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INTRA-INDUSTRY TRADE AND SPECIALISATION IN PROCESSED AGRICULTURAL PRODUCTS: THEORY AND ISSUES

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1. INTRODUCTION

Neo-classical trade theory, as embodied in the Heckscher-Ohlin-Samuelson model, predicts that trade between two countries will take place on the basis of comparative advantage generated by differing factor endowments. As a result, it is expected that the pattern of trade will be of an **inter-industry** nature. However, empirical work on the evolution of the European Economic Community by Verdoorn (1960), Drèze (1960, 1961) and Balassa (1965), and later work by Grubel and Lloyd (1975), has indicated that a considerable part of the growth in world trade, particularly between developing countries, has been of an **intra-industry** nature, i.e. the simultaneous export and import of products which are very close substitutes for each other in terms of factor inputs and consumption (Tharakan, 1985).

Much of the early work on intra-industry trade can be characterised as having been measurement and intuitive theorising, prompting the comment that it was a "phenomenon in search of a theory" (Greenaway and Milner, 1986). However, since the publication of Grubel and Lloyd, a considerable literature has emerged to explain the observed patterns of developed country trade. Although no general model of intra-industry trade has been developed[1], an important synthesis of international and industrial economics has occurred with a formal emphasis on the role of imperfect competition in industrial markets, particularly the existence of economies of scale and product differentiation. Perhaps the best-known models that have been developed are those based on monopolistic competition by Krugman (1979, 1980, 1981), Lancaster (1980) and Helpman (1981), and those based on duopolistic interaction by Brander (1981) and Brander and Krugman (1983).

In the context of the emerging theory of intra-industry trade, most of the empirical work has focussed on industrial products, however, given the nature of market structures in developed countries' food processing sectors, one may expect *a priori* that intra-industry trade will be a feature of trade in high value-added food and related products[2]. Therefore, the objective of this paper is to give some background to the hypothesis testing that could be conducted in relation to trade in processed agricultural products[3].

The outline of the paper is as follows: Section 1 reviews in some detail the important contributions in the theory of intra-industry trade and summarises the general hypotheses that can and have been tested. Section 2 outlines several of the indices that have been developed to measure the extent of intra-industry trade and specialisation and considers some of the technical problems associated with measurement. Section 3 surveys briefly some of the cross-sectional econometric work that has been conducted to explain inter-industry and inter-country differences in intra-industry trade. Finally in Section 4, the research implications of intra-industry trade for trade in processed agricultural products will be considered.

1. THEORIES OF INTRA-INDUSTRY TRADE

(a) Early Developments

At the time that intra-industry trade was first observed, a number of developments took place in international trade theory that can loosely be described as the neo-factor proportions theory[4]. For example, Posner (1961) proposed a technological gap argument for trade whereby comparative advantage is based upon product innovation rather than factor proportions, whilst Keesing (1965) and Bhagwati (1965) developed a human capital approach in which endowments of skill factors form the basis of comparative advantage[5]. Subsequently, Grubel and Lloyd suggested that many of these hypotheses could be considered as models predicting intra-industry trade. However, as Tharakan (1983) argues, the relevance of many of these theories to intra-industry trade is, in most cases, tenuous and they are only operational with additional assumptions. Nevertheless, it is recognised that the contributions of Linder (1961) and Drèze represent important steps in the development of a theory of intra-industry trade.

Linder argued that whilst export potential may exist on the basis of comparative advantage, such potential can only be realised where substantial domestic demand for the product exists and also trade between two countries is limited to goods for which markets exist in both countries. Upon the assumption that income levels determine taste patterns, Linder predicted that trade in similar but differentiated products will take place between countries having similar per capita income levels, an outcome precisely opposite to that of the Heckscher-Ohlin-Samuelson model(6). Elements of Linder's hypothesis have subsequently appeared in the more formal models of intra-industry trade proposed by Helpman (1981), Shaked and Sutton (1984) and Falvey and Kierzkowski (1987).

As Tharakan (1983) notes, the existence of similar income levels and product differentiation may in themselves be insufficient to generate intra-industry trade unless economies of scale are also entered as part of the argument. Drèze argued that if there are economies of scale in production, then even though two countries with high and similar income levels would demand a wide variety of products, each country could only produce a sub-set of the range of products in order to reap economies of scale. Therefore, intra-industry specialisation(7) will occur where countries have similar income levels and factor endowment patterns.

As a consequence of these theoretical contributions by Linder and Drèze, the relevance of product differentiation and economies of scale in examining trade patterns was recognised. However, whilst later work by Gray (1973) and Davies (1977) incorporated these factors in their analyses[8], it was not until Dixit and Stiglitz (1977) and Lancaster (1979) suggested alternative means of dealing with economies of scale and product differentiation in a general equilibrium framework[9] that rigorous models of intra-industry trade were developed.

(b) Modern Theories

In surveying the modern theories of intra-industry trade, only the contributions that have received the most attention in the literature will be considered[10], and these can be broken down into three basic forms of market structure; **monopolistic competition, duopoly, and oligopoly.**

Monopolistic Competition

Essentially two types of model explaining intra-industry trade have evolved in the spirit of monopolistic competition, associated with the approach of Krugman (1979, 1980, 1981) and the approach of Lancaster (1980) and Helpman (1981). As Lancaster (1982) notes, there are several differences between the two approaches, however, the most striking difference lies in the specification of the demand side and hence the mode of product differentiation.

Krugman's model is set in the context of Spence's (1976) and Dixit and Stiglitz's work on monopolistic competition. Individuals are assumed to derive utility from variety *per se* and therefore consume all differentiated goods being offered in a particular group. Consequently, product differentiation takes the form of producing a variety not yet in supply, although economies of scale at the firm level constrains the number of goods that can be produced in equilibrium.

In contrast, the models of Lancaster (1980) and Helpman deal with demand for differentiated goods in the spirit of Hotelling's analysis of spatial location. Using Lancaster's (1966, 1979) approach, consumers demand goods that embody bundles of characteristics and they are assumed to have an ideal bundle. Consequently, only one type of differentiated good is purchased by consumers, but given diversity of tastes, there is an aggregate demand for variety. Therefore, product differentiation in this case takes the form of a firm offering a variety of good with a different bundle of characteristics to those already on offer. Again economies of scale limits the number of products in equilibrium.

(i) Notwithstanding this basic difference in the demand technology, both types of model can generate intra-industry trade. First, looking at Krugman's (1979, 1980, 1981) model[11], the initial focus is on the autarchy equilibrium. An economy consists of one industry which produces a variety of goods[12] from a continuum of potential goods. The goods produced enter each consumer's utility function symmetrically and all consumers have the same utility function of the form:

$$U = \Sigma c_i^{\theta} \ , \ 0 < \theta < 1 \qquad i = 1,\ldots,n \qquad (1)$$

where c_i is the consumption of the i^{th} good. This function has the property that the elasticity of substitution between any two goods is a constant equal to $\sigma = 1/(1-\theta)$.

Labour is the only factor of production in this economy, and all goods are produced with the same cost function of the form:

$$l_i = \alpha + \beta x_i \ , \ \alpha, \ \beta > 0 \qquad i = 1,\ldots,n \qquad (2)$$

where l_i is labour used in production of the i^{th} good and x_i is output of the i^{th} good. This function implies a fixed cost element, constant marginal costs and decreasing average costs. Such a cost function is sufficient to ensure only a limited number of varieties are produced in the economy.

The output of any good x_i must equal consumption in equilibrium, so assuming consumers are also workers, output of any good is simply the consumption of one individual multiplied by the labour force L:

$$x_i = Lc_i \qquad i = 1,\ldots,n \qquad (3)$$

and assuming full employment in the economy:

$$L = \Sigma(\alpha + \beta x_i) \qquad i = 1,\ldots,n \qquad (4)$$

Under autarchy, equilibrium in the economy can be derived by assuming a market structure of monopolistic competition where no two firms produce the same good and free entry[13] drives profits to zero. The equilibrium is derived in the following manner; consumers maximise their utility function subject to the following budget constraint:

$$I = \Sigma p_i x_i \qquad i = 1,\ldots,n \qquad (5)$$

where I is income and p_i is the price of the i^{th} good. The first-order condition from this problem is:

$$\theta c_i^{\theta-1} = \lambda p_i \qquad i = 1,\ldots,n \qquad (6)$$

where λ is the shadow price on the budget constraint, i.e. the marginal utility of income. Using (6) and (3), the inverse demand curve for the i^{th} good is:

$$p_i = \theta\lambda^{-1}(x_i/L)^{\theta-1} \qquad i = 1,\ldots,n \qquad (7)$$

Given a sufficiently large number of goods are produced in equilibrium, the pricing decision of one firm has no impact on the marginal utility of income λ, consequently (7) implies that the elasticity of demand facing an individual firm is, $\epsilon_i = 1/(1-\theta)$, which is the same as the industry elasticity of substitution σ. Profit-maximising behaviour on the part of firms implies:

$$mc_i = mr_i = p_i(1-1/\epsilon_i) \qquad i = 1,\ldots,n \qquad (8)$$

so letting w be the wage rate, the profit maximising price for the i^{th} firm will be:

$$p_i = \theta^{-1}\beta w \qquad i = 1,\ldots,n \qquad (9)$$

given θ,β and w are the same for all firms, prices will be the same for all firms[(14)], i.e. $p_i = p$.

