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Does Trade Cause Firms To Specialize?

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Abstract

The paper models the rationalization effects of trade barriers and market size on the firm's decision to produce one or more products. Firms tend to choose multiproduct plants when market size is small in relation to plant size, when product changeover costs are low, when the demand for individual products is relatively inelastic, and when products are poor substitutes in demand. By expanding effective market size, free trade tends to produce specialized plants. The likelihood that specialized plants will emerge when markets are integrated depends on the magnitude of transport costs. Rationalization takes the form of savings on changeover costs in specialized plants.
The likely effects of trade barriers and market size on the equilibrium characteristics of imperfectly competitive industries has been one important theme in the development of the 'new trade theory' of the 1980s. The central concept is the notion of 'rationalization'. An increase in the size of an industry's market or a reduction in trade barriers can produce rationalization at the firm level through increases in plant-scale, larger output per firm, and lower equilibrium prices.\(^1\) The rationalization literature also contains references to greater specialization of product lines within plants.\(^2\) There is evidence that firms exposed to larger national markets or more closely integrated international markets will be forced/induced to shed product lines and lengthen production runs in individual plants (e.g.: Baldwin and Gorecki 1985, 1986; Daly 1986; Caves 1989).

The present paper models multiproduct production as a function of market size parameters and trade barriers. The domestic market is assumed to be occupied by two industries, one of which is perfectly competitive. The second industry consists of a duopoly producing two differentiated products. Each duopolist operates a single plant of fixed size and can choose to produce one or both of the two differentiated products subject to a capacity constraint on total plant output. Section 1 shows that the nature of the Cournot-Nash equilibrium that emerges in the duopoly industry under autarky depends on the demand characteristics for the two products, the size of the domestic market, the size of each duopolist's capacity constraint, and the added cost of producing two rather than one product in the same plant. The latter cost is referred to as the changeover cost. Depending on all of these conditions, autarky Cournot-Nash equilibrium can be characterized by specialization in production (single-product plants) or by diversified production (multi-product plants). Section 2 generalizes the duopoly equilibrium to the large-numbers case and compares the results to the duopoly results. Section 3 confronts the domestic duopoly with international trade opportunities (threats) with or without trade barriers. The effect of trade opportunities is to shift the domestic equilibrium away from Cournot-Nash solutions with multi-product plants and in the direction of one-product plants. Trade thus rationalizes production in the sense of producing product specialization. Section 4 concludes with comments on product-line rationalization in the context of plant-size rationalization and on the role of conjectures in models of this kind.
1. Multiproduct Equilibrium: A Duopoly Model

The argument that market size has something to do with multiproduct plant outcomes suggests that the demand side will be the key feature here and should receive the most detailed attention. Accordingly, the supply side will be kept relatively simple. Assume that a single production factor underlies the model and can be used to produce a numeraire good under constant returns (CRS). Thus, all costs for the duopoly industry can be expressed in terms of either the single production factor or the CRS good. Each duopolist incurs fixed cost by operating a single plant of fixed size. The marginal cost of producing either of two products is zero up to a combined output of $X_c$ which represents the capacity constraint for the fixed plant. If the duopolist chooses to produce two products rather than just one a changeover cost equal to $Z$ is incurred.

The demand side of the model follows well-known theory. Each (identical) consumer in the domestic economy has a quasi-linear utility function (linear in the CRS good) that is quadratic in the two goods produced by the duopoly industry (e.g.: Harris 1985, Horstmann and Markusen 1986, Mai and Hwang 1988, Muller and Rawana 1990). As a result, the inverse demand function for either good produced by the duopoly is linear in per capita consumption. In this case, simplicity is gained and nothing essential lost by assuming that the demand structure is completely symmetric such that the price of either good (in terms of the CRS numeraire) is given by:

$$p_i = a - bx_i - cx_j, \quad i = 1,2; \quad i \neq j$$

(1)

