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Gilroy, Bernard Michael and Broll, Udo

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INTRA-INDUSTRY TRADE AND DIFFERENCES IN TECHNOLOGY

UDO BROLL AND B. MICHAEL GILROY

Department of Economics, Universität Konstanz, Federal Republic of Germany; University St. Gallen, Switzerland

I

INTRODUCTION

Casual observation of the international exchange of goods disclose the empirical reality that the import and export commodity structures among industrial nations are becoming increasingly similar. Important export branches of individual countries are simultaneously significant import branches. The phenomenon of an increased intra–industrial exchange of goods is founded on the supply side of international markets through the degree of product differentiation as a competitive force between firms as well as on the demand side of these markets through consumer wishes for product diversity. The origin of an increasing international intra-industry trade among industrial countries on the one hand, and among developing countries on the other, evolves largely out of their similar levels of development as inherent in their production technology and their standards of living.[1]

The political economical implications of intra-industry trade flows are far-reaching. The rising intensity of international trade flows (given that imports may rise quicker than exports) should not be judged alone simply from the perspective of international market segment distributions of egoistic countries (compare Helpman and Krugman, 1985, Siebert, 1986, Broll and Gilroy, 1985).

Intra–industry trade rather expresses an intensive specialization effect within the various domestic branches of the international economy combined with an increasing expansion of the differentiated product assortments of multinational firms. Multinational enterprise operations within the European Common Market have to a great extent consisted of horizontal investments. The establishment and development of an integrated market has promoted the "rationalisation" of operations on a horizontal basis, allowing firms to obtain economies of scale through international division of production.[2]

The approach focussed on allows one to examine theoretically the empirical observation of increasing levels of intra–industry trade flows founded upon an increasing similarity of technology between countries and

[1] Compare Erzan and Laird (1984), Balassa (1986).

[2] See Fishwick (1982), Helpman (1984).

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firms. Within the framework of a simple model of international trade in differentiated goods it is demonstrated that in an international free trade scenario ranking high in product differentiation and monopolistic market structures the intensity of intra-industry trade is dependent upon the degree of differences present in applied technology. Technological similarity among nations results in high levels of intra-industrial trade; whereas persistent differences in available technology reduces intra-industrial trade flows.

II

A TRADE MODEL WITH DIFFERENTIATED GOODS AND DIFFERENCES IN TECHNOLOGY[3]

For the sake of simplicity, assume that a representative economy consists of two commodity producing sectors. The agrarian sector Y produces a homogeneous good (food), whereas the manufacturing sector X is the supplier of differentiated goods to prices $p_1, p_2, \ldots, p_n$. Each consumer possessed a preference for some "ideal" differentiated good in the sense that individuals regard themselves to be better off when they can consume a differentiated product which exactly fits their view of their ideal design for that class of products than when they do not.

An individual thus decides to purchase one unit of his ideal good, given that it is available, if the market price of the good does not exceed the consumer's subjective reservation price (ζ) he is willing to pay for one unit.[4] Assuming that there exists a continuum of varieties of the differentiated product, a variety v_i $(i = 1, 2, \ldots, n)$ different from a consumer's most–preferred variety specification α will be valued lower according to preferences in product space.

The product space is characterised by a one–to–one correspondence between the continuum of varieties and a circumference of a circle with radius $1/2\pi$. Consumers are respectively distributed along the product circle with regard to their most–preferred specification of brand. The domestic consumer distribution is $\beta \equiv L/2\pi$ radius; L representing domestic consumers. Thus, ideal products are evenly distributed on the circumference of the circle. This assumption assures symmetry in aggregate demand for differentiated products. The foreign consumer distribution is $B^* \equiv L^*/2\pi$ radius.

The market demand function facing a firm j is then simply the sum of demand over the firm market width interval $[\bar{z}, \underline{z}]$. The relevant market

[3] For the basic model see Economides (1983), (1984).

