In general we can say that Post-Keynesians either see demand creating its own supply fully, or if the response of the money supply is not fully accommodating, then velocity will increase to fill the gap. Changes in the money supply and changes in velocity are considered substitutes for one another. The interest rate is exogenously set by the central bank which then determines credit demand and velocity accommodates the needed supply. The interest rate is not viewed as having any direct affect on the desire to hold money i.e. on any portfolio composition demand. And the stability of velocity is based on money supply, or better yet, credit supply accommodation and not on conventional Monetarist reasoning.

Neo-Ricardians take the position that it is the wrong approach to model the financial side of the system in terms of specifying separate demand and supply curves for money. As Professor Moore puts it: “Money does not enter the system like manna from heaven—or from the sky via Milton Friedman’s helicopter. Nor is it simply the creature of the central bank policies.” One should regard the money supply as essentially endogenous responding and accommodating to the level of money wages. And this view is in keeping with the historical fact, that the purpose of central banks has been to accommodate the stock of money to changes in the needs for trade.

Let us end by saying that when we take the interest rate as exogenously determined, and then view velocity in the Post-Keynesian frame, we do sever the Keynesian link between velocity and the rate of interest.

NOTES
2. ibid., p. 157.
4. ibid., p. 96.

A Product Line Life Cycle Model of Intra-industry Trade
William Milberg*

Disatisfaction with traditional, static, factor endowments theories of international trade has recently surged (Gray, 1982, 1988, Krugman, 1983, Scott and Lodge, 1985). In the past fifteen years alternative theories have been developed that go further than the static Heckscher-Ohlin model in explaining recent trends. In this paper, two of these alternatives, the theory of intra-industry trade and the technology gap theory, are combined in order to account for trade competitiveness based on technological progress. The argument shows that research and development expenditures (R&D) are a necessary ongoing form of investment and not a discretionary item as implicit in much of the literature on the theory of the firm. The result is that simply to maintain world market share and to remain profitable, an industry must, for some period of time, be at least as innovative as the same industry in a rival country.

In the model of intra-industry trade presented below, products are differentiated on the supply side. Innovativeness determines the firm’s ability to create a differentiated product, which in turn determines import penetration. By introducing the concept of the product line, we explicitly model the link between technological progress and world market share for each manufacturing sector. This model contrasts markedly with Chamberlinian models in which intra-industry trade follows trivially from commonly made assumptions on the preference and cost structures.

We call the process depicted in the model the “product line” life cycle, since it is similar to the product life cycle but with the added component that the more innovative producer may develop a new, technologically sophisticated variety of existing products and drop from the product line the technologically less sophisticated goods in response to cost competition. The firm’s choice will influence its share of the world market and the level of import penetration. This view is perhaps more Schumpeterian than either the product life cycle or Bhagwati’s (1982) “biological” model. In the product life cycle, technical progress is inevitable. In the “biological” model, it is performed with perfect foresight until the marginal revenue from innovation equals its marginal cost. In our model, relative technological progress is a requisite for survival in the market; the market creates the incentive for innovation for firms in the high-cost industry.

The firm must be concerned not with the phase in the product life cycle of a single product, but with attaining or maintaining competitiveness in the technologically sophisticated goods in the product line. The traditional product life cycle view, associating a single product with a single industry, is obsolete, relevant only in the moments between phases of product innovation, when the product line consists exclusively of mature goods. Instead, however, the product life cycle consists of goods in all phases of the product life cycle. As a result, industry life expectancy

*University of Michigan, Dearborn, Dearborn, MI 48128. I would like to thank H. Peter Gray for his detailed suggestions on an earlier version of this paper. Alfred Einseher, Margaret Andrews, Robert Blinder and Elchan Gosok also provided helpful comments.
is no longer necessarily bound by product life expectancy. The industry which fails to innovate, however, will die as its products mature and become obsolete. The firm then has two reasons to be innovative. First, product innovation (destandardization) creates a favorable change in import penetration. Second, we assume that the firm's feasible markup over average full cost is greater the greater the is technological sophistication of the product. As a result, relative innovativeness gives the industry a choice in its pursuit of adequate cash flow.

