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MONOPOLISTIC COMPETITION AND INTERNATIONAL TRADE THEORY*

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Abstract

Almost twenty-five years after the appearance of Dixit and Stiglitz's paper on monopolistic competition and optimum product diversity, I try to take stock of the progress which has been made in applying their approach to international trade theory. I review the principal applications to trade theory and present a new one: by embedding DS preferences in a specific-factors framework, I sketch a model which shows how multinational corporations can emerge even between countries with similar factor endowments. Finally, I address some limitations of the approach, including its treatment of variety, returns to scale, entry and firms' strategies.

JEL: F12, F23, F10

Keywords: Dixit-Stiglitz model; international trade with increasing returns and product differentiation; monopolistic competition; multinational corporations.

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1. Introduction

"the theory of monopolistic competition has had virtually no impact on the theory of international trade."

− Harry G. Johnson (1967, p. 203)

My opening quotation, taken from a *festschrift* for E.H. Chamberlin, is slightly closer in time to us than it is to Chamberlin's pioneering *Theory of Monopolistic Competition*. Yet it belongs to a bygone era. The theory of monopolistic competition has had a huge impact on modern trade theory, and no serious student of the subject can afford to neglect its many applications. Nor is any student likely to be allowed neglect them. It is even rumoured that there are universities where the graduate trade curriculum covers nothing but monopolistic competition!

One factor above all others is responsible for this shift: the publication in 1977 of Avinash Dixit and Joe Stiglitz's paper which introduced an elegant, parsimonious and tractable formalisation of the Chamberlinian model. Dixit and Stiglitz themselves (henceforth "DS") applied their innovation only to the classic issue in industrial organisation of whether monopolistically competitive industries would yield an optimal level of product diversity. But within a few years, a sizeable literature had already developed applying the approach to international trade. The DS approach provided a framework for modelling some distinctive features of contemporary international trade, especially trade in manufactured goods between developed countries, which traditional competitive models failed to capture. Above all, it allowed consideration of the implications of increasing returns to scale and product differentiation in general equilibrium. It is not that there is any inherent virtue in general rather than partial equilibrium. It is simply that many of the principal questions which arise in trade theory are fundamentally general equilibrium: the determinants of trade patterns, the impact of trade policy on income distribution, and the effects of international factor mobility,

to name only a few. Some way of linking goods and factor markets is essential if these issues are to be addressed at all, and until 1977 the only framework within which this could be done was that of competitive general equilibrium.

The DS approach was not the only formal model of monopolistic competition which was proposed around this time. Spence (1976) developed his own variant, very similar to that of DS, and the form is sometimes referred to as "SDS" or "Spence-Dixit-Stiglitz" preferences. (I discuss this further below.) Lancaster (1979) developed a different specification based on the idea (due originally to Gorman) that consumers have preferences over characteristics rather than over goods themselves. Each individual has an "ideal" variety and ranks all available varieties by their distance from this ideal. Provided individual consumers have tastes which differ in a symmetric manner over varieties, aggregate demand exhibits the same preference for diversity as the one-consumer model of DS. This was in many ways a more satisfactory way of modelling demand for differentiated products, and it was successfully applied to international trade by Lancaster (1979, 1980) himself and by Helpman (1981). Ultimately though, these alternative approaches proved less tractable and hence less fruitful than the DS specification.

In this paper I try to take stock of the progress which has been made in applying monopolistic competition to trade theory since the appearance of the DS paper. I do not attempt a comprehensive survey, partly for reasons of space and partly because there are already many other surveys available.[1] Instead I give a personal view of both the achievements and the limitations of the approach. Section 2 reviews the DS model and discusses very briefly some of the principal applications to trade theory. Section 3 tries to

[1] See in particular Helpman and Krugman (1985), Ethier (1987), Krugman (1989) and Helpman (1990). More recent applications to economic geography are surveyed in Fujita, Krugman and Venables (1999), Fujita and Thisse (2000) and Neary (2001).

give the flavour of some of these applications by presenting a new one: a model which shows how multinational corporations can emerge even between countries with similar factor endowments. Section 4 turns to address some issues which have been neglected in the literature and Section 5 attempts an overall assessment.

2. The Dixit-Stiglitz Model and Trade Theory

"A universal adoption of the assumption of monopoly must have very destructive consequences for economic theory."

− John Hicks (1939, p. 83)

Hicks could not have been more wrong. The widespread adoption of the DS approach to monopolistic competition has had hugely positive consequences for many branches of economic theory and especially for international trade theory. I begin with a brief review of the DS specification and then discuss some applications.

2.1 Preferences and Demand

DS were concerned not with trade, macro or growth, but with the social optimality of a Chamberlinian industry. In particular, they revisited the once passionate but now largely forgotten debates about whether such an industry would produce too many varieties, and whether it would operate with "excess capacity" (meaning at above minimum average cost). For the record, they overturned conventional wisdom by showing that, in a plausible central case, the outcome is of the Goldilocks kind: not too many, not too high, but just right! Specifically, with symmetric CES preferences for the differentiated products, the market equilibrium coincides with the constrained social optimum, constrained in the sense that lump-sum taxes or transfers to firms are not feasible. However, it was the technical tools they introduced rather than their substantive conclusions which were to have most effect on later

work.

DS were able to address the issues clearly because they adopted a particular specification of the aggregate utility function:

$$u \quad = \quad U[x_o, V(x_1, \ldots, x_n)] \qquad \textbf{(1)}$$

where utility depends on consumption of the numeraire good x_0 and on a sub-utility function V, which in turn is defined over a large, and potentially variable, number of differentiated products, indexed from *1* to *n*.

DS made two key assumptions about the structure of preferences. First, obvious from (1), is that utility is separable in the numeraire good x_0 and the differentiated goods. This was a simple importation into industrial organisation of a concept already well established in demand theory, and now seems natural to us. But it is worth emphasising how much it contributed to analytic clarity. Previous writers had debated the appropriate definition of an "industry", or, in Chamberlin's preferred term, a "group". Typically, definitions were given in terms of cross-elasticities of demand, sometimes of *both* direct and inverse demand functions. (See Bain (1967, pp. 151 ff.).) DS cut through all this fog: instead of restricting the demand functions by imposing arbitrary limits on inter- and intra-industry substitutability, they made a single restriction on the utility function, which implies that (in symmetric equilibria) all products within an industry should have the *same* degree of substitutability with other goods.