[4] The consumer's utility when he consumes the variety v_j may be characterised as $u = y - p_i + \{\zeta - (\alpha - v_j)^2\}$; where y is income and α is the "ideal" product.

demand of a domestic firm j producing a differentiated good is thus[5]

$$x_j(.) = \int_{\underline{z}}^{\bar{z}} \beta(\alpha)\, d\alpha = \beta \,.\, (\bar{z} - \underline{z}). \tag{1}$$

Differentiated goods are produced under a non-convex technology. Dual to the production function of firm j the cost function $C_j(x_j) = F + b \,.\, x_j$ may be derived, exhibiting constant marginal costs b. F designates fixed costs. It is assumed that such a similar cost function is applicable to all firms in the manufacturing sector in a country. The firm's goal is to maximize its profit function Π_j:

$$\max_{p_j} \Pi_j(\cdot) = (p_j - b)x_j(\cdot) - F. \tag{2}$$

The profit function of a firm j is concave. That is for given product varieties $(v_1, v_2, \ldots, v_n)$ there exists an optimal price P_j, as long as neighboring firms have positive market shares. It can be shown that there exists a non-cooperative Nash-equilibrium in prices (compare Economides, 1983). In an international symmetrical trade equilibrium all firms are equispaced and the profit maximizing price is derived as

$$P_j = b + H^2 \qquad \forall j \tag{3}$$

with $H \equiv 1/(n + n^*)$ representing the well-known Herfindahl-Index of supplier concentration (where n and n^* are the number of domestic and foreign firms in the X sector).

The integrated market consists of $(n + n^*)$ firms which supply exactly $n + n^*$ product varieties; no variety will be produced by more than one firm.

It is now possible to analyse differences in technology structure and its effects upon levels of intra-industry trade flows. Consider the situation in which the cost structure of domestic producers is such that $b > b^*$, that is foreign firms possess a marginal cost advantage compared to domestic firms. The respective domestic and foreign cost structures are thus represented by

$$C(x_j) = F + b \,.\, x_j \tag{4.1}$$

$$C^*(x_j^*) = F^* + b^* \,.\, x_j^* \tag{4.2}$$

with x_j $(j = 2i)$ for domestic firms and x_j^* $(j = 2i - 1)$ for foreign firms (with $i = 1, 2, \ldots, n$). Firms are interleaved i.e. there is a firm of the home country between any two firms of foreign country (see Economides, 1984; Lancaster, 1984). Since the cost function is the dual concept to the production function incorporating the technology, differences in technology may be illustrated applying the cost functions.

[5] $\bar{z}(\underline{z})$ are the "marginal consumers" of the firm j. We have $\bar{z} = \{(\bar{p} - p_j)/(\bar{v} - v_j) + \bar{v} - v_j\}$. $\beta/2$ and $\underline{z} = \{(p_j - \underline{p})/(v_j - \underline{v}) + v_j - \underline{v}\}$. $\beta/2$, in which $\bar{v}$ and $\underline{v}$ designate the neighboring firms' varieties and $\bar{p}$, $\underline{p}$ the respective prices of these brands.

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$$\Pi_j^*(\cdot) = (\beta + \beta^*)\left\{\frac{1}{H}\right.$$

It follows immediately that

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[6] See Economides (1983), (1984)

An entrepreneur in sector X faces a three–stage decision problem. The first stage is with regard to entering in the market or not. The second decision concerns the optimal choice of variety on the product circle. Finally a decision must be made as to optimal pricing of the produced variety (see Friedman, 1977).

Under the postulated cost conditions and symmetrical equilibrium the following optimal prices may be derived[6]

$$P_j = \frac{2b + b^*}{3} + H^2 \tag{5.1}$$

$$P_j^* = \frac{2b^* + b}{3} + H^2. \tag{5.2}$$

As mentioned above a situation characterised by similar marginal costs $b = b^*$ has an equilibrium price in free trade $P_j = P_j^* = b + H^2$ for all j. Due to the difference in marginal cost (assume $F = F^*$), the domestic product price P_j is higher than the foreign product price P_j^* in free trade.