Modeling intra-industry trade with a supply-side instead of demand-side differentiated product is not merely a case of a trivial alteration of the description of a process without changing the results. For example, the Chamberlinian model results in a trade pattern that could persist ad infinitum. Under the supply side version, the duration of intra-industry trade depends on the extent of the gap in technological knowledge between countries and the relative speed at which technological progress occurs in industries in two countries. The determinants of intra-industry trade thus affects its duration (Gray and Martin, 1980).

Most interesting about this process is that innovativeness plays a key role, independent of the level of productivity. An industry may be a relatively high-cost producer of a given variety (i.e. be at a comparative disadvantage in the Ricardian sense) and yet be competitive (i.e. maintain constant import penetration) because of relative innovativeness. The relative level of unit costs indicates competitiveness in the standardized product market, but the sector's ability to innovate determines its ability to expand the product line and retain market share. Static comparative cost analysis alone may provide too narrow a view of an industry's international competitiveness.

I. THEORIES OF INTRA-INDUSTRY TRADE

Intra-industry trade is the simultaneous import and export of products in the same industry. Models of intra-industry trade must therefore differ essentially from the simple Heckscher-Ohlin or comparative cost model. Intra-trade may occur for three reasons: economies of scale, product differentiation and availability of factors (Grubel and Lloyd, 1975, Gray 1988). Development of the theory of intra-industry trade in the past ten years has concentrated almost exclusively on the first two. The models typically assume that both trading nations have identical per capita income and tastes and, in this way, assume away the fundamental issues relating to intra-industry trade.

In the typical formulation of the intra-industry trade model, all consumers have identical preferences, and production functions in each industry are uniform across countries. Each industry is monopolistically competitive and consists of "a group of products which are all produced with the same factor proportions" (Kruger, 1982). Products are thus differentiated only from the perspective of the demand side. Equilibrium price and quantity of each "variety" of each good are determined with the standard Chamberlinian tangency solution. Profit maximizing firms produce where marginal revenues equal marginal cost and set price depending on demand conditions. With free entry and exit, profits are forced to zero. Assuming full employment in each industry then permits determination of the number of firms and varieties in an industry in the long run. The foreign industry maximizes profits under the same conditions. Intra-industry trade results since firms can differentiate costlessly and by so doing are guaranteed as much of the market as any other producer. The differential in "industry size" in the two countries determines the extent of intra-industry trade.

Bhagwati's (1982) biological model is based on the notion that countries have genetic and environmental traits, thus requiring trade theorists, "to give up the Heckscher-Ohlin assumption that all firms, and nations, share identical know-how ex-ante" (Bhagwati, 1982). Countries may be alike genetically (e.g., in terms of per capita income and level of R&D investment), yet different products are developed (e.g. small cars in Japan, large cars in the United States). Then, perhaps because of "localized technical change" in the type of product each produces, the know-how of producing the product is restricted to their respective country of origin,"with the result that one is now dealing with a situation of ex-ante differentials in the know-how of producing and selling different types of cars." When tastes are diffused across countries, international trade in these "similar" products occurs. Bhagwati stresses that in this theory, "Scarcity economies with identical ex-ante production functions do not play any role ..."

Feintra (1983) formalized Bhagwati's "biological" model of intra-industry trade. In his version, trade increases demand, creating the possibility of profitable product innovation, previously non-existent in autarky. Trade equilibrium is reached when no profitable opportunity for product innovation exists in any country. While this approach is unrealistic in its assumption of certainty knowledge ex-ante or profit from innovation, it represents an attempt to capture the importance of product innovation for intra-industry trade.