The actual profits of a firm can be written down as:

$$\pi = px_i - (\alpha + \beta x_i)w \qquad i = 1,\ldots,n \qquad (10)$$

and in the tradition of monopolistic competition, if $\pi_i > 0$, entry will occur until profits are driven to zero, which is the familiar tangency solution of

Chamberlin. Hence using expression (9), (10) can be solved out for x_i by setting it equal to zero:

$$x_i = \alpha/(p/w - \beta) = \alpha\theta/\beta(1 - \theta) \qquad i = 1,\dots,n \qquad (11)$$

as α,β and θ are the same for all firms, outputs will be the same for all firms, i.e. $x_i = x$.

Consequently, using the full employment condition in (4), and using expression (11), the number of goods produced in equilibrium can be derived:

$$n = L/(\alpha + \beta x) = L(1 - \theta)/\alpha \qquad (12)$$

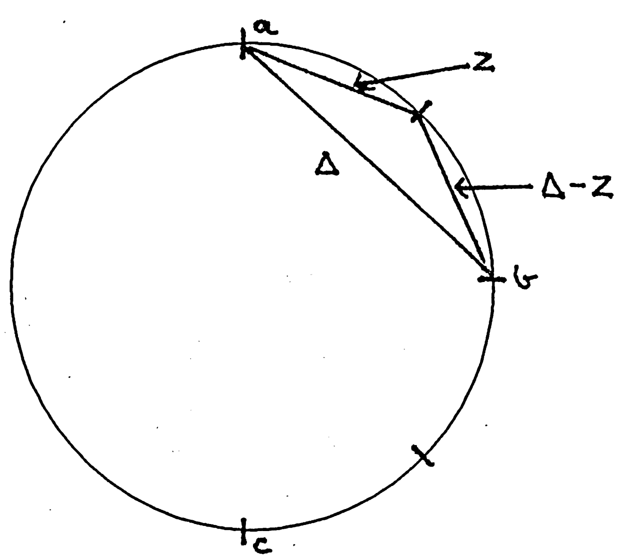
i.e. the number of goods produced is a function of the size of the labour force L, the level of fixed costs α and the value of θ from the utility function[15].

Given this structure, it is straightforward to show how intra-industry trade will occur in a trading equilibrium. Suppose that there is another economy identical to the one just described such that there is no reason for conventional Heckscher-Ohlin-Samuelson-type trade to occur. However, if expression (12) is considered, it can be seen that the number of goods that will be produced in equilibrium will be 2n because effectively the labour force L has doubled. Trade occurs because of the production technology, i.e. each good will only be produced by one firm in one country but is sold in both countries, generating **pure intra-industry** trade. Consequently, the gains from trade are greater diversity for consumers as they spread their incomes over twice as many varieties, which, given the symmetry in the model, implies that in equilibrium each firm's output is the same as under autarchy, i.e. expression (11) holds before and after trade, so there are no gains from fuller realisation of economies of scale[16].

Also, in the trading equilibrium, the prices of any good in either country are the same, and real wages are the same, i.e. there is factor-price equalisation. The **volume** of trade in the model is determinate in that each country exports half of the output of its products, however the **direction** of trade is not determinate, i.e it is arbitrary which country produces which goods[17].

(ii) As noted earlier, the clearest difference between the Krugman-type model and those of Lancaster (1980) and Helpman is the specification of the demand technology, however, the way in which the latter models are set up also allows monopolistic competition to be integrated easily into the Heckscher-Ohlin-Samuelson framework[18]. Again considering the situation under autarchy, an economy consists of an agricultural sector producing a homogeneous good, and a manufacturing sector producing a number of varieties of a good with different bundles of characteristics[19]. There is a continuum of manufactures which can be represented as points around a circle, i.e. a, b and c in Figure 1[20]:

Figure 1



In this set-up, each consumer has a most preferred variety, so that if x is the preferred good and y is the agricultural good, utility can be denoted as:

$$U = u(x,y) \tag{13}$$

However, if the consumer is unable to obtain his ideal variety, mixing of varieties being ruled out, other types of good need to be considered for a complete preference ordering. In order to deal with this, Lancaster (1980) and Helpman introduce the notion of a compensating function, defined as h(v). This function is such that a consumer is indifferent between x units of his ideal product and h(v)x units of an available good which is at an arc distance v from the preferred good. Assuming the first and second derivatives of h(v) are such that, $h'(v) > 0$ and $h''(v) > 0$, then the further an available good is away from the ideal good, the more is required to generate indifference between it and one unit of the ideal good, and there is also increasing marginal compensation.

Hence if x(v) is an available good, arc distance v from the ideal, and y is also consumed, then utility can be written as:

$$U = u[x(v)/h(v),\ y] \tag{14}$$

The consumer's decision problem therefore is to allocate his budget over the agricultural and manufactured good, his demand functions being written as:

$$x(v)/h(v) = f[p_x h(v),\ p_y]I \tag{15}$$

$$y = g[p_x h(v),\ p_y]I \tag{16}$$

where p_x is the price of the manufactured good, a distance v from the ideal good, p_y is the price of the agricultural good and I is income.

Having chosen an available good x(v) with a price of p_x, it can be argued that the **effective** price per unit of the ideal good is $p_x h(v)$ due to the consumer being indifferent between one unit of the ideal good and h(v) units of the available good. Therefore, the consumer will choose the available variety providing him with the lowest effective price of his ideal product.

Given this demand structure, it is assumed that there is a continuum of consumers around the circle who all have the same levels of income and similar utility functions. If the population of consumers is uniformly distributed around the circle, and there is preference diversity, then preferences are uniformly distributed around the circle with similar densities of consumers at each point[21]. This effectively introduces the same sort of symmetry into aggregate demand as exists in the Krugman-type model.

On the supply side, the agricultural good is produced with inputs of labour and capital under constant returns of scale with a market structure of perfect competition. Manufactures are also produced with labour and capital and all firms have the same cost function that exhibits economies of scale[22]. As a result, not all types of manufactured good are produced. The firm's decision problem is to choose a variety to produce and set its price. Suppose goods a and c in Figure 1 are already in supply at prices p_a and p_c, and there are no other varieties between a and c. If a new firm enters with variety b, it will attract consumers whose ideal good is b as long as p_b does not exceed the effective price of b as measured by the price paid for either a or c. Assuming this is satisfied, it is necessary to know the **market width** for variety b, i.e.

the number of other consumers who will consume b. Suppose the sub-set between a and b is considered; a consumer who is an arc distance z away from good a priced at p_a, and $\Delta - z$ away from b priced at p_b, where Δ is the total arc distance between a and b, will be indifferent between goods a and b if the following is satisfied:

$$p_a h(z) = p_b h(\Delta - z) \tag{17}$$

i.e. the effective price is the same in both cases. Because of the symmetry built into the model, this point of indifference will lie halfway between goods a and b, i.e. $\Delta = 2z$. Hence the market width for a new product b will be a half-market either side of its location.

Like the Krugman-type model, it is assumed that there is free entry into the manufacturing sector, consequently new varieties will be located around the circle until profits are driven to zero, an equilibrium that Lancaster (1980) describes as **perfect monopolistic competition**. Given the assumed uniform distribution of preferences, the number of goods sold will be spaced evenly around the circle and in equilibrium will be sold at the same price. The actual number of goods supplied will be a function of the degree of preference diversity, the degree and nature of scale economies, and the size of the market.

Given this economy under autarchy, the trading equilibrium can now be examined. Suppose there is another economy exactly equivalent to the one described with an identical production technology for manufactures, the same utility functions, and equal factor endowments with the population uniformly distributed around the circle. As the two economies are identical, they will produce the same number and configuration of goods.

If costless trade can now take place between these two economies, subject to trade being balanced, then effectively the world is a uniform economy with twice the number of consumers as in the individual component economies. The equilibrium that emerges will be sensitive to the assumptions made about the structure of the cost function and the income elasticity of demand.

If the technology is given by a production function homogeneous of degree k, where for economies of scale, k is a constant greater than one, then the number of goods produced and their configuration in the trading equilibrium will be the same as for each country under autarchy, but the quantity of each good produced increases. Because of economies of scale, only one firm in one country will produce a variety of good, so in equilibrium each country sells half of the number of goods it produced under autarchy to a market twice the size. Therefore, there is **pure intra-industry** trade with each country exporting half of its output of manufactures, with all goods selling at the same price, and each country producing its own agricultural needs.

The assumption of homogeneity drives this result because even though average costs fall for each good with the doubling of the population, the ratio of average to marginal costs remains constant, hence there is no incentive for firms to enter with new products[23]. The gains from trade occur due to greater realisation of economies of scale generating lower prices for goods and hence higher real incomes. This equilibrium also assumes that the income elasticity of demand is zero, however if it is greater than zero, more is spent on the manufactured goods and output will more than double.