The second assumption made by DS is that u is homothetic in all its arguments. This combined with separability allows the consumer's decision to be characterised as one of two-stage budgeting, which simplifies the derivations a lot. It also leads naturally to general-equilibrium applications, especially in trade theory, where the assumption of homotheticity,

though patently unrealistic, is routinely made to allow a focus on supply-side determinants of trade patterns. DS themselves noted that their specification differed from that of Spence (1976), published in the preceding year, who assumed that preferences were quasi-linear: $u = x_0 + V(x_1, \ldots , x_n)$. This difference in assumptions had relatively minor implications for the Chamberlinian issues with which both papers were concerned; but it ensured that the DS specification was better suited to general-equilibrium applications.

Just as important as the assumptions of separability and homotheticity was what was not in the utility function: no Hotelling beaches, Gorman-Lancaster characteristics or other indirect ways of modelling tastes for differentiated products. Instead, DS invoked the elementary property of convexity of indifference curves, with the utility function defined over consumption of all possible (not just actual) varieties. This made it a much simpler and more tractable way of modelling a preference for diversity.

Even with all this, DS might have had few emulators if they had not considered three further technical restrictions on the utility function U: symmetry of V in the x_i; a CES form for V; and a Cobb-Douglas form for U itself. DS themselves explored the implications of these three assumptions two at a time. However, most applications to trade, with only a few exceptions which I will mention below, have adopted all three. Indeed, it is now standard to refer to this very special case as "Dixit-Stiglitz preferences", confirming that the paper has taken the first step on the road to classic status: to be widely cited but never read. (The second step, to be widely quoted but never cited, is probably imminent.) Since DS themselves did not use this special case, perhaps "Dixit-Stiglitz lite" would be a better label.

Incorporating these restrictions, the utility function (1) becomes:

$$u = x_0^{1-\mu} V^{\mu}, \qquad V = \left(\sum_i^n x_i^{\rho} \right)^{1/\rho} \tag{2}$$

Here μ is the share of nominal income Y spent on manufactures, while ρ measures the substitutability between varieties: ρ must be positive (since some of the x_i may be zero) and less than one (to ensure concavity). The elasticity of substitution between varieties, σ, is in turn related to ρ: $\sigma = 1/(1-\rho)$; so σ must exceed one. Utility maximisation leads to demand functions for individual varieties, which are log-linear in own price p_i and in total spending on manufactures μY, both deflated by a manufacturing price index P:

$$x_i = \mu \left(\frac{p_i}{P} \right)^{-\sigma} \frac{Y}{P} \qquad \text{where:} \qquad P^{1-\sigma} = \sum_j^n p_j^{1-\sigma} \tag{3}$$

2.2 Production and Equilibrium

Turning to producers, DS made two key simplifications. First, they modelled increasing returns in an ingeniously parsimonious way: "It is easy and probably not too unrealistic to model scale economies by supposing that each potential commodity involves some fixed set-up cost and has a constant marginal cost." (DS, p. 297) Denoting the latter by F and c respectively, the marginal cost curve is horizontal at the level c, and the average cost curve, equal to $c+F/x$, is a rectangular hyperbola with respect to the vertical axis and the marginal cost curve. See Figure 1, where the curves are labelled *MC* and *AC* respectively. Since all firms are identical, subscripts can be dropped from here on.

Second, DS implemented the Chamberlinian tradition of atomistic firms with no perceived interdependence by assuming that each firm takes income Y and the industry price index P as fixed when choosing its own price. (More on this on Section 4.) Equation (2) is then a simple constant-elasticity demand function, with the elasticity of demand equal to

σ, and marginal revenue in turn is a constant fraction of price:

$$MR = \frac{\sigma - 1}{\sigma} p \qquad \textbf{(4)}$$

The implied demand and marginal revenue curves are also illustrated in Figure 1, labelled *D* and *MR* respectively.

Equilibrium now exhibits the familiar Chamberlinian properties. Profit maximisation sets marginal revenue equal to marginal cost, while free entry sets price equal to average cost. For both conditions to hold, the famous tangency condition between the demand and average cost curves must be met, as Figure 1 illustrates. Moreover, the special functional forms yield very simple solutions for equilibrium price and output. The price-marginal-cost mark-up depends only on the elasticity of substitution σ:

$$p = \frac{\sigma}{\sigma - 1} c \qquad \textbf{(5)}$$

While the level of output depends only on the cost parameters *F* and *c* and on σ:

$$x = (\sigma - 1)\frac{F}{c} \qquad \textbf{(6)}$$

Changes in any other parameters or variables lead to adjustments in industry output via changes in the number of firms only.

2.3 Empirical Anomalies

This completes the basic DS apparatus. To explain why it came to be applied to trade issues, I must digress to recall the empirical background.

Two strands of empirical work in the 1960s and 1970s had led to increasing questioning of the then-dominant competitive paradigm and especially of the Heckscher-Ohlin

model. First was the finding that a great deal of international trade consisted of two-way trade in apparently similar goods. Ever since Ricardo's example of England and Portugal exchanging cloth for wine, trade theory had sought to explain the pattern of *inter*-industry trade. But it became increasingly clear that much trade did not fit that pattern. Rather it seemed to be better described as *intra*-industry. Careful empirical work by Grubel and Lloyd (1975) showed that this was not just an artefact of aggregation. Even when trade data were finely disaggregated, intra-industry trade continued to account for a large fraction of total trade. This seemed particularly true of trade between advanced countries, which in turn raised a further paradox. Trade based on comparative advantage arises from *differences* between countries (differences in technology for Ricardo, in factor endowments for Heckscher-Ohlin). But the evidence suggested that trade volumes were highest between countries that were *similar* in terms of incomes, technology and stage of development.

The second set of empirical findings concerned the degree of disruption induced by trade liberalisation. Studies by Balassa (1967) and others of the effects of the European Economic Community in the 1950s and 1960s showed that adjustment to tariff reductions required surprisingly little change in the scale of industrial sectors. Rather it seemed to take the form of specialisation *within* sectors, as increased competition forced consolidation of product lines. As a result, the reduction of trade barriers between countries at similar stages of development did not impose large costs of adjustment.

