than a lower quality at zero price. The upper bound to the number of products is completely unrelated to either the fixed cost or the density of the consumer income distribution depending solely on the *width* of the latter.

10. The first part of the inequality rules out the case of natural monopoly, where there is room for only one firm even at very low levels of fixed cost. The second part implies that the market is sufficiently narrow for at most two firms to be able to obtain positive market shares in a Bertrand-Nash equilibrium.

11. For the above optimal prices to be valid we must have $V_j \equiv (u_{j1}-u_R)/(u_{1j}-u_{2j}) \geq (b_j+a)/a$ (see Shaked and Sutton [1982]) which, as shown in Constantatos and Perrakis [1992], implies that u_{2j} must be no smaller than $u_{cj} \equiv [\bar{u}(k_j-1)+3u_R]/(k_j+2)$, a weighted average between the high quality and the reservation quality, where $k_j=(b_j-a)/a$, $j=S,L$,. A sufficient (but not necessary) condition for this is $\underline{u} \geq u_{cj}$. In what follows, we assume that $\underline{u} \geq u_{cL}$. $\equiv [\bar{u}(k_L-1)+3u_R]/(k_L+2)u_{cS}$.

12. See Gabszewicz, Shaked, Sutton et Thisse [1981] and Shaked et Sutton [1984].

13. While the quality - specific nature of F does not protect a lower quality firm, it confers to a high quality first mover advantages that are ignored in our simultaneous move specification of the game.

14. Recall that the higher quality is always at $\bar{u}$.

15. Note that if entry is not deterred Hung and Schmitt (1992) show that in a class of cases similar to those examined here, Firm I does not gain anything by forcing Firm 2 to choose a lower quality.

16. Note incidentally that the optimal pricing rules in any given country can be obtained as the limits of the integrated economy as the size of the other country tends to zero, *i.e.* $\lim_{di \to 0} b_I = d_j$, $i \neq j$, and $\lim_{di \to 0} p_h = p^j_h$, $h=1,2$, $i,j=S,L$, $i \neq j$.

17. This is so since $\Phi^L{}_c(x^{-1},x,\beta_L)<0$

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r $t \le b_S$: $R_1=p_1[d_L(b_L-t)+d_S(b_S-t)]$, $R_2=p_2(d_L+d_S)(t-$ (A.1)

for $t>b_S$: $R1=p_1d_L(b_L-t)$, $R_2=p_2[d_L(t-b_S)+(d_L+d_S)(b$ (A.2)

Assuming first $t \le b_S$, we maximize the revenue functions in (A.1) with respect to prices to obtain the following optimal pricing rules for the integrated economy (hereafter, the index I indicates values of variables in the integrated economy)

$$p_{1I} = \frac{2b_I - a}{3}.\frac{1}{r_1}, \qquad p_{2I} = \frac{b_I - 2a}{3}.\frac{1}{r_I - 1} \tag{A.3}$$

and the resulting equilibrium value of t[16]

We need to verify whether the value of t_I obtained above is indeed smaller than or equal to b_S, *i.e.*, that the high quality is sold in both countries after trade liberalization. We note first that $t_I<t_L = (b_L+a)/3$ since $b_I<b_L$. At the same time, $b_L<4a<2b_S$ and $a<b_S$, so $b_L+a<3b_S$, therefore $t_I<(b_L+a)/3<b_S$. On the other hand, if t is assumed to be greater than b_S this yields a non-admissible solution. In this case, (A.2) should be maximized instead of (A.1). After finding the optimal pricing rules corresponding to (A.2) and substituting them into the definition of t we obtain the equilibrium value of $t \equiv t'=[d_L(b_L+a)-d_S(b_S-a)]/3d_L$. For $t'>b_S$ we must have $b_L>2b_S+(b_S-a)(d_L+d_S)/d_L$, which is impossible since the second term on the RHS of this inequality is positive and $b_L<4a<2b_S$, hence, t' is not an admissible solution and the price game of the integrated economy has a unique solution described by (A.3) and (A.4). The latter are similar to the corresponding expressions (4) and (5) pertaining to the separate economies. Q.E.D.

B) Replacing j by L and b_I by its value from Lemma 1, the expression in (11) becomes:

$$\delta_L > \left(\frac{\delta_L b_L + (1-\delta_L)b_S - 2a}{b_L - 2a}\right)^2 \qquad \text{(B.1)}$$

Define, $\gamma_i = b_i/2a$ and note that $\gamma_I = \delta_S\gamma_S + \delta_L\gamma_L$. Then, the above becomes

$$> \left(\frac{\gamma_L - 1 - (1-\delta_L)(\gamma_L - \gamma_S)}{\gamma_L - 1}\right)^2 \Leftrightarrow \delta_L > 1 - 2(1-\delta_L)x + (1-\delta_L)^2 x^2. \qquad \text{(B.2)}$$

$$-(1-\delta_L)x^2 + 2x - 1 > 0$$

which is the expression (11) in the text.

