Market Size, Differentiated Scale Economies and Interindustry Trade

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Abstract

A stylized pattern of interindustry trade between developing and developed regions identifies the former as specialists in light manufactures and latter in heavy manufactures. Conventional explanations for this pattern rely on the factor proportions model, which is empirically suspect. This paper proposes an alternative model that relies on the interaction between scale economies and domestic market size. Unlike standard increasing returns analysis, the model provides a rich yet tractable characterization of variations in scale economies across industries. The model, in applying a limit pricing framework to the open economy, offers a new approach to analyzing imperfect competition and interregional trade.

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1. Introduction

A major stylized fact in North-South interindustry trade is the specialization of developing economies in “light” manufactures and of developed economies in “heavy” manufactures. Recently attention has been drawn to a similar pattern in the intranational distribution of economic activity, specifically between urban and rural areas. That is, industries based in the countryside have been observed to supply light consumer goods such as apparel, handicraft, and footwear to urban centers, either for domestic consumption or for export.

Such a general pattern for interregional trade (where region denotes either a country or a subnational area) begs for an explanation within a unified model. A coherent framework that explains this stylized fact, aside from its intrinsic academic interest, can be useful for informing industrial promotion policies on light and heavy industries, in both urban and rural areas.

The typical explanation for the pattern relies on Hecksher-Ohlin theory: light industries are labor intensive activities, which would tend to be exported by regions which are relatively labor abundant, i.e. developing economies and rural areas. According to this theory, specialization is attributed entirely to factor proportions; the relative magnitude of scale economies in light and heavy goods is irrelevant, as what really matters is their relative factor intensities. Industries are in fact assumed to be subject to constant returns to scale.

The Hecksher-Ohlin model is appealing because the simple analytics of its general equilibrium solution. However it is well known that the basic Hecksher-Ohlin proposition is not empirically tenable. In line with recent trade research, this paper confronts the possibility that fundamentals other than factor proportions may be at work in determining the pattern of interindustry trade.

A natural way to distinguish light from heavy industry is by differences in scale economies (rather than by differences in factor intensity.) Meanwhile regions may be ranked not by factor proportions, but by size of domestic demand, as proxied by market size. Relating market size to the size of scale of economies adopted at equilibrium would therefore be an alternative approach to explaining the stylized fact.

Scale economies animate the "new trade theory". However the new approach is most directly applicable to the analysis of *intra*industry trade. As for *inter*industry trade, one variation in the increasing returns literature is to fall back on the factor proportions explanation. On the other hand, another variation in the literature offers an alternative explanation based on demand. The resulting hypothesis is stated as the *home market effect*: the region with a larger domestic demand for an increasing returns commodity is predicted to be an exporter of that commodity. The effect highlights the role of market size, thereby countering some of the empirical difficulties of attributing trade patterns purely to factor proportions.

Within these new generation models however, industries remain caricatured into an increasing returns/constant returns dichotomy. A better approximation of reality would be a model in which equilibrium is characterized by smaller scale industry exports by developing regions, and larger scale industry exports by developed regions. Incorporating diversity of scale economies in the standard Dixit-Stiglitz monopolistic competition framework has however proven to be an intractable task.

In this paper we propose an alternative imperfect competition model that explains the stylized fact in terms of scale economies and market size. The significant property of this model is that differences in magnitude of scale economies is introduced in an intuitive and flexible manner. Instead of the monopolistic competition model, we adopt the limit pricing set-up pioneered by Murphy, Schliefer, and Vishny (1989) in their analysis of scale economies and the role of market size. We extend their basic framework from its original closed economy setting to case of the open economy.

The rest of the paper is organized as follows: In Section 2 we provide a real world setting to the stylization, as well as a review of plausible explanations. The model is then presented in Section 3; Section 4 concludes.

2. Interindustry and interregional trade: Patterns and explanations

We motivate the discussion here with a broad illustration of the stylized fact asserted in the Introduction. This is followed by a quick review of theoretical explanations and the corresponding empirical support.

2.1. Patterns of trade

Assembling systematic evidence on patterns of interindustry trade and scale economies is beyond the scope of this paper. A major obstacle to a rigorous presentation is that "light" and "heavy" industries are not easily defined in the absence of disaggregated production analysis. As an approximation, the category of transport equipment and machinery is identified here as heavy industry, while the category of textiles and clothing correspond to light industry.