Both of these findings were in conflict with the trade theory of the day and generated much talk of the need for a new paradigm. Was the work of Balassa, Grubel and Lloyd by itself sufficient to stimulate a new approach? I believe that it was not. The Leontief Paradox had not led to the abandonment of Heckscher-Ohlin trade theory in the 1950s, for the good reason that no other satisfactory general equilibrium theory of trade was available. Moreover,

criticism of international trade theory (and indeed of neoclassical economic theory as a whole) for its neglect of imperfect competition had been widespread for many decades. What was new in the late 1970s was simultaneous progress in the theory of industrial organisation, and especially the development of the DS approach, which provided a framework in which the empirical anomalies could be explained and, ultimately, integrated with traditional theory.

2.4 Product Differentiation as a Cause of Trade

Applications of DS to trade issues were not slow in coming. The first to be written appears to have been a 1976 paper by Victor Norman (which also showed how to integrate the new approach with Heckscher-Ohlin theory, the subject of the next section).[2] However, the first to be published and the neatest example was Krugman (1979).

To see Krugman's results, consider the special case of (2) with no numeraire good (or, equivalently, with $\mu=1$).[3] Let labour be the only factor of production and take it as numeraire. The aggregate resource constraint is then $L = n(F+cx)$. Using (6) to eliminate x, the equilibrium number of varieties produced equals $L/\sigma F$. This is unaffected by opening the economy up to trade with a foreign country: the equilibrium illustrated in Figure 1 is unchanged. The only effect is that consumers have a wider choice. Since they prefer diversity, they consume foreign as well as home varieties: more varieties in total, with less consumption of each.

Note that the two countries may be *ex ante* identical in this case. Hence the DS model

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[2] Dixit and Norman (1980), p. 281, introduce their Section 9.3 with the words "The model is based on Norman (1976), but has several similarities with Krugman (1978a, b)." The Krugman papers are cited here as Krugman (1979) and (1980) respectively. Neither cites Norman or Dixit and Norman.

[3] In other respects Krugman (1979) used a somewhat more general version of the DS model than (2), which I discuss in Section 4.

implies that trade will take place between countries with identical technology and factor endowments. Moreover, the pattern of trade, with countries exchanging relatively similar differentiated products, is consistent with the empirical evidence on the importance of intra-industry trade. *All* trade is intra-industry, consumers unambiguously gain from greater variety, and trade liberalisation need not imply any changes in relative sector sizes, consistent with the evidence of Balassa (1967) cited in Section 2.3.

2.5 The Return of Factor Endowments

Showing that monopolistic competition could be an independent source of trade, and that the outcome resembled real-world intra-industry trade, was a useful contribution. However, it is unlikely that it would have come to dominate the literature if it had not been integrated with the standard Heckscher-Ohlin approach. In fact, this integration was carried out almost immediately. Here the main original contributions were Dixit and Norman (1980, Section 9.3), Helpman (1981) and Ethier (1982).[4] (All three of these were circulated at least as early as 1979. Ethier (1979) may have been the first to explain intra-industry trade between similar economies, though as discussed in the next section, his model lacked satisfactory microfoundations.)

Return to the two-sector specification in (2). Think of the numeraire good as labour-intensive "agriculture", produced under constant returns to scale by a competitive sector. Similarly, think of the differentiated products as capital-intensive "manufactures". Finally, in the tradition of the Heckscher-Ohlin-Samuelson model, assume two countries and confine attention to free-trade equilibria in which both sectors remain active in both countries and in

[4] Krugman (1981) also looked at the interaction of factor endowments and monopolistic competition, but only for a special case of symmetric international endowment differences.

which factor prices are equalised internationally. Once again, Figure 1 (with factor prices suitably normalised) illustrates any such trading equilibrium.

The key idea is that Heckscher-Ohlin trade is driven by *differences* between countries, whereas DS trade is driven by *similarities*. Heckscher-Ohlin, like any comparative-advantage-based theory, postulates international differences (specifically, in factor endowments) which generate differences in equilibrium autarky prices and hence an incentive to trade. The greater the differences, the greater the volume of trade is likely to be. (With factor-price equalisation, two countries, and fixed world factor endowments, this result is strengthened: the volume of inter-industry trade is a linear function of the differences in factor endowments.) By contrast, under DS assumptions, each variety is unique, and consumers want to consume as many varieties as possible. Hence the volume of trade between two countries will be greatest when they are identical in size. Combining the two sources of trade leaves the results basically unchanged, except of course that the Heckscher-Ohlin prediction applies to inter-industry trade and the DS one to intra-industry trade. This synthesis was consistent with the empirical evidence on intra-industry trade discussed in Section 2.3; it has proved empirically fruitful (see Section 2.8 below); and it constitutes one of the major "bottom-line" messages of the new trade theory.

2.6 Intermediate Goods

All the papers discussed so far considered trade in final goods only. By contrast, intermediate goods constitute a much higher fraction of world trade, one of the considerations which motivated Ethier (1982) to extend the DS approach to trade in differentiated intermediate goods. He used the same functional form as the right-hand side of (2), but reinterpreted "V" as a production function rather than a sub-utility function. Hence the

driving force in the model is not that more varieties raises consumers' utility but rather that they increase total factor productivity. He showed that the implications which held in models with differentiated consumer goods, for intra- and inter-industry trade, and for the distributional consequences of trade policy, continued to hold.[5] More importantly, he showed that increased specialisation leads to productivity gains which depend on the world rather than the national scale of the industry. Extending Adam Smith's vision, the division of labour is limited by the extent of the *global* rather than the local market: production of inputs need not be geographically concentrated. This specification provided a micro-economic rationale for a model of *international* returns to trade (in contrast with traditional national returns to scale) which Ethier (1979) had earlier explored. It has also proved very influential in growth theory. Romer (1987, 1990) adopted Ethier's specification explicitly in his work on endogenous growth, where increasing returns arise from specialisation in the production of intermediate inputs. Subsequent work on growth in both closed and open economies, covered in other contributions to this conference, has made extensive use of the DS specification to model horizontal product differentiation.