where $p_i$ is the price of good $i$, $x_i$ is per capita consumption of good $i$, $x_j$ is per capita consumption of good $j$, and $b>c>0$. The last restriction implies that the two goods are imperfect substitutes in consumption ($b=c$ implies perfect substitutes). Market size is modelled by assuming that there are $N$ identical consumers (e.g.: Anderson 1991) such that equation (1) can also be written as

$$p_i = a - bX_i/N - cX_j/N$$

(2)

where $X_i, X_j$ are the total outputs of commodities $i$ and $j$ produced by both firms. With two firms (A and B), the output of goods 1 and 2 by Firm A will be denoted by $X_1$, $X_2$ and the output of goods 1 and 2 by Firm B by $X_1^*, X_2^*$. 
Note that $X_1 + X_2 \leq X_c$ and $X_1^* + X_2^* \leq X_c$. Assuming that each product's perceived marginal revenue is strictly positive, the inequality holds weakly: firms always produce to capacity. Total revenues for the two firms are $TR = p_1X_1 + p_2X_2$ for Firm A and $TR^* = p_1X_1^* + p_2X_2^*$ for Firm B. Thus, total revenue for Firm A is

$$TR = \frac{[a - b(X_1+X_1^*)/N - c(X_2+X_2^*)/N]}{}X_1$$

$$+ \frac{[a - b(X_2+X_2^*)/N - c(X_1+X_1^*)/N]}{}X_2$$

(3)

and analogously for Firm B. Assuming Cournot-Nash conjectures on the outputs of Firm B and noting that full-utilization of capacity for Firm A implies $dX_2/dX_1 = -1$, Firm A's marginal revenue with respect to changes in its output of good 1 can be written (after simplification) as

$$MR_1 = \frac{dTR/dX_1 = -4(b-c)X_1/N + 2(b-c)X_c/N - (b-c)(X_1^* - X_2^*)/N}{}$$

(4)

Note that (4) takes into account the reduction in Firm A's output of good 2 required to expand output of good 1, given the binding capacity constraint. Suppose both firms produce both products. Since marginal cost is zero, profit-maximization implies $MR_1 = 0$ for Firm A ($MR_1^* = 0$ for Firm B). Setting (4) equal to zero and noting that $X_2^* = X_c - X_1^*$, Firm A's reaction function can be written as

$$X_1 = -X_1^*/2 + 3X_c/4$$

(5)

Analogously, Firm B's reaction function is

$$X_1^* = -X_1/2 + 3X_c/4$$

(6)

Equilibrium is stable ($dX_1/dX_1^* = -1/2$ for Firm A and analogously for B) and completely symmetric, yielding equilibrium values $X_1 = X_1^* = X_2 = X_2^* = X_c/2$. Since both firms are producing both products, both are absorbing the required changeover cost ($Z$) for multiproduct firms.

The symmetric multiproduct equilibrium obtained from (5) and (6) need not be globally sustainable. Each firm does have the option of defecting from the multiproduct equilibrium by choosing to produce only one product, thereby saving changeover cost $Z$. Firm A, for example, could decide to specialize in product 1 (setting $X_1 = X_c$) while eliminating its production of product 2 ($X_2 = 0$).
Why would Firm A choose to defect from multiproduct equilibrium and specialize? The disadvantage of specializing is that Firm A's expanded production of good 1 drives down the price and marginal revenue for good 1 while reduction in its output of good 2 increases price and marginal revenue for good 2. From the point of view of maximizing total revenue, specialization means producing the 'wrong' mix of the two goods. Carrying over Cournot-Nash conjectures to the defection decision, Firm A will decide to defect if the saving on changeover cost (Z) is greater than its perceived loss of total revenue from producing the 'wrong' mix, assuming that $X_1^* = X_2^* = X_c/2$.