If the production function is homothetic but not homogeneous, trade will increase the output of each good and reduce average cost relative to marginal cost, consequently, firms will make profits as marginal revenue and marginal cost are equalised. This will attract new firms into the market, resulting in goods becoming closer in their specifications and all goods will be produced in smaller quantities. If there are more goods available, the price elasticity of demand for each good increases which lowers the ratio of price to marginal revenue, whilst lower output increases the ratio of average to marginal costs thus moving the system to equilibrium. Therefore, under these circumstances, the number of goods produced in equilibrium exceeds the total number produced under autarchy and so the consumer gains from greater diversity[24].

In the case where countries are completely similar, the **volume** of trade is determinate[25], however, as with the Krugman-type model, the **direction** of trade is indeterminate. Both Lancaster (1980) and Helpman indicate though that the model can be generalised and synthesised with the Heckscher-Ohlin-Samuelson model in order to make some prediction about the direction of trade. If it is assumed that the production of manufactures is relatively capital-intensive and one of the two countries has a larger endowment of capital than the other, then the country with the higher capital-labour ratio will produce less of the agricultural good and more varieties of manufactures and vice-versa for the other country[26].

As a result of allowing for differing factor endowments, whilst both countries export and import manufactures, the country with the higher capital-labour ratio will be a net exporter of manufactures and a net importer of agricultural output, and vice-versa for the other country. In the limit, with large enough differences in factor endowments, **pure inter-industry** trade will exist in equilibrium[27]. Helpman has also argued that given higher capital-labour ratios are likely to result in higher per capita incomes, then the closer are the per capita incomes of the two countries, then the greater the proportion of intra-industry trade, a prediction having a flavour of Linder's hypothesis.

(iii) In conclusion, it should be noted that various criticisms can be levelled at both types of model; in particular, the Dixit-Stiglitz representation of preferences in the Krugman model, the uniformity of preferences in the Lancaster-Helpman model[28], the assumption of free entry and also the costless adjustment to free trade. However, as argued by many observers, these models represent an important development in the understanding of intra-industry trade in that they represent coherent explanations of the phenomenon and importantly they can be set in a general equilibrium framework.

Duopoly

An alternative, more "exotic" theory (Helpman and Krugman, 1989) of intra-industry trade has been developed by Brander (1981) and Brander and Krugman (1983), which suggests that two-way trade in identical goods may occur. Assume there are two identical economies, i = 1,2, and there is one producer of an identical good in each country. Importantly, it is assumed that each firm treats the two markets as segmented and their interaction in the two markets is modelled as a one-period Nash quantity game, i.e. each firm sets output in order to maximise profits given the output of the other firm. Each firm faces the same linear cost function:

$$c(x) = f + g(x) \qquad (18)$$

where x is output, f is fixed costs, g represents constant marginal costs, and initially there are no transport costs.

The inverse demand functions for the two goods in each country can be written as:

$$p_1 = a - b(x_{11} + x_{12}) \tag{19}$$

$$p_2 = c - d(x_{22} + x_{21}) \tag{20}$$

where the first subscript refers to market, the second subscript refers to firm, and it is assumed a = c and b = d for symmetry.

The profits of the two firms can be written as:

$$\pi_1 = p_1x_{11} + p_2x_{21} - f - g(x) \tag{21}$$

$$\pi_2 = p_2x_{22} + p_1x_{12} - f - g(x) \tag{22}$$

Given the two markets are segmented, the profit-maximising choices for the two firms in each market are independent, hence the focus is initially on firms 1 and 2 in market 1, the first-order conditions for profit-maximisation being:

$$\delta\pi_1/\delta x_{11} = a - 2bx_{11} - bx_{12} - g = 0 \tag{23}$$

$$\delta\pi_2/\delta x_{12} = a - bx_{11} - 2bx_{12} - g = 0 \tag{24}$$

(23) and (24) can be rearranged to give the reaction functions of each firm, i.e. the level of output that will maximise profits, given the output of the other firm:

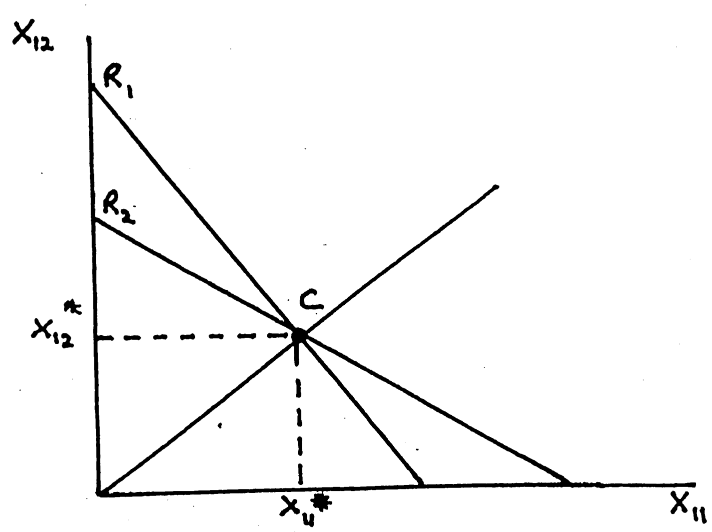
$$x_{11} = (a - bx_{12} - g)/2b \qquad (25)$$

$$x_{12} = (a - bx_{11} - g)/2b \qquad (26)$$

Assuming the appropriate stability conditions hold, equilibrium values of x_{11} and x_{12} can be derived. In a one-period Nash quantity game this will be the Cournot equilibrium C in Figure 2, where R_1 and R_2 are the reaction functions for firms 1 and 2 respectively.

Because of the assumptions made about costs, each firm will have the same market share in market 1, i.e. $x_{11}^* = x_{12}^*$. Repeating this exercise for market 2 would indicate that in equilibrium, $x_{22}^* = x_{21}^*$, and given the symmetric demand conditions, $x_{11}^* = x_{12}^* = x_{22}^* = x_{21}^*$, i.e. each producer supplies half of the market in each country, hence there is **pure intra-industry** trade in the identical good. Essentially, the supernormal profits made under autarchy are an incentive for each firm to trade.

Figure 2



The model can be extended to allow for transport costs, which can be represented in "iceberg" form, i.e. some proportion t of exports is absorbed by freight charges so that tx_{12} arrives in market 1 from firm 2 and tx_{21} arrives in market 2 from firm 1, where $0 < t < 1$. The profits expressions (21) and (22) can now be re-written as:

$$\pi_1 = p_1x_{11} + p_2x_{21} - f - g(x_{11} + x_{21}/t) \qquad (27)$$

$$\pi_2 = p_2x_{22} + p_1x_{12} - f - g(x_{22} + x_{12}/t) \qquad (28)$$

Focussing on the first-order condition for firm 2's exports to market 1:

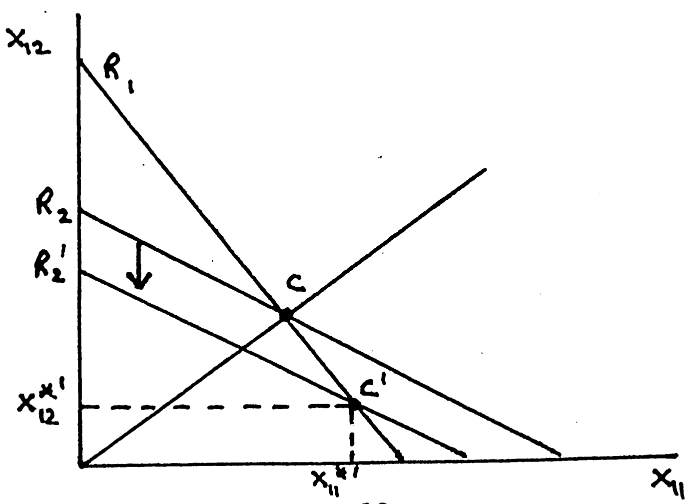
$$\delta\pi_2/\delta x_{12} = a - bx_{11} - 2bx_{12} - g/t \qquad (29)$$

giving the reaction function for firm 2 in market 1 as:

$$x_{12} = (a - b_{11} - g/t)/2b \qquad (30)$$

As t tends to one, the reaction function in (30) converges to that of (26), but as t falls, the reaction function for firm 2, in Figure 3, shifts downwards from R_2 to R_2'.

Figure 3



The new Cournot-Nash equilibrium is at C′, and the new equilibrium outputs are such that $x_{11}^{*\prime} > x_{12}^{*\prime}$ and $x_{11}^{*\prime} > x_{11}^{*}$, $x_{12}^{*\prime} < x_{12}^{*}$. This exercise can be repeated for firm 1′s exports to market 2, and assuming symmetry in transport costs, $x_{11}^{*\prime} = x_{22}^{*\prime} > x_{21}^{*\prime} = x_{12}^{*\prime}$. Allowing for asymmetry in transport costs, and also in the parameters of the cost and demand functions, will clearly affect the equilibrium outcome in both markets. Brander and Krugman have described this type of intra-industry trade as **reciprocal dumping**, which follows from the fact that firms charge lower effective prices in their export markets than in their home markets(30), i.e. the f.o.b price of exports is lower than the domestic price, hence the role of price discrimination in intra-industry trade.