2.7 New Trade Theory Goes Global: Multinationals and Economic Geography

So far, I have described the applications of new trade theory to important old questions: the pattern of trade and the consequences of trade liberalisation. However, it was not long before the new approach was also applied to questions which had not been previously addressed. The first of these was the rationale for multinational corporations, which could not be explained in a competitive framework. Helpman (1984) extended the DS

[5] Whence the assertion by Krugman (1989, p. 1186) that the extension to differentiated intermediate goods makes little difference.

approach to explain why a firm might choose to vertically disintegrate. He postulated the existence of different activities within the firm: in the simplest case, production of a final good required both "headquarter services" (finance, marketing, R&D, etc.) and manufacturing. Crucially, these two activities had different factor intensities, so it would be profitable to locate different activities in countries with factor endowments appropriate to them. For example, if manufacturing is more unskilled-labour-intensive, it would be located in the more unskilled-labour-abundant country. (In his model, the fact that all firms behaved in this way would by itself equalise factor prices, but nevertheless the initial incentive for vertical disintegration came from an incipient divergence of factor prices.)

The second novel issue to which new trade theory came to be applied was the possibility of industrial agglomeration. Krugman (1980) had allowed for transport costs on monopolistically competitive goods and had shown that they generate a "home-market effect". A rise in the number of home firms is associated with a fall in the local price index for manufactures (since home-produced varieties do not incur transport costs, whereas imported ones do). Since (at initial wages) an increase in home demand can only be accommodated by a fall in the local price index, it leads to a magnified increase in the number of home firms. Hence larger countries produce disproportionately more manufacturing varieties and so tend to export them.

The home-market effect is of some interest in itself, but since it takes incomes as exogenous its implications were unclear. Hence the lead was not followed for some time, not least by Krugman himself, who in his 1985 book with Helpman concentrated on the case discussed in Section 2.4 above where all trade barriers are absent so factor prices are equalised internationally. In Krugman (1991) he returned to his 1980 model and made incomes endogenous by adding the possibility of international factor mobility. Now the

home-market effect generates a "demand linkage": an extra firm in one country raises demand for labour there which encourages in-migration; the resulting increase in local demand raises profits which encourages more firms to enter, and so on, in a process reminiscent of the Keynesian multiplier or the "cumulative processes" of 1950s development economics. (With the difference that, as in many other contexts surveyed by Matsuyama (1995), they now have a simple but rigorous theoretical foundation.) This effect shifts the demand and marginal revenue curves upwards in Figure 1, as indicated by the arrow numbered "1". The fact that larger countries have lower price levels also generates a "cost linkage" since this too encourages further in-migration (workers are attracted by the lower cost of living in a large location). The resulting fall in local wages shifts the average and marginal cost curves downwards, as indicated by the arrow numbered "2". Both these linkages therefore tend to encourage agglomeration. However, this outcome is not inevitable, since there is always an orthodox competition effect which tends to lower profits and so work against agglomeration: the fall in the local price index shifts the demand and marginal revenue curves downwards, as indicated by the arrow numbered "3". Whether agglomeration results or not depends on the balance between these competing forces, which in turn depends on the underlying parameters of the model: transport costs work against agglomeration, while high demand (i.e., a higher value of μ) and a high preference for diversity (i.e., a *lower* value for σ) work in favour of it.

While international labour mobility on the scale needed may seem implausible, Venables (1996) showed that the same outcomes could arise in a model with no migration but with intermediate goods. These two mechanisms form the basis for what Krugman has termed the "new economic geography". Though it has not met with universal enthusiasm (for reasons I discuss in Neary (2001)), it undoubtedly represents an interesting development.

2.8 The Proof of the Pudding?: Testing the New Trade Theory

As I have noted, the starting point of the new trade theory was a dissatisfaction with the alleged inability of traditional competitive theories to explain the observed patterns of international trade. Hence one might expect that the widespread acceptance of the new approach arose from its empirical success. But in fact this was not the case. Though the early theoretical papers made much of the *plausibility* of their stories and their consistency with stylised facts, they did not attempt to test the new theories formally.[6] When such testing did eventually come, the results were mixed. Even for Krugman (1994, p. 20): "It must be admitted that the state of empirical work on the new trade theory is a bit disappointing."

The first attempt to test the predictions of the models based on DS was that of Helpman (1987). He specified an empirical model consistent with the theory and showed that it gave a plausible account of the level and pattern of intra-industry trade. In particular, bilateral intra-industry trade was closely related to relative country sizes. However, subsequent work questioned whether this was indeed a test of the monopolistically competitive theory. As reviewed by Deardorff (1998), the central issue is that Helpman's specification, often called a "gravity equation" since it resembles Newton's law of gravity, is consistent with any theory in which countries specialise in different goods. Helpman (1998) in response has questioned whether alternative theories can account for the observed trade patterns. But the fact that there is no clear discriminating test between perfectly and monopolistically competitive trade theories is a drawback. Leamer and Levinsohn (1995) in their influential survey paper have responded with the nihilistic advice "Estimate, do not test",

[6] Note I am not suggesting that the *same* people who make theoretical contributions should be expected to check their empirical validity. Taken literally, this would forego all the benefits of division of labour within the economics profession.

but taken literally this would preclude the application of scientific method to this field.

When transport costs are admitted to the model, however, it is possible to devise a test which can in principle discriminate between perfectly and monopolistically competitive models. A series of papers by Davis and Weinstein (e.g., 1998) have implemented this idea. (Their research is mostly unpublished, so a summary may be premature. I discuss it in more detail in Neary (2001), Section 6.) They draw on Krugman's "home-market effect" (discussed in Section 2.7 above) which predicts that in monopolistically competitive models, a larger home market should encourage exports. By contrast, competitive models predict that it should encourage imports. The results of their tests are close to a tie, with monopolistic competition apparently accounting for just over 50% of OECD trade in manufactures.

Clearly this line of research is important and may yet coalesce into a coherent picture of the empirical value of the new approach. For the present, the results are sufficiently mixed that both proponents and opponents of the new approach can derive some satisfaction from them.