The two models reviewed above provide alternative approaches to intra-industry trade. The prototype Chamberlinian model has three fundamental shortcomings. For one, the homogeneity of preferences and uniformity of intra-industry elasticities guarantees triviality, two-way trade. These assumptions are made in all neoclassical models of intra-industry trade. No doubt they simplify the analysis, but they also predetermine the result. If all varieties of a good command 1/n of world spending on the good (due to uniform intra-industry elasticities), and a fixed positive fraction of each individual's income is spent on each category of goods (due to homotheticity), then two-way trade is guaranteed.1

The second weakness in the prototypical Chamberlinian trade model is the supply-side assumption of uniform cost curves in an industry, free entry and exit in all industries, and equality of factor prices in all countries. If cost curves are identical for all producers of varieties of a good in all countries, and differentiation itself is costless, then scale economies matter only in a trivial sense. No rational firm would ever replicate the variety of another firm. Since this condition holds between firms in different countries as well as between domestic "rivals," intra-industry trade, again, results trivially.

If, as modeled below, the firm's survival relies on its edge in technological innovation relative to foreign competitors, R&D expenditure is crucial. But the zero-profit equilibrium of the Chamberlin model renders such expenditure impossible and it thus anathema to intra-industry trade creation. This third point may be less crucial than the first two since achievement of the zero-profit equilibrium itself is unlikely. Kaldor (1935) makes the point that due to indivisibilities in capacity, the tangency solution is likely to be unattainable. Capacity cannot easily be reduced to exactly the level of output at which average costs and average revenue are equated.

In sum, the assumptions used in Chamberlinian trade models predetermine the result of intra-industry trade. The model provides little insight on why certain countries are competitive in some varieties of goods and not others. While demand-side product differentiation is certainly a factor in international (and domestic) exchange, its costliness and arbitrariness in the prototype formal intra-industry trade model is unsatisfactory. A meaningful theory of intra-industry trade must allow for technological and demand differences among countries.
II. THE PRODUCT LINE MODEL

The biological model provides a good starting point for the development of an intra-industry trade model based on a technology gap for manufacturing industries in developed countries. Suppose products are differentiated on the supply side as well as on the demand side. These products are produced with different production functions and are of different quality and even to some extent, function. An example might be photocopying machines. One machine reproduces single sheets. Another, technologically more sophisticated machine, reproduces multiple sheets, collates and staples. Another machine might do all this, and in color. These products are based essentially on the same technology, but differ in important ways from a production standpoint. Most manufacturing industries, if capable, produce such an array of products. We will refer to this array of goods as a "product line."

Formally, the "product line," is defined as follows:

\[ X_i = \{x_{i0}, x_{i1}, x_{i2}, \ldots, x_{in}\} \]

where

\[ x_{ij} = \text{product line, sector } i \text{ in sector } j \text{ product line.} \]

Goods in the product line are distinguished on the supply side by cost of production and markup and on the demand side as having positive elasticity of substitution between any two products in the line. Goods in the product line can be ranked by cost of production. For example:

\[ C(x_{i0}) > C(x_{i1}) > \cdots > C(x_{in}) \]

where \( C(x_j) \) = average total cost of \( x_j \).

The goods at the top of this ranking are considered those most sophisticated technologically. They require, for example, greater amounts of high-skilled labor. We assume only that the relatively more innovative country can produce those goods. Firms are full-cost pricers, and the mark-up correlates with the cost of production. Firms choose to produce a subset of products from those they are capable of producing. Thus the relatively innovative sector may choose to produce all goods in the product line (if the mark-up over cost for those at the low end of the product line is non-negative) or just those at the top with highest mark-up over cost.

For simplification, assume there are two countries (foreign country values denoted with asterisk) and, in a given industry (say, industry i), a product line of just two goods:

\[ X_i = \{x_{i0}, x_{i1}\} \]

(3)

The two goods in the product line are differentiated by technological sophistication. Let \( x_{i0} \) be the standardized product and \( x_{i1} \) be the non-standardized good, requiring more high skilled technology than \( x_{i0} \). Thus \( x_{i0} \) can be produced by industry i in both countries, while \( x_{i1} \) can be produced only in the more innovative country. If we assume the home-country sector is the more innovative, then it chooses to produce any subset of the full product line. The other country's sector may only produce the standardized variant.

Firms are assumed to be world market share maximizers, subject to the constraint that they are able to generate revenue sufficient to expand capacity in order to meet demand growth, and to support R&D expenditure necessary to maintain market share, given current technology.