Whilst this model proves quite robust under a variety of assumptions about cost and demand conditions, it has been criticised for its behavioural assumptions (see Greenaway and Milner, 1986)(31), and the fact that intra-industry trade is in identical products (see Kierzkowski, 1985). Whilst it can be shown that this type of model is sensitive to whether firms use either quantity or price as their strategic variables(32), in a recent paper Fung (1988) has used the Kreps and Scheinkman (1983) result to argue that in such a setting, the Cournot-Nash equilibrium will be a sustainable equilibrium(33) in a two-stage game where firms choose capacity in the first stage and then compete in price in the second stage. Also, as Dixit (1988), Cheng (1988) and Fung have shown, it is possible to capture product differentiation in a linear demand system and hence two-way trade in similar but differentiated products can be derived in a simple duopoly model(34).

Oligopoly

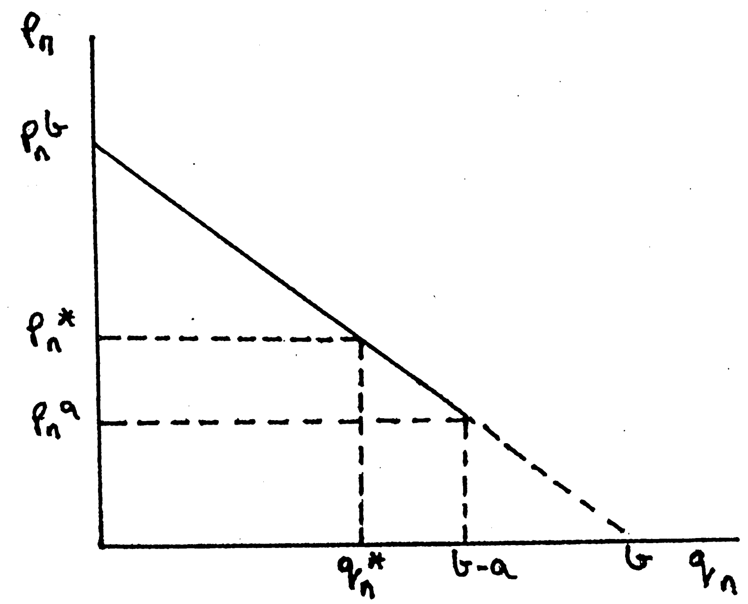
Finally, oligopoly and intra-industry trade can be considered by focussing on the contribution of Shaked and Sutton (1984)[35]. The basic defining characteristic of their model is the nature of product differentiation. Lancaster's approach has been described as "horizontal differentiation" whereby goods differ in specification but not in quality. However, it is possible to conceive of a situation where goods differ in quality such that, when faced with two goods of the same price, all consumers prefer the highest quality good. This has been called "vertical differentiation" and has been developed by Jaskold Gabszewicz and Thisse (1980) and Shaked and Sutton (1982, 1983).

Consider first the situation of autarchy. Market equilibrium can be treated as a three-stage game where; first, firms decide whether or not to enter; second, good quality is selected; and third, prices are chosen. As is common in many game-theoretic settings, the equilibrium is derived by solving backwards from the third-stage. Equilibrium in the final stage will be a Nash equilibrium in prices, i.e. each firm sets a price to maximise its profits, given the prices chosen by its competitors. A Nash equilibrium is also sought in the other two stages of the game (sub-games), the overall solution being a perfect equilibrium[36].

Given this game structure, the third stage of the game can be considered by reference to an example from Shaked and Sutton (1984). Assume that consumers have identical tastes over varieties, but, given differences in their incomes, wealthier consumers are willing to pay a higher price for higher-quality goods. Also, a marginal consumer on the boundary between two bands of income is indifferent between buying the higher-quality good, which has a higher price, and buying the next quality good with a lower price. Consumer incomes are uniformly distributed over the range [a, b], where a > 0. On the production side, firms can produce a single good of some quality level under a technology where average variable costs are zero, the burden of costs coming in the form of fixed R+D costs which vary positively in quality.

Consider the situation where one firm offers the highest quality good n at a price p_n, and the next quality of good n-1 is offered at a price of $p_{n-1} = 0$. In Figure 4, given the income distribution of [a, b], the vertical intercept of the demand curve for firm n will be given by p_n^b where the richest consumer is willing to pay a positive price to consume good n, rather than good n-1. As the price of n is lowered, consumers on lower incomes are willing to purchase product n. Once the lower end of the income distribution is reached at price p_n^a, the poorest consumer is just willing to purchase good n rather than n-1, hence total demand for n is denoted as b-a. In the figure, point b refers to the point where a consumer of zero income would be willing to pay a zero price for good n[37].

Figure 4

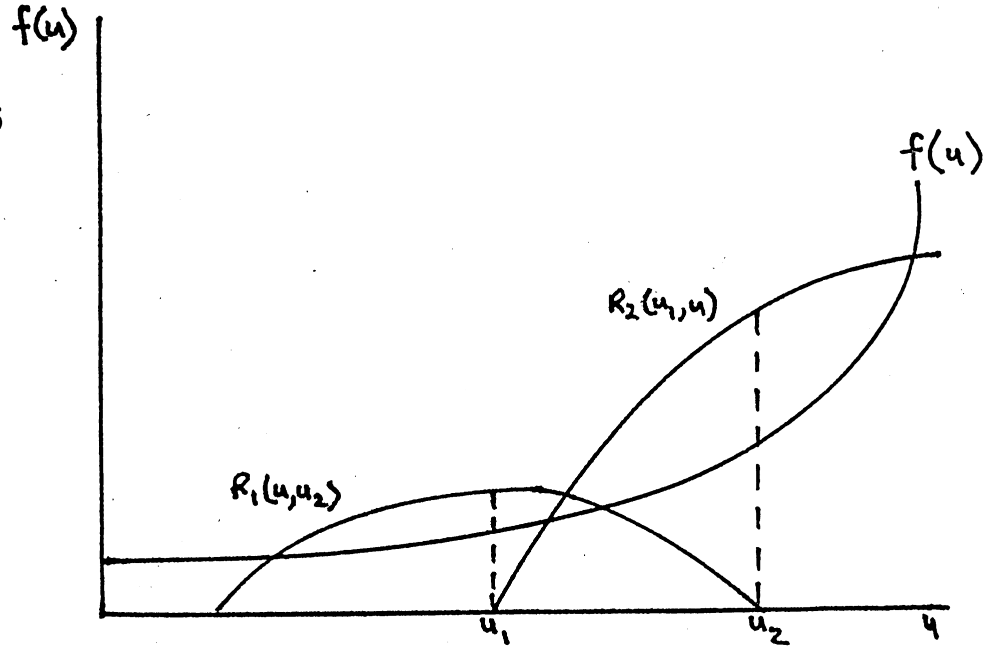


Given this demand curve for a good of quality n, the profit-maximising firm will set a price to maximise profits, i.e. when average variable costs are zero, it will be the mid-point of the demand curve corresponding to p_n^*, q_n^*, where q_n^* is b/2. From this it is possible to define the equilibrium market structure. If the income distribution is (b-a) < b/2, the firm can set a price p_n so low that it is a monopolist, and firm n-1 has a zero market share. This is easily interpreted by rearranging (b-a) < b/2 to be a > b/2, i.e. the distribution of incomes is sufficiently narrow.

If the income distribution is broader, i.e. a < b/2, firm n will not be a monopolist. If the income distribution is such that b/4 < a < b/2, then it can be shown that only two firms can exist in equilibrium, n and n-1. In a Nash game in price with such an income distribution, only two firms can have a positive market share in equilibrium and set prices in excess of average variable costs because prices fall to the point where the poorest consumer just prefers to buy good n-1 at a positive price rather than a lower quality good n-2 at a zero price. Consequently, the number of firms that survive in equilibrium is bounded, depending in general on consumer tastes and the distribution of income. Shaked and Sutton (1983, 1984) describe this as the **natural oligopoly** case[38].

In order to understand the equilibrium of the game more completely, it is necessary to solve the stage two and stage one sub-games. Suppose that the income distribution is such that b/4 ≤ a < b/2, implying only two firms can exist in equilibrium if average variable costs are zero. From the previous analysis, in the third stage of the game, a Nash equilibrium in prices will be established given the qualities of good on offer. Therefore, each firm is faced by a level of profit which is a function of both its quality choice and that of its rival(s).

Figure 5



Suppose the fixed cost of quality improvement is described by the function f(u) in Figure 5, where u is the level of quality, and suppose two firms have entered at stage one of the game. Focussing on the revenue function for firm 2, $R_2(u_1,u)$[39], which is drawn for the choice of quality u_1 by firm 1, the optimal quality choice of firm 2 can be considered. If it chooses u_1, no profit will be made, because two firms selling the same good with zero average variable costs in a Nash game in price, simply bid the price down to cost, i.e. the standard Bertrand outcome. If firm 2 chooses a quality level $u > u_1$, its revenue will increase as it sells a higher quality good at a higher price, the optimal choice being that which maximises the difference between revenue and fixed costs, i.e. at u_2.