3. An Extension

"modeling the role of economies of scale as a cause of trade ... requires that the impact of increasing returns on market structure be somehow taken into account, but in this literature the main concern is usually to get the issue of market structure out of the way as simply as possible."

− Paul R. Krugman (1989, p. 1179)

"The main response to decreasing costs on the part of mainstream 'new' trade theory has been to muffle the impact of scale economies by 'convexifying' assumptions, e.g. the Dixit-Stiglitz (1977) model of monopolistic competition in which firms' profitability gains from returns to scale are strictly limited by consumers' desires for product diversity."

− Jose Antonio Ocampo and Lance Taylor (1998, p. 1524)

A striking feature of general-equilibrium models with monopolistic competition à la DS, especially when they assume international factor-price equalisation, is that they end up

looking very like competitive equilibrium models, except with more interesting interpretations. This can be seen as either a positive or negative feature, as my two opening quotations show respectively. To illustrate how this happens, let me work through a simple model which has the additional virtue of being new.

My starting point is Helpman's theory of multinational corporations, discussed in the previous section. Recall that he assumed that multinational corporations were vertically integrated firms engaged in monopolistic competition. Different activities within the firm had different factor intensities, and so each firm had an incentive to vertically disintegrate, locating in different countries in a way which matched the factor demands of each activity with local factor supplies. This gave a plausible description of multinational activity, which has proved influential in subsequent work. However, it made one key counter-factual prediction: multinationals could only emerge between countries with very different relative factor endowments. Even moderate similarity between countries in their relative factor endowments implied that factor prices were equalised when firms were solely national, and so there was no incentive to go multinational.

A number of authors have addressed this deficiency of the Helpman model. Ethier (1986) models firms' behaviour in a context where the outcome of R&D (headquarter services in Helpman's terminology) is uncertain, but it is not possible to write a state-contingent contract with an outside firm. The greater the costs of a poor R&D outcome, therefore, the greater the incentives firms have to internalise their downstream activities. The resulting model predicts when firms will choose to become multinational and operate their own plants in foreign countries (in Dunning's terminology, to "internalise" their production activities) rather than to license their technology to foreign firms: a choice which is taken for granted in Helpman's model and in mine. In the process it provides an explanation of intra-industry

foreign direct investment. An alternative approach adopted by Markusen and Venables (1998) is to assume that there are international transport costs, so that firms locate production facilities abroad if the fixed costs of operating an extra plant are outweighed by the advantages of better market access. Both these approaches are of interest, and both allow for multinationals to emerge between similar economies. However, these models are more complicated than mine, and by way of compensation, they assume that goods are homogeneous. Here I sketch an alternative model which stays closer to Helpman but abandons the Heckscher-Ohlin assumptions about factor markets.

The approach I adopt generalises the specific-factors model to allow for multinational corporations.[7] Assume a two-country world with two sectors, agriculture and industry, and three factors, land, unskilled labour and skilled labour. All three factors are internationally immobile and only unskilled labour is intersectorally mobile. Agriculture requires land as well as unskilled labour. Industry consists of two activities, headquarter services and manufacturing. Both require skilled as well as unskilled labour, with headquarter services more skill-intensive.

The equilibrium of the model is now easily illustrated, using a diagrammatic technique introduced by Dixit and Norman.[8] Assume first that all factors can move freely across international boundaries. In the resulting "integrated equilibrium", goods prices, factor prices and factor intensities are determined. In Figure 2, *OB* represents the land and unskilled

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[7] See Neary (1978) for references on the specific-factors model and Caves (1971) for an early discussion of multinational corporations in that context.

[8] The trick is to combine the Edgeworth-Bowley boxes for two countries in a world box, and to consider the effects of changes in relative endowments as movements of the endowment point within the box. With three factors, the world Edgeworth-Bowley box is three-dimensional. Dixit and Norman (1980, p. 124) consider a cross-section parallel to the axis of one of the specific factors, whereas Figure 2 illustrates the external face of the world box, perpendicular to the skilled labour axis.

labour used in the production of agriculture, while *OA* represents the unskilled labour used to produce industrial goods (at both stages of production) along with skilled labour. Assume for concreteness that, when we diverge from the integrated equilibrium, the endowment of skilled labour is equally divided between the two countries. Then, the line *EF* denotes the factor-price equalisation set: only if land and unskilled labour endowments lie along this line will it be possible, in the absence of multinational corporations, to produce the same vector of goods as in the integrated equilibrium.

The role of multinational corporations now becomes clear. If the endowments of land and unskilled labour do not lie along the line *EF*, there is an incentive to relocate the more unskilled-labour-intensive manufacturing activities to the country with the lower unskilled wages. The process of relocating such activities will itself tend to equalise unskilled wages internationally. Provided endowments lie in the set *OBO*A*, and provided techniques in headquarter services and manufacturing are sufficiently different, it will be possible to find an allocation of activities between countries which replicates the integrated equilibrium. Intra-industry trade will occur for all distributions of factor endowments. Inter-industry trade will occur (given homothetic tastes) provided the equilibrium does not lie at the point of intersection of the diagonal *OO** and the line *EF*. Finally, multinational activity will occur provided the endowment point does not lie along *EF*. Clearly it is possible to have either high or low levels of multinational activity co-existing with either high or low levels of inter-industry trade: trade and multinational activity may be either substitutes or complements. Moreover, the model shows how multinational corporations can emerge even between countries with similar (though not identical) factor endowments.

Finally, note that the model is isomorphic to a competitive model with the same assumptions about factor markets except that skilled labour is internationally mobile. (The

dynamics of that model are worked out in Neary (1995).) As my opening quotations suggest, the DS approach can be seen either as a brilliantly parsimonious approach to incorporating product differentiation and returns to scale into general equilibrium, or as a sleight of hand which forces these features into a largely neoclassical mould. In the next section I turn to consider the objections in more detail.

4. Lacunae

"oligopolistic markets seem empirically more important than those that combine atomism with product differentiation"

− Joe S. Bain (1967, p. 175)

We have seen that the DS specification is extremely tractable, and, because it embodies homotheticity, it lends itself easily to general-equilibrium applications. But there is a price to be paid for this. The relatively clean functional forms for demand and supply impose a variety of special assumptions. And, like all versions of monopolistic competition, it neglects many issues which the modern theory of industrial organisation highlights.