C) The derivative of $x'(\delta_L)$ is

$$\frac{\partial x'}{\partial \delta_L} = \frac{-1/2\,\delta_L^{-1/2}(1-\delta_L) + (1-\delta_L^{1/2})}{(1-\delta_L)^2} \propto -\frac{1}{2}\varrho^2 + \varrho - \frac{1}{2} \qquad \text{(C.1)}$$

which is negative between its two roots p′=0 and p″=1.

Finally, notice that as δ_L approaches 1 both the numerator and the denominator of x' tend to 0.

By applying de l' Hospital's rule we obtain

$$\lim_{\delta_L \to 1} x' = \frac{\lim_{\delta_L \to 1} -\frac{1}{2}\delta_L^{-1/2}}{-1} = \frac{1}{2}.$$

D) **Proof of Proposition 4:** From (10) we get $r^{-1}_j = 9F + (b-2a)^2.d_j$, $j = L, S, I$. Substituting this into the appropriate expressions in (4) and (A.3) yields the necessary and sufficient condition for the price of the high quality to incrase after integration:

$$\frac{2b_j - a}{2b_I - a} < \frac{9F + (b_j - 2a)^2.d_j}{9F + (b_I - 2a)^2(d_L + d_S)},\ j = L, S \qquad \text{(D.1)}$$

Dividing both the numerator and denominator on the LHS of the above expression by a, those of the RHS by $a^2(d_L + d_s)$, substituting the definition of β_j and performing the necessary simplifications, we have that the inequality in? is equivalent to

$$-8\beta_j-4\beta_k+8\beta_j\beta_k+\beta^2_k-2\beta_j\beta^2_k-8\beta_j\delta_j+7\beta^2_j\delta_j+8\beta_k\delta_j$$

$$j,k= \tag{D.2}$$

$$-6\beta_j\beta_k\delta_j-2\beta^2_j\beta_k\delta_j-\beta^2\delta_j+2\beta_j\beta_k\delta_j-2(\beta_j-\beta_k)\Phi>0$$

where $\Phi \equiv \dfrac{9F}{a^2(d_2+d_s)}$, is a normalized fixed cost parameter.

Turning first to country L we substitute L for j and S for k in (D.2). Using the definition of x and isolating Φ we obtain that the inequality in (D.2) is eqiuvalent to $\Phi^L{}_c-\Phi>0$ where

$$\frac{\beta_L-2}{2x} \cdot [1-2\beta_L+2x(-1+2\beta_L+2\delta_L-\beta_L\delta_L)+x^2(1-2\beta_L-\delta_L+2\beta) \tag{D.3}$$

represents a critical value for the normalized cost.

Notice that $\dfrac{\partial \Phi^L_c}{\partial x}=\dfrac{1-(1-\delta_L)x^2}{2x^2}.(2\beta_L^2-5\beta_L+2)>0$, since the first term on its LHS is positive $\forall$ x, $\delta_L \in (0,1)$ and the second term is quadratic with roots $\beta'_L=1/2$ and $\beta''_L=2$ lying below any admissible value of $\beta_L \in (2,4)$. Further, $\Phi^L{}_c(x=1)=(3/2)(\beta_L-2)\delta_L$, hence the highest value of $\Phi^L{}_c$ is obtained at $\Phi^L{}_c(\beta_L=4, x=1, \delta_L=1)=3$. It follows that $\forall\ \Phi \geq 3$, $Y^L < 0$ so the price of the high quality falls in the L country. If on the other hand $\Phi \in (0,3)$ by setting $\Phi^c{}_L=\overline{\Phi}$ we can obtain the (β_L,x,δ_L) triplets that yield a specific level of $\Phi^c{}_L$. Solving for δ_L we obtain

$$\delta\text{L} = \tilde{\delta}_L(x;\Phi)=\frac{(2-5\beta_L+2\beta_L^2)(x-1)^2+2x\Phi}{x(\beta_L-2)[2(2-\beta_L)+x(2\beta_L-1)]} \tag{D.4}$$

which is defined for all $\beta_L \in (2,4)$ and x $\in (0,1)$.