In similar fashion, the optimal quality choice for firm 1 can also be analysed, given the choice of u_2 by firm 2. Focussing on the revenue function $R_1(u,u_2)$, if firm 1 were to choose u_2 then its profits would be zero, the Bertrand outcome. As it lowers quality its revenue rises reflecting the lessening of price competition as quality difference widens. However, there comes a point where consumers' willingness to pay for inferior quality declines, given quality

u_2, and so firm 1's revenue function falls. The optimal choice of good is u_1 where profits are maximised. For the pair (u_1, u_2) to be an equilibrium, no other quality choices for either firm 1 or firm 2 can lead to higher profits.

This is the unique equilibrium that would result if two firms entered, given the assumptions made about costs and the distribution of income. If more than two firms entered, competition between the firms would ensure that only two firms could survive, the others making negative profits. Consequently, stage one of the game can easily be solved, given firms have information on the equilibria in stages three and two. Clearly, the wider is the income distribution, the more firms can be sustained in equilibrium and hence the larger the number of entrants at stage one.[40].

The effect of opening up trade in this model can now be considered. Suppose there are two economies that have identical structures to that just described, the only difference being their size. Shaked and Sutton (1984) identify two trade effects in such a situation. In the short-run, the world economy is simply of a larger size, but it can only sustain two firms in equilibrium given the income distribution and technology. Consequently, one producer of each quality of good will be driven from the market by price competition. For intra-industry trade to occur, one firm in each market produces one quality of good, however, the direction of trade is indeterminate. The only gain from trade is a reduction in equilibrium prices.

If the two countries' income distributions are dissimilar, when they trade a larger number of goods can be produced in equilibrium than under autarchy as the income distribution is wider. The direction of trade will also be determinate in this case, as the country with the higher average level of income will tend to specialise in higher quality goods and vice-versa for the country with the lower average level of income. This focus on income gives the model a link back to that of Linder.

In the **long-run**, as the world economy is larger due to trade, the revenue curves in Figure 4 shift up, increasing the marginal returns to a given level of R+D expenditure. Hence in equilibrium, the optimal choices of u_1 and u_2 are higher than under autarchy, so that firms gain from trade and consumers get higher quality. Some difference in the distributions of income will ensure determinacy in the direction of trade.

In summary, whilst the Shaked and Sutton (1984) approach is relatively sophisticated, using a specific, perfect information game-theoretic solution, their model captures some important styleised facts about market structures and production technology for certain goods and also the nature of trade in such goods,(Greenaway and Milner, 1986, suggest the example of cars and consumer electronics).

(c) Summary of Hypotheses

The foregoing analysis reviewed in some detail the various ways in which intra-industry trade can be rationalised theoretically. However, the fact that very different assumptions about market structure, production technology and product differentiation can generate intra-industry trade in an open economy, creates a problem for hypothesis testing. In the case of the Heckscher-Ohlin-Samuelson model, it is relatively easy to construct a test of the factor endowment explanation of inter-industry trade. In contrast, the various models outlined indicate that there is unlikely to be a universal test for the theory of intra-industry trade.

In principle, it ought to be possible to test specific hypotheses relating to intra-industry trade, however, as will be discussed in Section 3, making these models operational empirically is/has been difficult. Importantly, there are various problems of variable measurement, many of which are common to applied work in industrial organisation. For example, it is difficult to capture behavioral assumptions about oligopolistic interdependence and to measure product differentiation. As a consequence of this, little direct testing of the models of intra-industry trade has taken place, and whilst many empirical studies[41] have examined the relationship between intra-industry trade and economies of scale and product differentiation, as Greenaway and Milner (1986) note, none can be considered as having related to a specific model.

Notwithstanding the lack of a general model of intra-industry trade, there are various common themes in the literature that can loosely be described as a "general" set of hypotheses about its determinants. Adapting a table from Greenaway and Milner (1986), Table 1 lists various reasons for the existence or otherwise of intra-industry trade between countries. The extent of empirical evidence in favour of these characteristics will be outlined in Section 3.

Table 1 Factors Affecting the Level of Intra-Industry Trade

1. Taste Similarity
2. Product Differentiation
3. Scale Economies
4. Number of Firms in Differentiated Goods Markets
5. Oligopolistic Interdependence in Homogeneous Goods Markets
6. Technological Factors, Vertical Differentiation
7. Proximity of Markets
8. Extent of Tariff and Non-Tariff Barriers to Trade
9. Extent of Foreign Direct Investment

2. MEASUREMENT OF INTRA-INDUSTRY TRADE

As noted in the introduction, much of the work on intra-industry trade has focussed on its measurement. As the various indices of intra-industry trade have been carefully reviewed in Tharakan (1983) and Greenaway and Milner (1986) only the main indices are outlined here. Following Kol and Mennes (1986), measures of intra-industry trade can be grouped under two main headings; the first and most common type of index includes both imports and exports for a given country at an industry/sector/country level, hence the concept being assessed is **overlap in trade flows**. The second type of index compares **patterns** of imports and exports separately, focussing on a single country relative to a group of countries for an industry/sector/country. This type of measure can also be used to assess the degree of **intra-industry specialisation**, i.e. the extent to which factors of production are being used to produce specific products within an industry at the expense of other products.

(a) Overlap in Trade Flows

The focus here will be on the well-known indices of Balassa (1966) and Grubel and LLoyd. Balassa's index can initially be written as:

$$B_j = \frac{|X_j - M_j|}{(X_j + M_j)} \quad , 0 \leq B_j \leq 1 \qquad (31)$$

which measures the extent to which the value of a country's exports X_j is offset by its imports M_j, relative to gross trade, where j is a given level of aggregation. B_j takes a value of zero for pure intra-industry trade.

In aggregating across goods/industries/sectors, it is important to note the weighting characteristics[42] of the index, particularly if it is used as a summary measure of intra-industry trade at a country-level. Suppose j is an aggregate across two industries i = 1 and 2, (31) can be re-written as:

$$B_j = \frac{|X_1 + X_2 - M_1 - M_2|}{(X_1 + X_2 + M_1 + M_2)} \qquad (32)$$

If each industry i has the same sign on its trade balance, then the Balassa index is a weighted average of the two industries. If, however, the two industries have opposite signs on their trade balances, this weighting effect is lost. In order to guarantee the weighting property, B_j should be adjusted to:

$$B_j' = \frac{\sum_{i=1}^{n} |X_{ij} - M_{ij}|}{(X_j + M_j)} \qquad (33)$$

The bulk of the empirical work on intra-industry trade has used the index suggested by Grubel and Lloyd, which is written as:

$$GL_j = \frac{(X_j + M_j) - |X_j - M_j|}{(X_j + M_j)} \qquad (34)$$

which can be re-arranged as:

$$GL_j = 1 - \frac{|X_j - M_j|}{(X_j + M_j)} \quad , \; 0 \leq GL_j \leq 1 \qquad (35)$$

where GL_j is unity for pure intra-industry trade, i.e. it is simply $(1 - B_j)$. Consequently the Grubel and Lloyd index has the same weighting characteristics as the Balassa index and should be adjusted to:

$$GL_j' = 1 - \frac{\sum_{i=1}^{n} |X_{ij} - M_{ij}|}{(X_j + M_j)} \qquad (36)$$

Given these two measures of trade overlap, it is important to recognise two technical problems that arise in the measurement of intra-industry trade. The first concerns the adjustment of indices for **aggregate trade imbalance**. Given that products/industries/sectors can be chosen at a particular level of aggregation, it may be the case that there is no overall trade balance such that: $\sum_{i=1}^{n} X_{ij} \neq \sum_{i=1}^{n} M_{ij}$, which implies that, $\sum_{i=1}^{n} |X_{ij} - M_{ij}| > 0$. Looking at GL_j', it means that it must take a value less than one.

This characteristic of the indices has raised the question as to whether they are fundamentally biased measures of intra-industry trade. Both Grubel and Lloyd and Aquino (1978) argue that there is a bias and have suggested adjustments to the measurement of intra-industry trade. Focussing on Grubel and Lloyd, they argue that intra-industry trade should be derived as a proportion of total trade imbalance:

$$GL_j^{\circ} = \frac{(X_j + M_j) - \sum_{i=1}^{n} |X_{ij} - M_{ij}|}{(X_j + M_j) - \left| \sum_{i=1}^{n} X_{ij} - \sum_{i=1}^{n} M_{ij} \right|} \qquad (37)$$

which can be re-written as:

$$GL_j^{\circ} = GL_j'/(1 - \omega) \;,\; 0 \leq GL_j^{\circ} \leq 1 \qquad (38)$$

where: $$\omega = \frac{\left| \sum_{i=1}^{n} X_{ij} + \sum_{i=1}^{n} M_{ij} \right|}{(X_j + M_j)}$$

Hence the value of the adjusted GL_i^o index increases as ω increases and it indicates what would have been the level of intra-industry trade in the absence of a trade imbalance. Greenaway and Milner (1981, 1986) have questioned whether such an adjustment is actually necessary. In particular, the adjustment presumes *a priori* that the observed trade imbalance reflects trade disequilibrium. However, for a particular group of industries, trade imbalance is not necessarily inconsistent with macro-equilibrium. Therefore, some care should be taken when making the above type of adjustment.