4.1 Variety

Taste for variety was DS's starting point, so it is appropriate to begin by considering their treatment of it. In symmetric equilibria, utility rises steeply with the number of varieties for a given total outlay, all the more so the lower is σ. Figure 3 conveys the same information from a different perspective, showing how rapidly the true cost of living falls with the number of varieties.[9] Those familiar with the debates prompted by the Boskin

[9] The price of each individual variety, p, is normalised to unity in Figure 3. From Section 2.1, $\ln V = \ln x + [\sigma/(\sigma-1)]\ln n$. Letting $I=npx$ denote total expenditure on the differentiated goods, and eliminating x, we can solve for the indirect utility function: $\ln V = \ln(I/p) + [1/(\sigma-1)]\ln n$. Hence utility is increasing in n and convex for σ less than 2. Inverting (or,

Commission's report (which concluded that, because of substitution and other biases, the U.S. consumer price index over-estimates the growth in the true cost of living by up to one and a half percentage points per annum) may be surprised to see product diversity alone causing the true index to lie so far below the market prices of all goods. In a trade context, an implication is that greater product diversity can be a major source of gains from trade. Dixit (1984) himself has an elegant paper showing how this suggests a more benign view than usual of the implications for developing countries of long-term trends in the terms of trade. But does this optimistic perspective not follow directly from the assumptions? Variety may be the spice of life, but is it really so tasty?

One way out of this difficulty is suggested by Ethier (1982). The standard DS specification conflates two distinct aspects of consumer behaviour, responsiveness to price and taste for diversity. Ethier's generalisation disentangles the two:[10]

$$V = n^{\gamma}\left[\sum_{i}^{n}\frac{x_i^{\rho}}{n}\right]^{1/\rho} \qquad \textbf{(7)}$$

The specification is unwieldy, but it has a nice implication. The parameter σ (equal as before to $1/(1-\rho)$) continues to measure the elasticity of demand and hence the market power of a typical firm. By contrast, the parameter γ measures the preference for diversity (or, in a

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alternatively, solving from (3)), the true cost-of-living index in symmetric equilibria is: $\ln P = \ln p - [1/(\sigma-1)]\ln n$. This is decreasing and convex in n.

[10] This specification has had a shadowy history. It first appeared in a working paper version of the original DS paper (Dixit and Stiglitz (1975), Section 4), with the rationalisation that diversity as measured by n was a public good. However, this discussion was omitted in the published version. It was independently rediscovered in a consumption context by Benassy (1996).

production context, the gains from specialisation).[11] These two parameters can be varied independently, whereas the usual specification, which implicitly sets γ equal to $1/\rho$ or $\sigma/(\sigma-1)$, does not allow this. In particular, it is possible to assume a very low preference for diversity (γ close to one) while still allowing demand elasticities to be relatively low.

Yet the worry remains that, even when extended in this way, the DS specification imposes too benign a view of product diversity. It clearly fails to capture one of the concerns of anti-globalisation protesters: that liberalising trade may reduce rather than increase variety. Explaining this possibility would require taking account of both consumer heterogeneity and asymmetries between goods in the degree to which they benefit from economies of scale, especially in distribution.[12]

4.2 Returns to Scale

As we have just seen, σ serves two roles in describing preferences. It is often pressed into service for a third, as an inverse measure of "equilibrium returns to scale". Figure 4 (from Neary (2001)) illustrates how the equilibrium of the firm is affected by a reduction in the elasticity of substitution. This implies that demand becomes less elastic, products become more differentiated, and there is a greater preference for diversity. As a result, the equilibrium moves from *A* to *B*: other things equal, average firm output falls and more varieties are produced. It is also true that the average cost curve is more steeply sloped and that many conventional measures would suggest that returns to scale are greater. (Note that $\sigma/(\sigma-1)$, which has risen, equals the equilibrium ratio of the composite factor's marginal

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[11] As in the previous footnote, V equals xn^{γ} in symmetric equilibria. Constant total outlay then implies that $\ln V = \ln(I/p) + (\gamma-1)\ln n$. So $\gamma-1$ measures the preference for diversity.

[12] Francois and van Ypersele (2000) present an interesting model which goes in this direction.

product to its average product, or one over the output elasticity of total costs.) But it is clear that technology is unchanged: saying that returns to scale are greater at *B* does not correspond to what we usually mean when we discuss differences between industries.

If σ is given, and if the cost parameters are unchanged, then equation (6) shows that the output of each firm is given. In particular, it cannot be affected by trade policy. This is an unsatisfactory and counter-factual property. It can be overcome by working with a more general version of the basic model, drawn from Section II of DS. Instead of a CES utility function for manufactures, this assumes a general additively separable form:

$$V = \sum_{i=1}^{n} v(x_i) \qquad \textbf{(8)}$$

As DS showed, the elasticity of demand is inversely related to the curvature of the function v: $\varepsilon_i = -v'/v''x_i$; and, as Krugman (1979) showed, the derivative of this elasticity with respect to output, $d\varepsilon_i/dx_i$, determines the response of firm output to an expansion in market demand. In particular, average firm size rises provided this derivative is negative. The latter assumption is plausible, and so the extended DS model rationalises the empirical observations of Balassa mentioned in Section 2.3.[13] However, the specification in (8) has not proved tractable, and from Dixit and Norman (1980) and Krugman (1980) onwards, most writers have used the CES specification in (2), with its unsatisfactory implications that firm size is fixed by tastes and technology, and all adjustments in industry size (due to changes in trade policy,

[13] Krugman justified this assumption "without apology" since it "seems plausible" and "seems to be necessary if the model is to yield reasonable results". It can be shown that, as with many results in imperfectly competitive models, it must hold provided demand is not "too" convex. The elasticity of ε_i with respect to x_i equals $1+1/\varepsilon_i+\rho_i$, where ρ_i equals $-x_i v'''/v''$ and is a measure of the concavity of the demand function.

for example) come about through changes in the number of firms.[14]

4.3 Entry

Where entering firms come from, and where exiting ones go to, is never explained in models of monopolistic competition, any more than it is in models of perfect competition. New firms, exact replicas of existing firms, are assumed ready to spring up like dragon's teeth whenever a tiny profit opportunity presents itself; and existing firms exit without a murmur following any downturn in industry fortunes. This is justified as a long-run or equilibrium assumption. But, except over secular time horizons, it seems particularly inappropriate in applications to countries at different stages of economic development. Even in a developed-country context, it is unsatisfactory from many points of view. It implies that there is no value to incumbency, no learning by doing and no binding limit on the supply of entrepreneurial skills. Of course I am not saying that models with "unlimited supplies of firms" are useless. But even a cursory consideration of modern industry suggests that they provide a plausible description of very few sectors.