At the level of international trade, the following Table provides an illustrative comparison of export shares. The selected developing countries in the Table account for 45% of the world's population; meanwhile the selected developed countries are the world's top five exporters for 1999. Clearly, heavy industry dominates manufacturing exports of the developed economies. In contrast the manufacturing exports of the lowest income nations (Pakistan and Bangladesh in particular) in the Table display an unmistakable dependence on light industry.

[INSERT TABLE HERE]

The higher income developing economies in the table are rely less on textiles and garments. For China – the largest developing economy in the listed in the Table – over half of manufacturing takes the form of equipment and machinery. The greater concentration of heavy goods in Indonesia compared to India (which has a larger GNP) may seem to be an anomaly; however, India's PPP-adjusted per capita income is similar to that of Bangladesh and Pakistan, suggesting a large demand for agricultural goods (the Engel effect) relative to manufactures, compared to better-off Indonesia and China (whose PPP-adjusted per capita incomes are roughly at par.)

We turn now to intranational, urban-rural patterns in industry specialization. Unfortunately systematic data on urban-rural trade is sparse, as few statistical agencies differentiate output by geographic source, particularly in developing countries where the rural population shares remain substantial.

Instead we simply enumerate the following stylizations culled from various literature surveys: First, a large part of manufacturing employment in poor countries is rural-based. Going by figures cited in Leidholm and Kilby (1989), rural areas can account for 52% to 86% of total manufacturing employment in these countries. Second, rural-based manufacturing is typically small scale. As much as 85% of rural industries employ fewer than five persons (Leidholm and Mead, 1987). Third, within rural-based manufacturing there is a subset of nontraditional activities that cater to external demand. This distinction between traditional and modern activities in rural-based industry was suggested by Ranis and Stewart (1993).Traditional activities (such as household rice milling and hand-loom weaving) conform to the Hymer-Resnick (1969) stereotype of primitive rural industries that cater only to local demand. On the other hand, contrary to stereotype, there exists a vibrant sector of modern activities (metalworking or machinery production) that produce for urban markets, are undertaken in small modern factories, and produce high quality products. Such activities would likely be found in rural towns rather than in villages.

Modern small-scale production is the cutting edge of a dynamic rural nonfarm economy, as illustrated in East Asian experience, particularly that of Taiwan and mainland China. Reardon (2000) notes that urban-linked but rural-based manufacturing (e.g. knitwear, vehicle parts production) is at various stages of development across continental areas: it is weakly developed in Africa and South Asia, growing in Latin America, and well-advanced in East Asia. It is the presence of this modern rural-based "export" sector that makes urban-rural linkages conforms to our stylization in the pattern of interregional trade.

What could account for these patterns in international and intranational specialization? The possible answers can be sorted into four broad categories: *productivity differences*, *external economies*, *factor proportions*, and finally, *domestic* *demand*. Productivity differences have received relatively little attention in the literature given the absence of a general theory of technological change and diversity across locations. External economies meanwhile have fallen out of favor given the invisibility of spillover effects needed to obtain variations in the degree of industrial concentration. This leaves factor proportions and domestic demand as the leading candidates for an explanation.

2.2. Empirical evidence

The factor proportions explanation differentiates regions in terms of relative factor endowments, and industries in terms of factor intensity. It predicts that a region specializes in the good that uses more intensively the factor it possesses in relative abundance. The statement holds under constant returns as in traditional Hecksher-Ohlin models, as well as under increasing returns as in standard monopolistic competition models, e.g. Dixit and Norman (1980).

In the case of international trade, the theory is however empirically suspect. In a multi-country, multi-factor setting, empirical implementation rests on Hecksher-Ohlin-Vanek (HOV) proposition: a country's exports (imports) embody factors which it possesses in relative abundance (scarcity). Multicountry studies, initiated by Bowen et. al. (1987) and summarized in Helpman (1999), consistently reject the HOV proposition.

Current empirical work on the issue has tried to assess what modifications need to be introduced in order to make HOV theory more consistent with trade data. Trefler (1995) finds that an important reason why HOV performs poorly is "missing trade", i.e. the total amount of trade is far lower than what is suggested by factor endowment differences. He finds that a correction taking into account home demand bias greatly improves data fit. This leads us to an examination of demand-based explanations of trade.

We reserve the term “demand-based” for models in which demand factors affect industry costs in the presence of economies of scale; The study of demand-based explanations of trade is largely undeveloped, despite the longstanding suspicion that scale economies combined with market size might be a determinant of trade patterns. Deardorff (1984) for one cites work in the 1960s by Drezé and Linder that make the connection. More recent formal models hypothesize a home market effect: given trade costs and increasing returns, a country will tend to export a good for which it has a relatively greater demand. Note that in the absence of scale economies, the home market effect will not hold as larger domestic demand for a good simply increases imports.