The second technical problem that arises in the measurement of intra-industry trade is known as **categorical aggregation.** This occurs when products are aggregated together in inappropriate trade groups and is essentially the same problem that occurs in applied industrial organisation, i.e. what is the correct way of defining an industry? Given that intra-industry trade is defined as trade in similar but differentiated products, the researcher needs to be sure that is what is being measured, as opposed to industry mis-specification.

Essentially two procedures have been adopted to deal with the problem:

-first, researchers have re-grouped trade data into their own concepts of an industry. For example Balassa (1966) grouped third and fourth-digit SITC data into 91 industries. Clearly such a method is open to subjective bias.

-second, researchers have selected a particular level of statistical aggregation in the published data that best conforms to their concept of an industry. In principle, such a technique should make use of external evidence on factor inputs and elasticities of substitution. Greenaway and Milner (1983, 1985) note that there appears to be a fair degree of consensus over which level of SITC category to use, most researchers adopting the third-digit classification. Although consensus does not imply correctness, casual tests indicate that the choice of the third-digit level is not unreasonable. For example, Greenaway and Milner (1983) regrouped third, fourth and fifth-digit SITC data into SIC Minimum List Headings for the UK and found, for the Grubel and Lloyd index, a high degree of correlation between the two classifications. They also indicate that in moving from the third to the fourth-digit level of the SITC, whilst there is a decline in the recorded values of intra-industry trade, it is not a substantial decrease. Hence they take the essentially pragmatic view that the three-digit level is not an unreasonable proxy for an industry.

(b) Trade Patterns

The second type of index in the literature is aimed at examining patterns of exports and imports separately and can be used to establish the extent to which intra-industry trade is accompanied by intra-industry specialisation. The focus here will be on an index suggested by Glejser, Goosens and Vanden Eede (1982). Their index is one of either export or import specialisation, based on measuring changes in an individual country's trade relative to changes in total trade of a group of countries. For example, if a country's exports increase at a rate equal to or less than that for the group, this represents intra-industry specialisation in supply. However, if exports change at a faster rate than that for the group, this is inter-industry specialisation.

Focussing on exports, the following coefficient can be calculated[43]:

$$\xi = 1/n \sum_{j=1}^{n} \log[\{X_{ij}/\Sigma X_{ij}\}/\{\Sigma X_j/\Sigma X\}] = 1/n \sum_{j=1}^{n} \xi_j \qquad (39)$$

where ξ = the mean level of export specialisation at a point in time.

X_{ij} = exports of industry j by country i to a group of countries, e.g the EC.

ΣX_{ij} = total exports of all industries from country i to the group.

ΣX_j = total intra-group exports of industry j, excluding those of i.

ΣX = total intra-group exports of all industries, excluding those of i.

If intra-industry specialisation within the group is a predominant feature of trade in industry j for country i, the ratio inside the brackets will be close to one (close to zero in logs). Further, if intra-industry specialisation is a feature of a country's trade with a group, one would expect the variance of the ξ_j around the mean to be small, the variance being given as:

$$1/n \sum_{j=1}^{n} (\xi_j - \xi)^2 = s^2\xi_j \qquad (40)$$

This can be used to ascertain whether intra-industry specialisation for a country has increased significantly over time, i.e the variances should be significantly smaller (using an F-test[44]). The test is given by:

$$s^2\xi_j^t / s^2\xi_j^{t'} = \rho \quad \text{where } t \neq t' \qquad (41)$$

McCorriston and Sheldon (1989) have also shown that the Glejser *et al* measure can be adjusted to measure the geographical distribution of intra-industry specialisation for a given product. It may be the case that within any group of countries, growth in intra-industry specialisation for any given product could differ significantly between different national markets within the same trading bloc, and hence shed some light on the extent of market integration/fragmentation.

3. ECONOMETRIC TESTING

Relative to the number of econometric studies of the profits/concentration relationship in the industrial organisation literature, very few studies have been made of the determinants of intra-industry trade. Greenaway and Milner (1986) have reviewed most of these studies and Connor (1988) has summarised many of the results, however it is worth reviewing the basic findings of the studies to date.

Most empirical work has set out to estimate a regression model of the following styleised form:

$$IIT_j = \alpha_0 + \alpha_1 c_{1j} + \ldots\ldots + \alpha_n c_{nj} + \epsilon_j \qquad (42)$$

Where the dependent variable IIT_j is an index of intra-industry trade for an industry $_j$ and the c_{ij}, i = 1,...,n, are a vector of either industry and/or country characteristics such as those listed in Table 1. Most studies have estimated (42) over a cross-section of industries using either bilateral or multilateral trade data, whilst some studies, notably those of Balassa (1986) and Balassa and Bauwens (1987), have adopted a multi-industry, multi-country framework.

As noted in Section 2 of the paper, there are several problems in measuring the explanatory variables in (42), however, as these problems are fairly familiar to applied researchers in industrial organisation, only brief mention will be made of some of these. Given the importance of product differentiation, economies of scale and market structure in the theoretical work on intra-industry trade, it is perhaps unfortunate that they prove the most problematic to characterise in econometric analysis[45]. At the outset it is crucial to recognise that these characteristics can only be proxied in a fairly crude way and hence any results need to be treated with caution.

In the case of **product differentiation**[46], the earlier analysis suggested a variety of means in which demand technology can be tied down theoretically all of which are difficult to capture empirically. Most commonly, industrial economists have proxied horizontal differentiation by using some measure of advertising intensity. However, such a variable suffers from a variety of well-known problems, in particular, it may be determined endogenously by market structure rather than exogenously by preference diversity[47].

Other researchers have proxied product differentiation with the Hufbauer (1970) index:

$$H = \sigma_{ij}/\mu_{ij} \tag{43}$$

where σ_{ij} is the standard deviation of the export prices for good i to country j and μ_{ij} is the unweighted mean of the export prices. The intuition of the index is that it captures the dispersion of export prices in a particular product group, and hence can be regarded as a measure of vertical product differentiation and possibly technological differentiation[48]. There are two obvious problems with the index; first, export price variations may have nothing to do with product differentiation, and second, some of the theories outlined earlier indicate that a country may export a small range of products to a wide variety of destinations.

The other common method of characterising product differentiation has been to choose a level of disaggregation in the SITC and then to count the number of goods categories at a lower level of disaggregation. Clearly such a method can be regarded as *ad hoc* and may well be open to the problems of categorical aggregation outlined in Section 2.

In the case of **economies of scale** it is important to recognise that most of the theoretical literature on intra-industry trade characterises firms' cost structures in terms of a fixed cost element rather than the more conventional manner of plant scale, and very often these economies are constrained to occur locally along the cost function. Consequently, care has to be taken in using the normal scale-type indicators such as proxies for minimum efficient scale (m.e.s). It may be the case that the link between intra-industry trade and economies of scale is discontinuous such that, when m.e.s is very large relative to market size, the number of producers sustainable in long-run equilibrium is very small and generates product standardisation rather than differentiation. Notwithstanding this problem, the usual array of proxies for economies of scale have been used in econometric work such as, length of production runs, plant and establishment size, and m.e.s relative to market size.

The models outlined in Section 1 all draw on different models of **market structure** with associated forms of market conduct. Empirical work in industrial organisation has long struggled with the problems of capturing market structure and inferring market conduct. Even though it has been rigorously shown[49] that the degree of firms' interdependence, measured in terms of conjectural variations, and seller concentration may both have a positive impact on the level of monopoly profits, conjectural variations parameters are difficult to estimate consistently across industries and there are many well-known problems associated with indices of seller concentration[50]. Therefore, at best, the effects of market structure on intra-industry trade can only be captured very roughly.

Bearing in mind these and other measurement problems, and also the difficulty of comparing studies with differing explanatory variables, sample sizes and periods, and functional forms, Table 2 summarises some of the econometric studies[51].

As is usual in cross-sectional studies of this type, and given the proxy nature of many of the explanatory variables, the values for R^2 tend to be low. In the case of the individual explanatory variables, the following conclusions can be drawn:

Taste Overlap - this has the expected positive sign and is significant at the 1% level in six studies.

Product Differentiation - in all but one study, both the census classification and Hufbauer indices have the expected positive sign, the latter being significant at the 1% level in three studies. The results for the marketing inputs and the advertising intensity indices are more mixed with positive and negative coefficients on both variables. The former index is significant at the 1% level in both the Balassa (1986) and Balassa and Bauwen's studies and the latter is significant at the same level in Greenaway and Milner's (1984) study.

Economies of Scale - the results for this variable exhibit the type of problem outlined earlier. Depending on the form of measurement, six studies found a negative coefficient for scale economies, significant at the 1% level in three cases, whilst three studies found a positive coefficient, significant at the 1% level in three cases.

Market Structure - Surprisingly, this is included in only four of the studies, but in all cases the coefficient on this variable has the expected negative sign, i.e. as a market becomes less competitive, there is less potential for intra-industry trade. In all cases the variable is significant at at least the 5% level.

Technological Factors - this variable is non-significant in all studies.