4.4 Strategies

My final worry about the DS approach is reflected in the line-up of speakers and topics for this conference. DS has been extensively applied in many fields, but it has had relatively little influence on the field of industrial organisation itself. This is an IO model for

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[14] There is, however, a mechanism whereby firm size can be influenced by extra-industry influences even in the simple DS model. Lawrence and Spiller (1983) and Flam and Helpman (1987) allow for differences in factor proportions between fixed costs and variable costs. Hence general-equilibrium effects on relative factor prices lead to changes in equilibrium size. This effect is absent from most applications of the DS approach, which assume that the production function is homothetic, so that fixed and variable costs have identical factor proportions.

export only! It is far removed from the concerns of IO practitioners (theorists of course, but also a growing body of empirical scholars) with all aspects of "perceived interdependence" between firms.

The DS model ignores perceived interdependence to the extent of assuming myopic behaviour by firms. They explicitly assumed that each firm ignores the effects of its price/output decision on the industry price index. Yang and Hejdra (1993) suggested that this neglect was unnecessary, while d'Aspremont et al. (1996) pointed out that DS firms also ignore the "Ford effect": the impact of their own pricing behaviour on income. Omitting these effects can be justified as an approximation, satisfactory for large *n*, and exact in the case of a continuum of firms.[15]

More serious in my view is that DS firms do not engage in any form of strategic behaviour. They cannot make commitments since they do not engage in any intertemporal behaviour. (Expenditures on fixed and variable costs are incurred simultaneously.) So investments in capacity, R&D or advertising ("selling costs" in Chamberlin's terminology) do not arise. For many purposes these omissions do not matter. But they restrict the usefulness of the model for discussing many aspects of industrial policy, technological progress or structural change.

My own conclusion is that, in its assumptions about entry and strategies, monopolistic competition resembles perfect competition much more than it resembles most models of oligopoly − and, arguably, more than it resembles the market structure of many industrial sectors in the real world (especially in relatively mature industries). This seems to have been

[15] Ironically, the first version of DS, Dixit and Stiglitz (1974), assumed a continuum of firms. In the second version they switched to the discrete case, because (as they laconically explained in a footnote which was in turn omitted from the published version) "technical difficulties of that case led to unnecessary confusion" (Dixit and Stiglitz (1975), p. 53).

the view of most pre-DS industrial economists (as in my opening quotation from Bain), and even of Chamberlin himself, who suggested that monopolistic competition was appropriate to the study of retail outlets, filling stations, and other markets where the twin assumptions of atomistic firms and differentiated products fit the facts well. The relevance of the model to international trade in particular, where exporting firms are typically above-average in size and have significant market power, is more questionable.

What is needed is a GOLE: a theory of General Oligopolistic Equilibrium! There are formidable obstacles to developing such a theory. Even in partial equilibrium the predictions of oligopoly models suffer from indeterminateness and sensitivity to changes in solution concepts. Extending them to general equilibrium introduces further problems of non-existence and sensitivity to choice of numeraire which have been extensively discussed by theorists such as Gabszewicz and Vial (1972), Roberts and Sonnenschein (1977), Bohm (1994) and Dierker and Grodal (1999). Yet the pay-off to even modest progress in this direction would be enormous. Perhaps the way to go is to adopt some of the same technical tricks, such as symmetry and aggregation over many agents, which have made the DS approach to monopolistic competition so useful.[16]

5. Conclusion

I began with a quote from Harry Johnson's 1967 survey of monopolistic competition and international trade theory. Let me end with a second quote from the same source: "what is required at this stage is to convert the theory from an analysis of the static equilibrium conditions of a monopolistically competitive industry ... into *an operationally relevant analytical tool* capable of facilitating the quantification of those aspects of real-life

[16] For a sketch of a model along these lines, see Neary (2000).

competition so elegantly comprehended and analyzed by Chamberlin but excluded by assumption from the mainstream of contemporary trade theory." [Johnson (1967, p. 218); italics added.]

In retrospect, Johnson articulated clearly what was missing from the literature on monopolistic competition in the decades between Chamberlin and Dixit-Stiglitz. The model's partial equilibrium implications had been worked out in geometric detail; and some of its insights had been incorporated into the general Arrow-Debreu model.[17] But it had little impact on the middle ground of applied theoretical fields which try to address real-world issues without neglecting economy-wide links between goods and factor markets. What was missing was "an operationally relevant analytical tool" which would allow Chamberlinian insights to be incorporated into applications-oriented general equilibrium models. This was exactly what DS provided.

The pay-off to trade theory in particular has been immense. I have tried to show that the DS approach has thrown a great deal of light on many central issues in the field: the interaction between inter- and intra-industry trade, the nature of adjustment to trade liberalisation, the role of trade in intermediate goods, the basis for multinational corporations, and the conditions favouring agglomeration. Nor are its potential applications exhausted. In Section 3 I sketched a model which combines DS preferences with the specific-factors model, and provides a parsimonious explanation of why multinational corporations may emerge even between countries with similar factor endowments.

However, I have also argued that, contrary to the claims of Krugman (1994), DS-based

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[17] Negishi, Nikaido and others had constructed models of general equilibrium with Chamberlinian monopolistic competition. However, they were primarily interested in issues of existence and stability under very general specifications, rather than in comparative statics implications, which as we now know require much more structure.

trade theory tells many of the same "big lies" as traditional competitive theory.[18] While it allows for differentiated products and increasing returns to scale, it retains the assumptions of identical, atomistic firms, free entry and no perceived interdependence. And of course, the price of tractability is a reliance on very special functional forms. These deficiencies do not matter for many purposes: the model makes distinctive predictions, and explains many phenomena which cannot even be discussed in a competitive framework. However, they make the model less relevant to many important issues than it may seem. And they call into question the extent to which it represents an advance in descriptive realism over traditional competitive models.