Figure 1 illustrates the perceived loss of revenue for Firm A from specialization in product 1 using the marginal revenue function (4). In the multiproduct equilibrium, $MR_1 = 0$. If firm A chooses $X_1 = X_c; X_2 = 0$, $MR_1 = -4(b-c)X_c/N + 2(b-c)X_c/N - (b-c)[(X_c/2) - (X_c/2)]/N = -2(b-c)X_c/N$. The perceived revenue loss, equal to the area of the triangle in Figure 1, is $((X_c/2)[2(b-c)X_c/N])/2 = (b-c)X_c^2/2N$. At least one firm will defect from the multiproduct equilibrium and specialize if

$$Z > (b-c)X_c^2/2N$$  \hspace{1cm} (7)

Suppose (7) holds but only Firm A specializes initially. Given that Firm A is specialized, what should Firm B do? Firm B can either adapt to Firm A's decision and continue to produce both products or it can specialize in product 2. Suppose Firm B adapts by producing both products. Since $X_1 = X_c$ and $X_2 = 0$, Firm B's reaction function (6) dictates $X_1^* = X_c/4$ and $X_2^* = 3X_c/4$ at which point $MR_1^* = -4(b-c)X_1^*/N + 2(b-c)X_c/N - (b-c)(X_1^* - X_2)/N = 0$. If, instead, Firm B specializes in product 2 ($X_1^* = 0; X_2^* = X_c$) when Firm A has specialized in product 1 ($X_1 = X_c; X_2 = 0$), then $MR_1^* = (b-c)X_c/N$. The triangular area measuring B's revenue change from specialization (analogous to Figure 1) is $((-X_c/4) [(b-c)X_c/N])/2 = -(b-c)X_c^2/8N$. Thus, given that Firm A is specialized, Firm B will also specialize if

$$Z > (b-c)X_c^2/8N$$  \hspace{1cm} (8)

Since $(b-c)X_c^2/2N > (b-c)X_c^2/8N$, satisfaction of condition (2) ensures that condition (8) is also satisfied and both firms specialize. This result is reasonable since the specialization decision by one firm, once made, makes it less costly for the second firm to specialize in the other product.
Figure 1  Revenue Loss from Specialization
Instead of beginning with the multiproduct equilibrium, one could also begin with both firms specialized in a single product and ask what conditions would cause them to defect from the specialized equilibrium in favor of multiproduct production. In this case, condition (8) becomes the requirement that must be met for each firm to remain specialized given that the other firm is specialized. If (8) is not satisfied then at least one firm, say Firm B, switches from specialized to multiproduct production. If the other firm, say Firm A, remains specialized at $X_1 = X_2 = 0$ then Firm B produces $X_1^* = X_2^* = 3X_c/4$ as described above.

What should Firm A now do, given that Firm B is producing both products? Firm A could continue to specialize, producing only good 1, or it could also switch to multiproduct production using the assumed Cournot-Nash conjecture that Firm B will continue to produce at $X_1^* = X_2^* = 3X_c/4$. If Firm A decides to produce both products, its reaction function in (5) dictates that it choose $X_1 = 5X_c/8$ and $X_2 = 3X_c/8$. At this production combination, $MR_1 = 0$. If, instead, Firm A continues to specialize in product 1, its marginal revenue $MR_1$ from (4) would be $MR_1 = -4(b-c)X_c/N + 2(b-c)X_c/N - (b-c)((X_c/4) - (3X_c/4))/N = -3(b-c)X_c/2N$. Firm A's change in revenue from specializing in this case is given by the triangular area $((3X_c/8)[-3(b-c)X_c/2N])/2 = -9(b-c)X_c^2/32N$. Firm A would want to remain specialized when Firm B is producing both products only if its saving in changeover cost from specialization exceeds its perceived revenue loss from specialization, i.e. only if

$$Z > 9(b-c)X_c^2/32N$$

(9)

But since Firm B switches from specialized to multiproduct production only if $Z < (b-c)X_c^2/8N$, equation (9) cannot be satisfied for Firm A if B has switched to producing both products. So, if one firm gains from switching from specialized to multiproduct production, both switch.