Lundback and Torstensson (1998) examine trade patterns of seventeen OECD countries and find that demand differences explain more of the net trade pattern than do factor proportions; moreover, high domestic demand in an industry leads to a net export in the majority of cases, consistent with the home market effect. Their evidence provides some but not clear cut support for a demand-based theory of trade. Davis and Weinstein (1999) obtain weak evidence for the home market effect in a sample of OECD countries; however, reapplying their analysis to Japanese regional data leads to a strong confirmation of the home market effect.

2.3. Scale economies and specialization patterns: theory

The foregoing suggests that modeling trade in terms of demand and scale economies is an empirically promising approach. Nevertheless, conventional theories of scale economies and specialization remain subject to considerable difficulties, which we develop more formally in the following.

The perennial difficulty associated with adopting increasing returns is modeling the resulting imperfectly competitive market. The preferred approach is to assume monopolistic competition. This market structure requires differentiated products, preferences for which are typically modeled in terms of Dixit-Stiglitz utility:

$$u = \left(\sum_i^N q_i^{(\sigma-1)/\sigma}\right)^{\sigma/(\sigma-1)}, \sigma > 1. \quad (1)$$

Here u is the utility function of the representative consumer, q_i is the consumption of the ith variety, σ is the constant elasticity of substitution between varieties, and N is the number of varieties. Utility rises with the number of product varieties N (assumed large enough to approximate a continuous measure.) Production of each q_i requires only homogenous labor, denoted by l_i, endowment of which is fixed at L for the economy. Technology is subject to increasing returns and takes a linear form assumed to be the same for all varieties:

$$l_i = f + cq_i . \quad (2)$$

Here f is the fixed start-up cost (in terms of labor) while c is the constant marginal product. Setting wage w as fixed from the firm's viewpoint, then marginal cost is a constant function $MC_i = wc$. This is below and asymptotic to the declining average cost curve $AC_i = fw/q_i + wc$. Increasing returns therefore implies that each variety is produced by only one firm.

Firms ignore the effect of their actions on other firms. Symmetric equilibrium ensures that behavior can be ascribed to a representative firm (hence the subscript may be suppressed.) Denoting price by p, firms maximize profit where

$$MC = p(\sigma - 1)/\sigma \ . \tag{3}$$

With free entry and exit, profits are zero at equilibrium, hence $p = AC$. It turns out that output is determined solely by the parameters σ, f, and c; the zero profit condition is achieved not by adjustments in output, but by adjustments in the number of firms.

So far the model pertains to a single economy consisting of one differentiated industry subject to scale economies. To obtain interindustry trade at least two industries and two economies must be present. In nearly all models developed, the other industry is assumed to produce a homogenous good under constant returns technology.

The model developed by Krugman (1980) to obtain the home market effect uses the foregoing framework and adds “iceberg” transportation costs of trade. With transport cost, a firm has an incentive to locate close to the area in which demand for its product is large. Hence, for example, the region with a bigger market (e.g. in this case a larger population) will contain a greater proportion of the total manufacturing sector. As consumers in both regions purchase all available varieties and goods, then the larger regions is a net exporter of the increasing returns industry.

The model has been extended in several directions. Krugman (1991) incorporates factor mobility to show how migration can have the cumulative effect of partial or even complete agglomeration of the manufacturing sector in one region. Still on the cumulative causation theme, Venables (1995) shows that vertical production linkages is another plausible mechanism driving agglomeration at the international level. Both vertical linkages and migration were combined in the study by Hanson (1996) of the garment industry in Mexico; his models shows how the urban center can specialize in the increasing returns intermediate input, while rural peripheries can specialize in the constant returns intermediate input.

A direction in which the theory should be extended, to better approximate the diversity of real world industries, is to accommodate differences in the degree of increasing returns. Unfortunately this approach is hardly taken in the literature. Fujita, Krugman, and Mori (1999) construct an urban systems model that most closely adopts this more general specification. In their model, industries are differentiated by degree of scale economies and by transport costs. Population growth leads to the formation of "frontier cities" at the fringes of the original urban center. Among the activities which would locate earliest to the frontier would be the smaller scale industries. One may interpret these frontier agglomerations as intermediate cities or urbanizing rural towns, which export light manufactures to the center in exchange for the heavier manufactures.