Of course, a twenty-fifth birthday conference should be an occasion for celebration rather than complaint. So it may seem churlish to criticise the model, especially when one of the authors is present. I hope not: better to see my comments in Section 4 as an agenda − or a wish-list − for future research than as criticisms of what has been achieved so far. And if the achievements of the monopolistic competition revolution in trade theory have sometimes been exaggerated, Dixit and Stiglitz cannot be held responsible for the more extreme claims of their followers. Indeed, their original paper contained no hint of the many applications which their approach would make possible. Maybe DS were lucky, in developing a persuasive but tractable model of monopolistic competition which had implications far beyond the IO topic which was their direct concern, and at just the moment when the

[18] The passage is worth quoting at length: "All economic theory involves untrue simplifying assumptions. Traditional trade theory, however, makes its big untrue assumptions - constant returns, perfect competition - at the beginning of the game, and plays by strict rules thereafter. The result is that traditional models, especially the 2-by-2 Heckscher-Ohlin-Samuelson model, tend to have a spurious air of generality and necessity: once you have become accustomed to the big untruths, you lose sight of the essential unrealism of the set-up. By contrast new trade theory models *avoid these big lies* but make many small ones along the way in order to keep matters tractable; the theorist can never forget the degree of falsification involved." [Krugman (1994, p. 15); italics added.] As I hope I make clear in the text, it just ain't so.

empirical failures of competitive trade theory were being highlighted. But it would be more correct to say that it is the rest of us who have been lucky. Without the DS specification, trade theory, like many other fields, would have been much less exciting, and would have made much less progress, in the past quarter century.

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Figure 1: Chamberlin-Dixit-Stiglitz Equilibrium

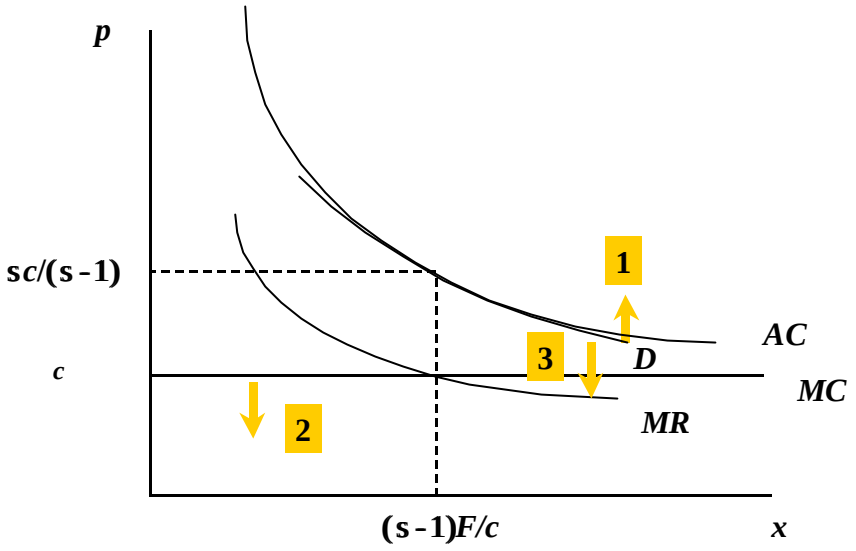

Figure 2: World Factor Endowments

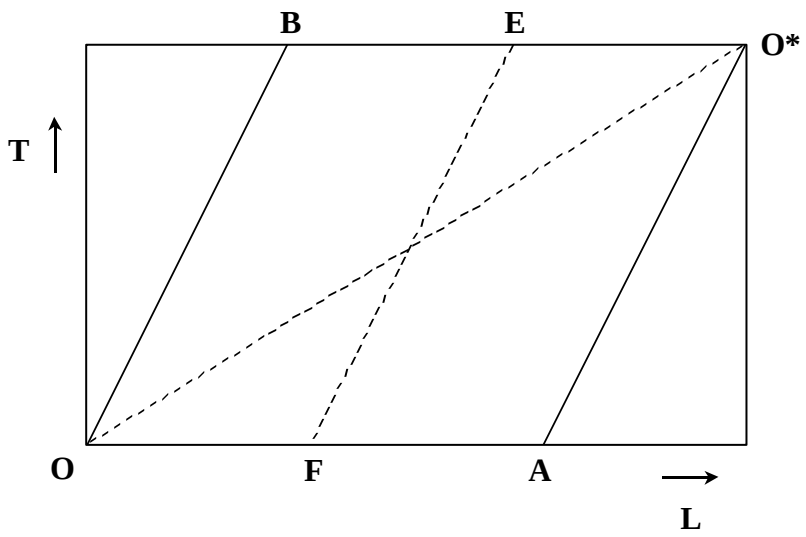

Figure 3: The Price Index and Variety

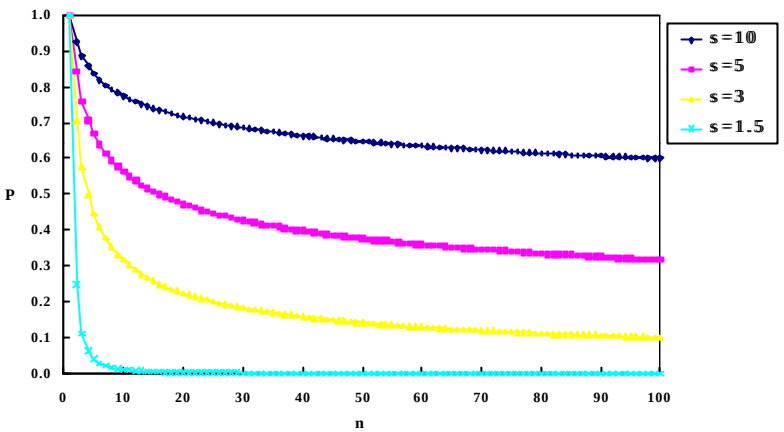

Figure 4: Changes in the Elasticity of Substitution