Equations (7) and (8) together imply that the presence or absence of multiproduct firms depends crucially on initial conditions in the duopoly model. If equilibrium starts out as a multiproduct duopoly with both firms producing both goods, the multiproduct equilibrium is sustainable under Cournot-Nash conjectures if $Z < (b-c)X_c^2/2N$. If, instead, $Z$ exceeds $(b-c)X_c^2/2N$, both firms switch over to specialized production. If equilibrium starts off with both duopolists specialized, then the specialized equilibrium is sustainable if $Z > (b-c)X_c^2/8N$. If $Z$ is below this
value, then both firms switch to producing both products. In the interval 
\((b-c)X_c^2/8N < Z < (b-c)X_c^2/2N\), either type of equilibrium is possible.

Suppose the initial position is asymmetric with one firm specialized and 
the other producing both products. As noted above, the multiproduct firm 
will switch to specialized production if \(Z > (b-c)X_c^2/8N\). The specialized 
firm will switch to a multiproduct firm if \(Z < 9(b-c)X_c^2/32N\). So, in the 
range \((b-c)X_c^2/8N < Z < 9(b-c)X_c^2/32N\), an asymmetric equilibrium switches 
to one of the symmetric cases with both firms either specialized or 
diverisified, depending upon which firm switches first.

Figure 2 provides a schematic diagram of the behaviour of the firms for 
alternative values of \(Z\) on the horizontal axis. On the vertical axis, MM 
denotes multiproduct production for both firms, MS denotes the mixed case 
with one specialized firm and one multiproduct firm, and SS denotes both 
firms specialized. The horizontal arrows indicate the range of \(Z\) over 
which the indicated equilibrium is sustained while the vertical arrows 
indicate transitions from one type of equilibrium to another.

Consider the symmetric multiproduct equilibrium as an initial condition. 
As discussed above, sustainability requires \(Z < (b-c)X_c^2/2N\). This condition 
will be satisfied for relatively small changeover costs (small \(Z\)), goods 
that are relatively inelastically demanded and poor substitutes in demand 
(large \(b-c\)), large plant capacities (large \(X_c\)) and small markets (small \(N\)). 
Note also that the multiproduct equilibrium is always inefficient.\(^3\) 
Switching to specialized equilibrium has no effect on the output of either 
good since both firms produce at capacity in either case while changeover 
costs equal to \(2Z\) will be saved by specialization. But when market size is 
less than \((b-c)X_c^2/2Z\), the inefficient multiproduct equilibrium is 
sustained. And an efficient specialized equilibrium will fail to be 
sustained if market size is less than \((b-c)X_c^2/8Z\). If (8) is not satisfied, 
multiproduct equilibrium occurs regardless of initial conditions. In this 
case, the outcome exemplifies the prisoner's dilemma problem. Each firm 
chooses multiproduct production - the non-cooperative result - no matter 
what decision its rival is assumed to take. Thus both firms always end up 
at MM in Figure 2. Since a switch to specialized equilibrium (SS) with each 
firm producing only one product saves changeover cost for both firms with 
no change in outputs, mutual specialization is superior but unattainable in 
the absence of cooperative behaviour. Public policy could play a role by 
ensuring the cooperative result.
$\alpha = \frac{(b-c)X_0^2}{N}$

Figure 2  Duopoly Equilibrium Behaviour
2. The Large-Numbers Case

The duopoly model in section 1 assumes that the market is occupied by a pair of firms with identical cost structures. Whether or not both firms specialize or both firms operate as multiproduct firms, equation (2) gives the price of either product as \( p_i = a - (b+c)X_c/N \) where \( X_c \) is the total (capacity) output of each firm. Suppose the market is occupied by \( n \) identical firms instead of only two. Also assume that equilibrium is symmetric in the sense that the subset of firms \( n^* (n^* \leq n) \) that specialize in one product or the other consists of \( n^*/2 \) firms specialized in product 1 and \( n^*/2 \) firms specialized in product 2 while the remaining multiproduct firms set \( X_i = X_c/2 \). From equation (2), the equilibrium price is now \( p_i = a - n(b+c)X_c/2N \) which depends inversely on the number of firms. Denoting the fixed cost of each firm's plant as \( F \) and continuing to assume marginal cost equal to zero up to plant capacity, average cost for specialized plants is \( F/X_c \) and for multiproduct plants is \( (F+Z)/X_c \). The zero profit free entry/exit condition for specialized plants is

\[
p_i = a - n(b+c)X_c/2N = F/X_c \tag{11}
\]

and for multiproduct plants is

\[
p_i = a - n(b+c)X_c/2N = (F+Z)/X_c \tag{12}
\]