Distance - there is some inconsistency in the results for this variable. It has the expected negative sign when measured by physical distance and is significant at the 1% level in two cases. Variable D2 implies that the further products can be profitably shipped, the less important are transport costs relative to other costs, suggesting *a priori* a positive sign on the coefficient. In four studies a negative sign is found on the coefficient, significant at the 1% level in two cases. In the case of the common border dummy, Balassa and Bauwen's study finds a positive coefficient, significant at the 1% level, whilst Bergstrand's (1983) study finds a negative coefficient, significant at the 1% level.

Trade Barriers - using the tariff dispersion measure, three out of five studies find a negative coefficient on this variable which is significant at the 1% level in the studies by Pagoulatos and Sorenson (1975) and Balassa and Bauwens. The non-tariff barrier variable also has a negative but insignificant coefficient in the former study and that of Toh (1982).

Foreign Direct Investment - only the studies by Caves (1981), Balassa (1986) and Balassa and Bauwens include this variable. When an index of the level of foreign direct investment is used, the expected negative coefficient is obtained in the three studies, significant at the 5% level and above in two. In the case of intra-firm trade between multinationals and their foreign affiliates, Caves finds

TABLE 2. ECONOMETRIC RESULTS: DETERMINANTS OF INTRA-INDUSTRY TRADE

	Pagoulatos and Sorenson (1975)	Finger and deRosa (1979)	Loertscher and Wolfe (1980)	Caves (1981)	Lundberg (1982)	Toh (1982)	Bergstrand (1983)	Greenaway and Milner (1984)	Tharakan (1986)	Balassa (1986)	Balassa and Bauwens (1987)
COUNTRY	USA	USA	OECD	14 OECD	Sweden	USA	14 OECD	UK	5 industrial countries	USA	38 countries, 18 developed, 20 developing
YEAR	1965, 1967	1963, 1967, 1972, 1975	1971, 1972	1970	1970, 1977	1970, 1971	1976	1977	1972, 1973, 1974	1979	1979
TIME PERIOD	Annual	Annual	Annual Avg.	Annual	Annual	Annual	Annual	Annual	Annual	Annual	Annual
TRADE FLOWS	Multilateral	Trade with 13 countries	Bilateral	Within industrial group	Multilateral	Multilateral	Bilateral	Multilateral	Trade with developing countries	Manufactures from SITC	Manufactures from SITC
PRODUCT GROUPS	Manufactures from SITC	SITC 5-8	SITC 5-8	SITC Matching U.S. SIC	ISIC 3	U.S. SIC	SITC 7	UK SIC	SITC 5-8	Subjective groups using 4-digit	Subjective groups using 4-digit
LEVEL OF AGGREGATION	3-digit	3-digit	3-digit	3-digit	4-digit	4-digit	2-digit	3-digit	3-digit	4-digit	4-digit
SAMPLE SIZE	102	75	59	94	77	112	130	68	102	167	152
FUNCTIONAL FORM	Double log-linear	Linear	Logit	Logit	Linear	Linear	Logit	Double log-linear	Logit	Logit	Logit
ESTIMATION PROCEDURE	OLS	OLS	WLS	OLS, WLS	OLS	OLS	WLS	OLS	WLS	NLLS (logistic)	NLLS (logistic)
INDEX OF INTRA-INDUSTRY TRADE	GL	GL	A	GL	GL	GL	GL, A, B,	GL, B	GL	B, A	B, A

KEY TO TABLE 2: GL = Grubel and Lloyd (1975); B = Balassa (1966); A = Aquino (1978)

(+)TO1 = direction of trade, similarity of per capita income
(+)TO2 = proxy of taste difference

(+)PD1 = number of products in 3-digit
(+)PD2 = Hufbauer index
(+)PD3 = inputs into sales activities
(+)PD4 = advertising/sales

(−/+)SE1 = measure of m.e.s.
(+)SE2 = production run, share of labour in large plants
(+)SE3 = scale factor

(−)MS1 = 5−firm concentration ratio
(−)MS2 = internationally adjusted concentration ratio
(−)MS3 = entry barriers to foreign firms

(+)TF1 = R&D intensity
(+)TF2 = technical personnel
(+)TF3 = product variety turnover

(−)D1 = physical distance
(+)D2 = distance shipped in U.S.
(+)D3 = dummy for border

(−)TB1 = nominal tariffs
(−)TB2 = non-tariff barriers

(−)FDI1 = extent of foreign direct investment
(+)FDI2 = importance of intra-firm trade

Sign in brackets is expected sign on coefficient

	Pagoulatos and Sorenson (1975)	Finger and deRosa (1979)	Loertscher and Wolfe (1980)	Caves (1981)	Lundberg (1982)	Toh (1982)	Bergstrand (1983)	Greenaway and Milner (1984)	Tharakan (1986)	Balassa (1986)	Balassa and Bauwens (1987)
TO1	*+		*+			n.s+		*+	*+	*+	*+
TO2							n.s+				
PD1	t +		n.s+	t +				*+	n.s−		
PD2	n.s+	t +		n.s+		*+				*+	*+
PD3				n.s−	n.s−					*+	*+
PD4				n.s−				*+	n.s+	n.s−	
SE1			*−	n.s−				n.s−			
SE2					n.s+	*+				*−	*−
SE3		n.s−					*+				
MS1								t −			
MS2						*−				*−	*−
MS3						t −					
TF1				n.s+	n.s+			n.s+			
TF2					n.s+						
TF3		n.s−									
D1							*−			n.s−	*−
D2	*+		*−	n.s−		n.s−			*−		
D3							t −				*+
TB1	*−			n.s+		n.s+	n.s−				*−
TB2	n.s−					n.s−					
FD1				t −						n.s−	*−
FD2				t +							*−
$\bar{R}^2$	0.40	0.12	0.07	0.27	0.25	0.32	−−	0.50	0.60	0.47	0.44
F	7.59	2.16	39.72	3.24	3.95	5.30	8.89	10.58	48.59	−−	−−

* = 1% level of significance
t = 5% level of significance
n.s = non−significant
+,− = sign on coefficient

a positive coefficient, significant at the 5% level, whilst Balassa and Bauwens find a negative coefficient, significant at the 1% level.

As noted earlier, given the problems in measuring many of the explanatory variables in equation (42) and also the associated econometric problems not discussed here, a good deal of caution should be exercised in drawing any firm conclusions from the empirical work on intra-industry trade. However, one can argue that the studies surveyed do indicate some support for the theory of intra-industry trade. Variables such as market structure, product differentiation and economies of scale do have some explanatory power along with other factors[52]. As Greenaway and Milner (1986) conclude,

> "Greater confidence in and refinement of these conclusions will require, however, that measurement/proxy errors can be reduced, and that in turn this will permit more sophisticated modelling."

4. INTRA-INDUSTRY TRADE AND PROCESSED AGRICULTURAL PRODUCTS

This review of theoretical and empirical work on intra-industry trade indicates a number of obvious directions in which research might go in relation to processed agricultural products:

- **first**, it is important to establish whether intra-industry trade is a characteristic of trade in processed products. Most empirical work to date has either excluded analysis of the food industries, included it in a wider sample of manufacturing industries, or derived only aggregate levels of intra-industry trade across the food and agricultural sectors. Assuming sensible industry definitions can be derived, it will be relevant to consider the extent of differences in intra-industry trade across food products, following some sort of classification system. For example, Elleson (1988) divides up high-value products into; **highly processed products** (e.g. preserved meat and cheese products), **semi-processed products** (e.g. wheat flour and animal feed) and **unprocessed high-value products** (e.g. eggs, fresh fruit and vegetables). Alternatively, Connor *et al* (1985) have adopted the "strategic groups" approach to describe the four major marketing channels in the US food chain. *A priori*, one would expect the advertised brands sector to show high levels of intra-industry trade in contrast to the producer goods, food service and unbranded goods sectors.

Such measurement could draw comparisons between the levels of intra-industry trade in food products for the US and other developed countries, either individually or in relevant groupings such as the EC, using both bilateral and multilateral analysis. The geographical pattern of intra-industry specialisation could also be considered, indicating the extent to which the US is being "locked out" of intra-European trade and other trading areas.

- **second**, as well as measurement of intra-industry trade, Sections 1 and 3 of the paper indicate the potential for cross-sectional analysis of the inter-industry, inter-country characteristics of trade in food products. Again, this could be conducted for the US and other developed countries on a bilateral and multilateral basis. Given the nature of market structures in the food industries, there is potential to test more directly the theories of intra-industry trade. For example, the advertised products sector could be characterised as having market structures lying along a spectrum between imperfect monopolistic competition and oligopoly, i.e. only a small number of varieties can be sustained in equilibrium. Technically, it ought to be possible to tie down the factors that limit the number of varieties under autarchy and hence test for the effects of trade and the role of such market structures. Alternatively, other sectors with more homogeneous products may exhibit trading characteristics of the reciprocal dumping model.