---

A PRODUCT LIFE CYCLE MODEL

The mark-up is specified to account for costs of expansion in the industry (Eichner, 1973, 1987). That is, the mark-up is viewed as a mechanism for firms to raise funds internally in order to finance capital investment and R&D required to meet growing demand and foreign competition. The rate of required investment depends directly on the industry growth rate and inversely on the industry incremental capital-output ratio. The rate of required investment, in turn, determines the cost of expansion.

Thus firms choose a level of supply of each good in the product line and a mark-up over costs for each product in the product line:

\[
\text{maximize } R/(R + R^*)
\]

subject to

\[ m_1 + m_3 > g_i b_i (p_i c_i) + b_i d_i (p_i c_i) \]

and

\[ m_i > 0, \text{ all } i, j, \]

where:

\[ R = p_i c_i + p_i c_i \]

\[ p_i = \text{price of } x_i \]

\[ x_i = \text{ith variety of sector } i \text{ product line} \]

\[ m_i = \text{price of } x_i \]

\[ c_i = \text{average variable cost of producing variety } j, \text{ sector } i \]

\[ v_i = \text{variable R&D cost for sector } i \]

\[ a_i = \text{weight for allocating } v_i \text{ across the product line, i.e. } a_1 + a_2 = 1 \]

\[ b_i = \text{growth in demand for variety } j, \text{ sector } i \]

\[ b_i = \text{incremental capital-output ratio, variety } j, \text{ sector } i \]

Prices depend on technology and the mark-up. The low-cost world producer determines the price of the standardized good (assuming the mark-up is the same in this good in both countries), and the price of the de-standardized good is set by its producer, the relatively innovative producer:

\[ p_i = \begin{cases} 
- c_i (1 + m_i) & \text{if } x_i / x_i^* > 1 \\
- c_i (1 + m_i^*) & \text{if } x_i / x_i^* < 1 
\end{cases} \]

(5)

\[ p_i = \begin{cases} 
- c_i (1 + m_i) & \text{if } c_i < c_i^* \\
- c_i (1 + m_i^*) & \text{if } c_i > c_i^* 
\end{cases} \]

where \( c_i \) = degree of innovativeness of sector i.

Demand is the sum of final demand and intermediate demand for the product in the two countries:

\[ D_i = X_i + X_i^* \]

(6)

\[ X_i = \sum x_i + Y_i \]

(7)

\[ X_i^* = \sum x_i^* + Y_i^* \]
where

\[ D = \text{world demand for sector} \times \text{goods} \]

\[ X, X' = \text{demand for sector} \times \text{goods in each country} \]

\[ Y, Y' = \text{final demand vector in each country} \]

Final demand is dependent on income and intermediate demand a function of income and technology.

Trade occurs in the standardized product if the low cost (times mark-up) producer can sell at a price the other producer cannot meet (given the constraint). If the constraint is binding on the high cost producer, and this producer still decides to include the good in its product line, then both countries may sell in the country of the high-cost producer, but there will be no exports to the other country. Trade occurs in the destandardized product because it is a short run non-competitive good. The relatively innovative industry is the only one capable of producing it, and thus meets demand in its home market and in the market of the less innovative producer. Thus, four cases are possible, depending on if the innovative industry is the low or high-cost producer.

CASE 1a: The relatively innovative producer is also the low-cost producer. There will be no intra-industry trade. If the foreign, innovative, low-cost producer produces the standardized good so cheaply that the mark-up constraint cannot be satisfied by the home industry, then import penetration is 100%.

CASE 1b: The relatively innovative producer is also the low-cost producer, but the other producer, though he may have to cut the mark-up, is still able to retain significant market share at home. In this case import penetration is less than 100% and depends on demand conditions, and there is still no intra-industry trade.

CASE 2a: The relatively innovative producer is not the low-cost producer. Intra-industry trade occurs. The relatively innovative industry is the sole producer, and thus exporter, of the destandardized good, and the low-cost (times mark-up) producer of the standardized goods exports its product. If the high-cost, relatively innovative producer cannot satisfy the mark-up constraint, then demand for the standardized good in both countries is completely met by the low-cost producer.