Since (11) and (12) are inconsistent, it must be that free entry/exit equilibrium consists of all specialized plants \( (n^* = n) \) or all multiproduct plants \( (n^* = 0) \). If the former is the case, the number of firms in free entry is the implicit solution for \( n \) from (11). If the latter, \( n \) is obtained from (12).

Following the approach in section 1, the question is: which of these equilibria will prevail? Provided the solution for \( n \) from either (11) or (12) is 'large', the answer turns out to be simpler than in the duopoly case. Consider any particular firm's marginal revenue function for product 1 given by equation (4). In equation (4), \( X_1^* \) and \( X_2^* \) were the outputs of the other duopolist. Now \( X_1^* \) and \( X_2^* \) must be interpreted as the total outputs of the two products by all other firms. In symmetric equilibrium with \( n \) large, the outputs of the two products by all other firms will be approximately equal no matter what any individual firm decides to do, i.e. \( X_1^* = X_2^* \) in (4), provided all specializing firms are evenly divided between
both products and the remaining multiproduct firms split their outputs equally between both products. Since each firm's own output is included in the symmetric equilibrium, rival outputs of each product are not exactly the same but they will be closer the larger is n. Any firm's marginal revenue becomes

\[ MR_1 = -4(b-c)X_1/N + 2(b-c)X_c/N, \quad X_1^* = X_2^* \quad (13) \]

As before, if a firm produces both products, \( MR_1 = 0 \) for \( X_1 = X_c/2 \) as expected. If it specializes in, say, product 1, \( MR_1 = -2(b-c)X_c/N \). The loss of revenue from specialization is again given by the triangular area in Figure 1 equal to \( (b-c)X_c^2/2N \). Because of the presence of symmetrically producing rivals \( (X_1^* = X_2^*) \), the condition for specialization in (7) is reversible. If \( Z > (b-c)X_c^2/2N \), equilibrium consists of specialized firms. If \( Z < (b-c)X_c^2/2N \), equilibrium consists of multiproduct firms.

The reason that the condition for specialization to be unsustainable is the same as the condition for multiproduct equilibrium to be sustainable in this case lies in the difference between rival behaviour for a duopoly and likely rival behaviour for large numbers of firms. Under duopoly, the rival firm must be either specialized or must produce both products. Which of these decisions is in effect makes a discrete difference to the firm's own product specialization decision. With many rivals, however, it is less relevant to examine equilibria in which rival firms produce asymmetric outputs. The more reasonable assumption is that rivals avoid specializing in the same good as far as possible, leading to equal numbers of rival firms specialized in each good (with any unspecialized rivals producing at \( X_1^* = X_c/2 \)).

So the multiproduct equilibrium message with large numbers is similar to the duopoly case but simpler. The condition to convert multiproduct production to specialized production is given by (7). As the number of specialized rivals increases, equation (8) approaches (7) as the condition to sustain specialization. When (7) is satisfied, specialization is in effect and price is determined by (11). When (7) is not satisfied, all firms produce both products and price is determined by (12). A further effect of free entry/exit is to pass the savings in changeover costs due to specialization forward to consumers. And when specialization is in effect, comparison of equations (11) and (12) indicates that the equilibrium number of firms is larger than under multiproduct equilibrium.
As expected, an increase in the number of firms lowers price in either type of equilibrium (pro-competitive effects). But whether or not a multiproduct equilibrium is sustainable depends on market size, per capita demand characteristics and firm size but not on the number of rival producers (n-1) in the market.4

3. Trade and Product-Line Rationalization

The duopoly and large-numbers models in sections 2 and 3 imply that market integration through free trade is a possible route to specialization and lower prices. Market integration raises the value of N and increases the likelihood that firms will choose specialized over multiproduct production. The mechanism is straightforward: the increase in N raises the perceived demand elasticities for both products so that the perceived revenue loss from specialization falls. Is it possible to generalize this market integration result to cases involving transport costs between the two markets?