The aggregated demand functions for domestic and foreign demand respectively for a variety are thus derived as

$$x_j(\cdot) = (\beta + \beta^*)\left\{\frac{1}{H} \cdot (b^* - b + 3H^2)/3\right\} \tag{6.1}$$

$$x_j^*(\cdot) = (\beta + \beta^*)\left\{\frac{1}{H} \cdot (b - b^* + 3H^2)/3\right\}. \tag{6.2}$$

In a free trade situation characterised by equal marginal costs $b = b^*$ (and on an unit product circle) we have an equilibrium demand $(L + L^*)/(n + n^*)$ for all firms.

Under the assumption of free market entry, the respective domestic and foreign profits in equilibrium are derived as:

$$\Pi_j(\cdot) = (\beta + \beta^*)\left\{\frac{1}{H}\left\{\frac{b^* - b}{3} + H^2\right\}\right\} - F \tag{7.1}$$

$$\Pi_j^*(\cdot) = (\beta + \beta^*)\left\{\frac{1}{H}\left\{\frac{b - b^*}{3} + H^2\right\}\right\} - F. \tag{7.2}$$

It follows immediately that

$$\Pi_j^*(\cdot) > \Pi_j(\cdot). \tag{7.3}$$

Given that the domestic and foreign fixed costs are identical, it follows that the profit of a foreign firm is always greater than the profit of a domestic firm. This implies that there does not exist a finite $H \equiv 1/(n + n^*)$ which permits an equivalence of profits $\Pi_j^* = \Pi_j$. This in turn implies that the necessary long–run zero–profit condition can be obtained only if the last existing domestic firm operation in sector X disappears from the market.

[6] See Economides (1983), (1984).

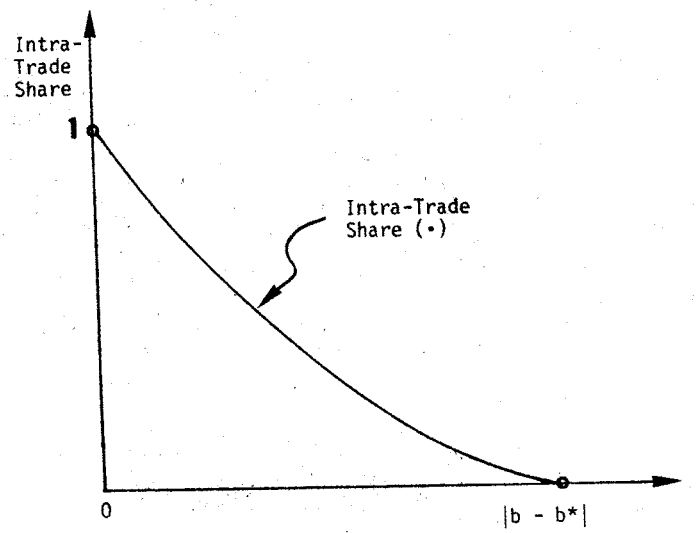

Figure 1. Intra-industry trade and differences in technology.

Due to differences in technologies in a long–run equilibrium firms with higher costs of production will be crowded out of the market. The posulated constellation $b > b^*$ leads to a situation in which only foreign firms act as suppliers of differentiated goods in the long-run. In a two–country, two-sector model, the domestic country imports differentiated products from the foreign X–sector and exports homogeneous goods from the Y–sector.

Based upon these differences in international cost structure in the differentiated sector X intra-industrial trade flows are reduced. With regard to the common Grubel–Lloyd index of intra-industry trade (see Helpman and Krugman, 1985) it will be zero in the limit (see Figure 1). A prerequisite for the intra-industrial exchange of goods is thus identical (or at least similar available technologies among nations.

III

Summary

Given differences in technologies among nations it has been demonstrated that the competitive market processes lead to a crowding out of high cost producers in markets for differentiated products, thus transforming on original intra–industrial exchange of goods into an inter-industrial exchange of goods. The observed tendency of high levels of intra-industry trade flows among industrialized nations is promoted through their similarities in applied technology as well as their similarity in demand patterns. Technology effects are an important aspect not to be overlooked when attempting to explain the current world trade expansion in which the volume of exports and imports simultaneously grow.

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