Further, $\partial\Phi^L{}_c/\partial\delta_L \propto 4x-2\beta_jx+2\beta_jx^2 \propto 2x(\beta_L1)+2(2-\beta_L)$ so $\partial\Phi^L_c/\partial\delta_L>0 \Leftrightarrow x>\tilde{x}_L \equiv 2(\beta_L-2)/(2\beta_L-1)$; the latter is true at any $\Phi^L_c \geq 0$ since $\Phi^L_c\ (\tilde{x}_L,\delta_L)$

= -(9/4)<0 and $\partial\Phi^L_c$ / ∂x>0. Thus, $\partial\delta_L/\partial x$ = $-(\partial\Phi^L_c/\partial x)/(\partial\Phi^L_c/\partial\delta_L)<0$ so expression (D.4) determines for any value of β_L a map of downward sloping contours in the (x,δ_L) space. Each contour divides the (x,δ_L) space in two parts such that $\forall$ (x,δ_L,φ) with $\delta_L>(<)\tilde{\delta}_L(x,\varphi)$ the price of the high quality increases (decreases) after integration. Moreover, the contour

$$\tilde{\delta}_L(x;0)=\frac{(2\beta_L-1)(1-x)^2}{x[2(2-\beta_L)+x(2\beta_L-1)]} \qquad \text{(D.5)}$$

defines combinations (x,δ_L) for which P_{1L} falls after integration independently of the level of F, Q.E.D.

It is easy to show that $\tilde{\delta}_L(x,0)$ lies above $x'(\delta_L)$ in Figure 1[17]. Thus, there exist a set of (x,δ_L) pairs lying between the $x'(\delta_L)$ and $\tilde{\delta}_j(x,0)$ curves for which p^L_1 falls even if the lower quality in the L country falls after integration.

With respect to country *S*, replace *j* by *S* and *k* by *L* in (D.2) to obtain Y^S. Define Φ^S_c analogously to Φ^L_c. The critical inequality for $Y>0$, and therefore $p_{1S}<p_{1L}$, turns out to be $\Phi^S_c-\Phi<0$ since the coefficient of Φ in Y^s is $(\beta_s-\beta_L)<0$. First, we show that Φ^S_c is always positive. Replacing δ_s by $1-\delta_L$ and β_s by $\beta_L+2x-\beta_L x$ (from the definition of x) we obtain $\frac{2-\beta_L}{2x}$

$$[1-2\beta_L+2(-4+2\beta_L+2\delta_L-\beta_L\delta_L)x+(7-2\beta_L-7\delta_L+2\beta_L\delta) \qquad \text{(D.6)}$$

and

$$\frac{\partial\Phi^S_c}{\partial x}=\frac{\beta_L-2}{2}\cdot\left[\frac{1-2\beta_L}{x^2}+(1-\delta_L)(2\beta_L-7)\right]<0 \qquad \text{(D.7)}$$

since $2\beta_L>x^2+1$ implies that the first term in brackets is always < -1 while $\beta_L<4$ and $\delta_L<1$ imply that the second term in brackets is <1. Thus the lowest value Φ^S_c can take is $\Phi^S_c(x=1)=(3/2)(\beta_L-2)\delta_L 0$, therefore, $\forall$ (β_L,δ_L,x) $\Phi^S_c>0$. Setting $\Phi^S_L=\overline{\Phi}$ and solving for δ_L we obtain:

$$\frac{+\beta_L(2\beta_L-5)](1/x)-4[4+\beta_L(\beta_L-4)]+[14+\beta_L(2\beta_L-11)]x}{(\beta_L-2)[4-2\beta_L-(7-2\beta_L)x]} \quad \text{(D.8)}$$

which is a well-defined function of x. To determine the sign of $\partial\hat{\delta}_L/\partial x$ we note that $\partial\hat{\delta}_L/\partial x = -(\partial\Phi_c^S/\partial x)/(\partial\Phi_c^S/\partial\delta_L)$ the numerator of which is negative from (D.7) while its denominator is positive since the denominator in (D.8) is negative. Hence, $\forall$ Φ expression (D.8) defines an upward sloping locus such that $\forall$ (x, δ_L, Φ) with $\hat{\delta}_L$ > (<) δ_L (x,Φ), $p_{1S}>(<)p_{1L}$.

It remains to show that $\Phi^S{}_c>\Phi^L{}_c$. Using (D.3) and (D.6) we get
$\Phi^S{}_c-\Phi^L{}_c=-(\beta_L-2)(1-x)[(1-2\beta_L)/x+2(\beta_L-2)(1-\delta_L)]$ (D.9)

The first two terms are positive while the third is negative since it is smaller than $(1-2\beta_L)/x+2(\beta_L-2)<0$ since $(2\beta_L-1)/2(\beta_L-2)>1>x$, Q.E.D.