To examine the effects of market integration with transport costs, one approach is to begin with a pair of identical autarkic regional markets, each populated by two firms (or, at least, an equal number of firms). Suppose each of the two regions has market size N sufficiently small that a Cournot-Nash multiproduct equilibrium is sustained in both regions under autarky (i.e.: \( Z < (b-c)X_c^2/2N \)). Further suppose that autarky is partly the result of artificial and prohibitive trade barriers between the two regions. When the artificial trade barriers are removed each firm can sell to consumers in either region but a firm selling into the other region must incur transport cost per unit of export sales equal to t. The basic structure now closely resembles the 'reciprocal dumping' model developed by Brander and Krugman (1983). Equilibrium prices of both goods are identical in both regions. Exporting firms in each region absorb transport costs on shipments to the other region. From (2), the inverse demand functions for good 1 in the two regions are

\[
\begin{align*}
 p_{1d} &= a - bX_1d/N - cX_2d/N \\
 p_{1f} &= a - bX_1f/N - cX_2f/N 
\end{align*}
\]  

where \( X_1, X_2 \) refer to total outputs of goods 1 and 2 and the superscripts refer to the domestic and foreign markets. Analogous equations apply to good 2. For a particular firm producing \( X_1d \) for the domestic market, total revenue from the sale of good 1 in the domestic market is
\[ TR_1^d = aX_1^d - bX_1^dX_1^d/N - cX_2^dX_1^d/N \]  

(16)

Denoting the total output of good 1 by the firm's rivals as \( X_1^{d*} \) such that \( X_1^d = X_1^d + X_1^{d*} \), (16) can be written as

\[ TR_1^d = aX_1^d - b(X_1^d + X_1^{d*})X_1^d/N - cX_2^dX_1^d/N \]  

(17)

The firm's marginal revenue from good 1 in the domestic market (assuming Cournot-Nash conjectures with respect to rival outputs) is

\[ MR_1^d = \partial TR_1^d/\partial X_1^d = a - 2bX_1^d/N - bX_1^{d*}/N - cX_2^d/N \]
\[ = a - bX_1^d/N - bX_1^{d*}/N - cX_2^d/N \]  

(18)

Similarly, the firm's marginal revenue for good 1 in the foreign market is

\[ MR_1^f = \partial TR_1^f/\partial X_1^f = a - bX_1^f/N - bX_1^{d*}/N - cX_2^f/N \]  

(19)

Provided equilibrium conditions are identical in both markets, \( X_1^d = X_1^f \) and \( X_2^d = X_2^f \). Subtracting (18) from (19),

\[ MR_1^f - MR_1^d = -b(X_1^f - X_1^d)/N \]  

(20)

where \( X_1^d + X_1^f = X_c/2 \) (symmetrically, \( X_2^d + X_2^f = X_c/2 \)). Optimal allocation of the firm's output of good 1 between the domestic and foreign markets requires that marginal revenue net of transport in the foreign market equal marginal revenue in the domestic market, i.e.,

\[ MR_1^f - MR_1^d = t, \quad X_1^d, X_1^f > 0 \]  

(21)

Combining (20) and (21) and rearranging,

\[ X_1^d - X_1^f = tN/b, \quad X_1^d > 0, \quad X_1^f \geq 0 \]  

(22)

If the firm does not serve the foreign market, then \( MR_1^f - MR_1^d \leq t \) at \( X_1^d = X_c/2, \quad X_1^f = 0 \). In this case, (22) becomes \( X_1^d = X_c/2 \leq tN/b \). Thus the condition for firms to export to the foreign market (reciprocal dumping) is

\[ t < bX_c/2N \]  