Also, in the context of the initial findings of Handy and Macdonald (1989), it will be interesting to consider the impact of multinational firms on the level of intra-industry trade in food products. In the limit, given that there are two-way international flows of capital in the food sector, it may be the case that foreign direct investment is a substitute for intra-industry trade, i.e. there are no observed trade flows but the benefits of variety, fuller realisation of economies of scale and competition are reaped in the relevant countries. Interestingly, Brander and Krugman, in their reciprocal dumping model, note that firms have an incentive to save transport costs by producing in the foreign market, generating two-way trade in foreign direct investment

In addition to regression analysis, using the variance-based measure of Glejser *et al* outlined earlier, an analysis of the variance of intra-industry specialisation in food products over time could be conducted. This may prove particularly relevant in the period after the time-tabled completion of the EC internal market in 1992. If internal barriers are to be removed by 1992, *a priori* one would expect to see markets becoming less fragmented and individual member countries becoming specialised in the production of certain varieties sold throughout the EC.

- finally, in conducting research on intra-industry trade, it is important to be aware of its potential policy and welfare implications. At first glance, the benefits of intra-industry trade, and hence the policy outcome, seem straightforward. It generates benefits in the form of greater variety, it possibly leads to the increased realisation of economies of scale and it may also act as a constraint on the use of market power. Therefore, the policy prescription would seem to be one of promoting free trade, which is in accord with the basic proposition of neo-classical trade theory, i.e. there should be no policy intervention unless there are distortions in factor and product markets (see Johnson, 1965, and Bhagwati, 1971). However, developments in the international economics literature indicate that there may be incentives for governments to intervene in markets where there is imperfect competition. Although space constraints do not permit a proper discussion[53] of this literature, it is important to note that work by Brander and Spencer (1985) and Eaton and Grossman (1986), amongst others, suggests that where markets are imperfectly competitive, there may be 'rent-shifting' arguments for intervention in the form of subsidies and tariffs.

In the context of intra-industry trade, much of this literature has focussed on models that have a similar structure to the duopoly, reciprocal dumping model of Brander and Krugman (1983). Returning to Figure 3, it can be seen intuitively that, in either the home or foreign market , governments have an incentive to try to shift market share and hence rents to their own firms by using either import tariffs in the home market, which shifts the foreign firm's reaction function, or export subsidies in the foreign market, which shifts the home firm's reaction function. Thursby (1988) has already modelled the effects of such intervention in relation to state trading in agricultural products.

Lancaster (1984) and Helpman and Krugman (1989) have also considered policy implications in the context of monopolistic competition. Lancaster has shown that under certain assumptions, the unilateral imposition of a tariff in the characteristics-type framework can lead to gains through greater product variety in the home market. Whilst Helpman and Krugman (1989) have shown that a positive tariff can lead to gains in the Dixit-Stiglitz framework by increasing demand for domestically produced goods whose price is greater than marginal cost.

In conclusion therefore, there are a number of directions in which empirical work on intra-industry trade might go in relation to processed food products, both in terms of basic measurement and econometric analysis. Having established its existence or otherwise, it is important to recognise its potential policy implications, and whilst empirical work on strategic trade policy is still in its infancy, the use of simulation models, such as those suggested by Dixit (1987) and Baldwin and Krugman (1987)[54], may prove to be another useful avenue for research on trade in processed food products.

NOTES

1. Helpman and Krugman (1985) have synthesised some of the theoretical work done in this area. See also Krugman (1987).
2. Greenaway and Milner (1986) note that intra-industry trade is often a recorded feature of trade in primary products and raw materials.
3. This survey will necessarily be selective, however Greenaway and Milner (1986) provide a reasonably thorough review of the literature.
4. This was largely prompted by Leontieff (1953) who found that US exports had a lower capital/labour content than US imports, despite the US being relatively capital abundant.
5. See Söderston (1980) and Ethier (1983) for discussions of the alternative theories of trade.
6. It is important to note that Linder's model does not predict the **direction** of trade.
7. Although the terms intra-industry trade and intra-industry specialisation tend to be used interchangeably, the latter refers to the concentration of factors of production on specific products in the same industry.
8. See Tharakan (1983) for a discussion of the exchange between Gray (1973) and Davies (1977).
9. The basic Chamberlin model lacked a rigorous treatment of the process of product differentiation, preventing its use in trade theory, see Johnson (1967) and Krugman (1987).
10. See Greenaway and Milner (1986) for a more complete coverage.
11. The description here follows Krugman (1980).
12. This can be generalised to several industries.
13. By implication, firms can costlessly differentiate their products.
14. Given $0 < \theta < 1$, then expression (9) indicates price will exceed marginal cost.
15. Real wages can also be derived.
16. Suppose under autarchy there were four goods, with symmetry each firm in equilibrium would have a quarter of the market, when trade occurs, there are eight goods in equilibrium, hence each firm has

an eighth of a market that has doubled in size, so output of each firm remains unchanged. As Krugman (1979) has shown and Lancaster (1982) and Mussa (1982) note, if the elasticity of demand were to increase with the number of goods, then firms would move down their long-run average cost curves, hence in a trading equilibrium there would be increased realisation of economies of scale.

17. Bhagwati (1982), Feenstra (1982) and Falvey Kierzkowski (1987) note that such an indeterminacy can be removed by allowing for technology differences.
18. Krugman (1981) has also done this.
19. Lancaster (1980) generalises his model to multiple manufacturing industries.
20. Alternatively a line specification can be used, although assumptions then have to be made about the end points of the line.
21. Helpman (1981) assumes the radius of the circle is $1 = 1/\pi$, therefore the population density at any point on the circle will be $L/(2\pi 1) = L/2$, where L is the population.
22. The trade equilibrium in Lancaster's model is actually quite sensitive to the nature of the cost function.
23. In equilibrium, average cost ac is equal to price p and marginal cost mc is equal to marginal revenue mr, hence, ac/mc = p/mr, where the second term is related to the price elasticity of demand. Hence if ac/mc is a constant for a homogeneous cost function and mc = mr in equilibrium, then if ac falls with increased output price must also fall and there will be no incentive for firms to enter.
24. Due to the entry of new products, existing firms will be forced to alter their product specifications which may result in losses to marginal consumers who can no longer consume their ideal product. This will be outweighed by gains to other consumers.
25. As Lancaster (1980) shows, the equilibrium will be stable with constant returns to scale in agriculture as long as the income elasticity of demand is greater than or equal to one.
26. This is the intra-industry trade equivalent of the Rybczynski Theorem.
27. It is still not possible to predict the precise direction of trade.

28. Lancaster (1979) does recognise the possibility of differing preference distributions between the two countries and indicates intra-industry trade occurs where the distributions overlap.

29. $a - g/t$ is the intercept of the reaction function, which given $0 < t < 1$, means $a - g/t < a - g$.

30. For each local firm, the perceived marginal revenue is higher in the foreign market than the home market due to lower market share, whilst the marginal costs of exports are higher due to transport costs. Thus perceived marginal revenue is equated with marginal cost in both markets at positive outputs, which leads to two-way trade, and export prices are lower because of transport costs.

31. The Brander and Krugman (1983) model has been criticised on the grounds that zero conjectural variations in the case of Cournot behaviour is inconsistent, as originally suggested by Bresnahan (1981), However, in a one-shot game, the Cournot result can be defended on the grounds that conjectures are not meaningful in a static game.

32. Eaton and Grossman (1986) have shown how differing behavioral assumptions have important implications for strategic trade policy.

33. The equilibrium in such a game is known as a perfect equilibrium which is one that rules out non-credible threats, therefore, each part of a two-stage game is sub-game perfect. Hence each firm chooses a level of capacity in the first stage that will generate credible equilibrium prices in the second-stage.

34. In the case of market 1, the demand function can be written as:

$$p_1 = a_1 - bx_{11} - \gamma x_{12} \ , \ \gamma \geq 0.$$

35. There are other models of oligopoly generating intra-industry trade, e.g. Eaton and Kierzkowski (1984).

36. This rules out a firm trying to offer a high-quality good at a low price which is not profitable.

37. If $p_{n-1} > 0$, this merely shifts out the demand curve for n.

38. Shaked and Sutton (1983, 1984) define a more general finiteness property in their model which depends on the relationship between average variable costs and quality.

39. This level of revenue is proportional to the size of the economy s, i.e. as s increases, so R^2 and R^1 will increase. However, no new firms can enter, because each firms' demand curve shifts proportionately, raising revenue and profits but leaving equilibrium prices unchanged.
40. The precise proofs of this equilibrium are contained in Shaked and Sutton (1982).
41. See Section 3.
42. The use of gross trade in the denominator can bias the estimate of intra-industry trade.
43. A similar coefficient can be constructed for imports.
44. The test has been criticised by Fase (1983).
45. Other explanatory variables such as non-tariff barriers are also difficult to measure.
46. See Greenaway (1984) for a fuller discussion.
47. Inspection of the Dorfman-Steiner condition for optimal advertising indicates this.
48. This is the outcome of innovations leading to improved products throughout the price/quality range.
49. See Cowling and Waterson (1976).
50. See any industrial organisation text.
51. Not all results have been reported.
52. It is interesting to note the results of Marvel and Ray (1987) here, who found little support for the product differentiation, economies of scale explanation for intra-industry trade.
53. See Helpman and Krugman (1989) for an analysis of this literature.
54. Helpman and Krugman (1989) have surveyed the literature to date using simulations.

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