Case 2b: The relatively innovative producer is not the low-cost producer, but the mark-up constraint is not binding. The high-cost, relatively innovative producer will choose to produce some or none of the standardized good. In this scenario import penetration for the innovative country may be lower than in case 2a. Furthermore, the import penetration rate in the country of the relatively innovative industry depends on that industry's decision over which products in the product line to produce.

The product line consists of more than two goods, intra-industry trade is more likely, and import penetration may be less extreme. That is, assume there are \( n \) standardized varieties and \( m \) non-standardized varieties of a commodity. By definition, only the relatively innovative producer is able to produce at lower costs, and non-standardized, thus likely such that both countries are now more likely in the 2-good case to demand both standardized and non-standardized goods. Of the four cases described above, only cases 1b and 2b are altered. In these cases the mark-up constraint is not binding on the high-cost producer of the standardized good. This producer now faces not the binary choice of producing or not producing the standardized, but of selecting some, all, or none of the standardized varieties to maintain in its product line. Depending on this choice, import penetration may be lower than in the simple 2-good product line example.

While we cannot determine precisely the equilibrium in a given market because of the uncertain nature of technological progress, it would not be surprising if a tendency to equilibrium were observed. For example, it is possible that the lead in innovativeness is cyclical. Being the imitating industry may create the ability to become the innovative industry. Thus technological leadership in a given industry may, over time, switch back and forth from one industrialized country to another. The model does not exclude, however, the possibility that the equilibrium or equilibrium tendency exists.

III. CONCLUSION

This paper has developed a model of intra-industry trade based on technological gaps in oligopolistic manufacturing industries in industrialized countries. The results of the analysis are that retention of world market share, and ultimately industry survival, requires an edge in innovation relative to foreign rivals. Innovation takes the form of enhancing the product line by creating new, technologically sophisticated varieties of existing products. R&D expenditure is thus a requisite for firm survival and not a discretionary item, as depicted in much of the literature on firm behavior. In this view, industry life is not necessarily synonymous with product life. Industry life expectancy depends on the overlap of many product life cycles; depending on the firm's ability to innovate, industry life may be much longer than the time it takes for a single product to reach maturity.

We contrasted this model favorably with other approaches to intra-industry trade, based on this model's reliance on technological progress as a key determinant of export competitiveness. Our approach to intra-industry trade overcomes the predetermined nature of Chamberlinian models which currently dominate the intra-industry trade literature, and the certainty of innovation and equilibrium in the "biological model".

NOTES

1. Kindleberger (1970, p. 283), commenting on the use of cross-sectional analysis in drawing general conclusions about the validity of the product life cycle theory, suggests adjusting by the phase of the product life cycle at a given moment in time. This is also relevant for the analysis of a multiproduct industry in which many products are at different phases of the life cycle.

2. It is certainly possible that the majority of the product life cycle is only transitory and that the apparently mature products may be destandardized or differentiated. This creates the possibility of multiple cycles for the same product, forces us to ask how long the majority phase of the cycle lasts, and why it might be of different duration in different industries. See Magee (1977) and Akerlof, Clark, and Kanterow (1983).

3. The empirical importance of intra-industry trade has been known for over twenty years, but its theoretical foundation was established only fifteen years ago (Balassa, 1967, Grey, 1973).


5. This critique of the Chamberlin model originated with Kaldor (1935) but appears to have been largely ignored in recent international trade versions of the model.

6. Dix and Nigg (1977), which inspired this flurry of trade model studies under monopolistic competition, sidestept this problem by assuming there are many firms.

7. Product differentiation on the supply side, implicitly introduced by Vernon (1966) and formally discussed by Hufbauer (1976), is based on the concept of the product life cycle.

8. Equilibrium may take two forms. One would occur if industries regularly switched roles as relatively...
innovative producers. Another would occur if rates of new product innovation and old product maturities were identical and preferences were such that demand for all varieties were equal.

REFERENCES