(23)
Assuming (23) holds, and since the firm's combined output of good 1 satisfies the condition \( X_1^d + X_1^f = X_c^d / 2 \), equation (22) implies

\[
X_1^d = X_c^d / 4 + tN / 2b \tag{24}
\]
\[
X_1^f = X_c^f / 4 - tN / 2b, \quad X_1^f \geq 0. \tag{25}
\]

The impact of market integration on the firm's decision to produce one or two products can now be examined using the approach used in section 1. Market integration produces reciprocal dumping for both products provided (23) is satisfied. Given the equilibrium outputs of both products under reciprocal dumping in (24) and (25), the multiproduct firm has to decide whether to continue producing both goods 1 and 2 or to switch over to specialized production of either good 1 or good 2. From (4), the change in the firm's marginal revenue due to switching production between the two goods in either the domestic or foreign market is \( \Delta MR_1 = [-4(b-c)/N]\Delta X_1^d \) under Cournot-Nash conjectures and the (triangular) change in total revenue from the switch is given by \([-4(b-c)/N]\Delta X_1^2 / 2\). Thus, if the firm abandons its entire domestic output of one good in favour of the other good, its revenue loss in the domestic market is \([4(b-c)/N][X_c^d / 4 + tN / 2b]^2 / 2\). Its revenue loss in the foreign market is \([4(b-c)/N][X_c^f / 4 - tN / 2b]^2 / 2\). The sum of the revenue loss in both markets is \([2(b-c)/N][X_c^d / 4 + tN / 2b]^2 + [X_c^f / 4 - tN / 2b]^2\] = \([b-c]/N[X_c^2 + t^2N^2 / b^2]\). The firm will want to switch to specialized production if the saving on changeover cost is greater than the sum of domestic and foreign revenue losses from specialization. Comparing the changeover cost to the sum of perceived revenue losses in both markets the firm chooses to specialize if

\[
Z > [(b-c)/N][X_c^2 / 4 + t^2N^2 / b^2] \tag{26}
\]

The righthand side of (26) is increasing in transport cost. For higher values of \( t \) the revenue loss from specialization is larger, so firms are more likely to continue producing both products when artificial trade barriers are removed. As \( t \) approaches zero, the revenue loss approaches \((b-c)X_c^2 / 24N\). In this case \((t=0)\), removal of the prohibitive artificial trade barriers is equivalent to doubling the market size available to firms in both regions and this maximizes the likelihood that firms will choose to specialize in one product. With \( t=0 \), the output changes from specialization are divided equally over both markets and have the least effect on prices and marginal revenues. When transport cost is just high enough to
eliminate exports, \( tN/b = X_c/2 \) from (23) and the righthand side of (26) equals \((b-c)X_c^2/2N\). Thus, for \( t \geq bX_c/2N \), removal of artificial trade barriers has no effect on the firm's specialization choice since 'natural' trade barriers (transport costs) lead to autarky with or without artificial barriers. As transport costs rise over the range \( 0 \leq t < bX_c/2N \), firms concentrate sales increasingly in their domestic markets making it less likely that elimination of artificial barriers will lead to product-line specialization.

Summarizing, the degree of market integration that results from free trade depends on the magnitude of natural trade barriers. In the absence of natural trade barriers, free trade allows firms maximum diversification of production over domestic and foreign consumers and minimizes the perceived reduction in revenue from product-line specialization. The larger are natural trade barriers, the greater the tendency for firms to confine themselves to their home markets and the greater the perceived revenue losses from specialization. Provided natural barriers are non-prohibitive, free trade increases the likelihood that firms will choose to rationalize their plants by specializing product lines. Rationalization produces changeover cost savings which may be passed on to consumers, depending on entry/exit assumptions (section 2).

4. Concluding Observations

The presence of negatively sloping demand curves for products that can be produced in the same plant opens up the possibility that firms will choose to diversify production over several product lines. The firm's revenue can be increased by such diversification. The disadvantage of diversified production is that the firm incurs product changeover costs that could be avoided by product-line specialization. The revenue disadvantage of specialization is alleviated by the presence of a larger market (more consumers) which increases the firm's perceived elasticities of demand for their individual products. This, in turn, makes it more likely that firms in large markets will choose to save on changeover costs by specializing product lines. Trade is an avenue to increased market size and therefore to product-line rationalization. The effectiveness of trade as an avenue to product-line specialization depends on the degree of natural separation (transport costs) between national or regional groups of consumers.

It is important to note that these product-line rationalization results are
conditional on assumed fixed plant-size captured by the plant-size parameter $X_c$. The presence of the plant-size parameter points up the need to extend the analysis to incorporate the choice of both plant-size and the number of products per plant. In fact, the present paper is strictly complementary to other analyses in which the number of products per plant is fixed (usually at one) while plant-size is explicitly responsive to market size (e.g.: Venables 1985; Muller and Rawana 1990). In a more general model, both plant-size and the number of products per plant would be endogenous functions of market size and trade. Inclusion of both plant-size and product-numbers as 'rationalization variables' should lead to richer results. For example, the present paper indicates that product-line specialization is less likely when plant capacity ($X_c$) is large. (The perceived revenue loss from specialization is larger when specialization involves larger absolute shifts in the output of each product.) At the same time, the existing plant-size rationalization literature indicates that larger markets lead to larger plants. It is likely, therefore, that one type of rationalization may substitute for the other in some cases.

Conjectures inevitably play a crucial role in imperfect competition models and related policy recommendations. The Cournot-Nash approach is often convenient but not definitive. In the present model, Cournot-Nash conjectures do double duty: they serve to define the reaction functions for firms producing both products (equations 5 and 6) and they initialize the outputs of rivals when firms are deciding to specialize or diversify their product lines. It is possible that firms form quantitatively different kinds of conjectures in these two contexts. And neither need be Cournot-Nash in nature. The resulting equilibrium is dependent on the nature of these conjectures. A single example will suffice to indicate the potential effect of alternative conjectures on the decision to specialize product lines. If each duopolist in section 1 were to assume that its own decision to specialize in one product would trigger a decision by its rival to specialize in the other product but not otherwise, then each firm's perceived total revenue would be independent of its decision to produce one or two products since the total output of each product remains the same in either case. Each firm would then specialize to save changeover cost irrespective of market size.
Notes


2. Quoting Markusen (1985, 126), "Small country firms may produce inefficiently many product lines per plant. Costs are incurred due to downtime as an assembly line is changed over from one product to another and/or due to the use of less specialized machinery, since the market is not large enough for the firm to incur the fixed costs of running several more specialized plants. Rationalizing effects of trade thus extend to the number of products produced per plant in addition to the length of production runs for individual products."

3. There is certainly one case in which multiproduct production can be welfare-improving. Suppose both firms are specialized with each producing at capacity. From (2), the price of each product is \( p_i = a - (b+c)X_C/N \). Assume fixed cost is \( F \) such that average cost per firm is \( F/X_C \). Suppose, further, that fixed cost is sufficiently large and/or market size sufficiently small that neither specialized firm breaks even at capacity output, i.e. \( p_i = a - (b+c)X_C/N < F/X_C \). Alternatively a single firm could produce only one product with \( p_i = a - bX_C/N \) but cannot survive if \( a - bX_C/N < F/X_C \). If a single firm produces both products then \( p_i = a - (b+c)X_C/2N \) and the single multiproduct firm survives if \( a - (b+c)X_C/2N \geq (F+Z)/X_C \). These comparisons do not consider multi-part pricing strategies.

4. As an aside it should be noted that large market size \( (N) \) and small firm-size \( (X_C) \) are both likely to contribute to the presence of large numbers of firms in equilibrium such that the conditions that lead to large numbers of rivals tend also to promote product specialization.

5. The strategic trade policy debate involving the use of state taxes and subsidies to alter oligopoly behaviour in the direction of national welfare-improving equilibrium is an example of this issue. The type of intervention called for depends crucially on the types of conjectures formed by the oligopolists (Eaton and Grossman 1986).
References