A major shortcoming of the model is however the adopted measure of scale economies, which is the elasticity of substitution σ in (1). To see why it has been so used, express the ratio of average over marginal costs (the elasticity of scale) as $\sigma/(\sigma-1)$, using (3). The problem with this (as with other Dixit-Stiglitz models) is that a parameter of *taste* is applied to characterize technology. Neary (2001) correctly points out that σ is not really a measure of scale elasticity, but rather of the degree to which returns to scale are exploited. A more natural approach to differentiating scale economies would be to use the explicit technological parameters, i.e. f_i and c_i; this tack however quickly leads to a loss of tractability.

To summarize: regional specialization in interindustry trade can be explained by factor proportions or by demand-based models, but these explanations remain unsatisfactory. Factor endowments fail to account for a large part of the trade pattern; data fit improves by incorporating demand considerations and increasing returns. However, within standard increasing returns models, the treatment of diversity of scale economies across industries as very limited. Attempts at more flexible characterization of scale economies have proved intractable within the dominant monopolistic competition framework.

The model we propose in Section 3 neatly ties up this loose end. However we need to depart from the monopolistic competition framework in favor of an even simpler formulation based on limit pricing monopoly, pioneered by Murphy, Schliefer, and Vishny (1989; henceforth MSV.)

3. The model

We present the model in stages. The basic framework is first set up for the case of the closed economy. Differentiation of scale economies is then introduced, follow by a discussion of the case of trading economies.

3.1. The basic framework for a closed economy

The basic framework adopts the original MSV formulation: consider a closed region which produces a continuum of goods, the total number of which is a fixed measure *N*. Each good is indexed by *i*, $i \in [0, N]$. The representative consumer has symmetric Cobb-Douglas utility, such that price elasticity of demand for each good is –1. Production uses only labor and takes the linear form of equation (2), rewritten as $l(i) = f(i) + c(i)q(i)$. As before labor endowment is fixed at measure *L*.

There are two alternative technologies for producing each good. The first alternative is constant returns production for which fixed labor input is zero and marginal cost is 1 under normalized units. This alternative denotes *traditional technology*, adopted by *traditional producers*. Taken together these producers form the *traditional sector*, which is free of impediments to entry and exit.

The other alternative is *modern technology*, for which $f(i) > 0$ and $c(i) < 1$. That is, modern technology is subject to increasing returns with positive fixed costs but marginal costs less than unity. For each good, only one firm, the *modern producer*, has access to increasing returns production. Taken together these producers constitute the *modern sector*. Within this sector production technology is homogenous, hence $f(i) = f$ and $c(i) = c$, for all *i*.

Labor is mobile across industries and sectors. All firms seek to maximize profit. The model is set in two periods: in period 1, all supply is undertaken by traditional producers, and entry decisions are made by modern producers; in period 2, entering modern producers commence production. With symmetry, traditional producers act the same way; let the output of the traditional sector act as the numeraire with unit price. Under constant returns the traditional producers must earn zero profit, and wage must be unity.

From the viewpoint of the modern producer, the unit price of traditional output functions as a limit price; the modern producer may not set a higher price, else she will be undercut by the traditional producers. We assume though that the modern producer of good *i* who sets a price of one will be able to monopolize the production of good *i*. That is, she exerts a downward pressure on the price, without discretely reducing it, thus ejecting the traditional producers. Unit elastic demand implies that the modern producer has no incentive to set a price discretely below one. Whether production is modern or traditional, therefore, output price is one.

Under symmetry, equilibrium output is identical across industries; hence we refer to a representative industry and suppress the index. There are only two candidate outcomes for the output of the representative industry. The first is the *traditional outcome*, in which all industries are produced using traditional technology. The second is the *modernized outcome*, in which all industries are produced using modern technology. In either outcome, full employment under symmetry implies:

$$l(i) = l = L/N \,. \qquad (4)$$

In the traditional outcome, profit must be zero; output is simply L/N . For the modernized outcome, output is given by

$$q = \frac{L - Nf}{Nc} \,. \qquad (5)$$

At the limit price of one, the profit π of any modern producer is given by

$$\pi = q(1-c) - f \qquad (6)$$

For a modern producer to enter, prospective π must be non-negative. MSV assume the modern producer ignores other modern producers' entry decisions. Using (4) and (6), the entry condition is therefore

$$L/N > f\,/(1-c)\,. \qquad (7)$$

If (7) satisfied, then equilibrium is the modernized outcome; else, equilibrium is the traditional outcome. Condition (7) implies that a sufficiently large labor endowment (and therefore market size) relative to the number of goods leads to a modernized outcome.

MSV use this basic framework to analyze the possibility of coordination failure, i.e. a situation in which entry by modern producers must be simultaneous (a Big Push) in order to reach an equilibrium modernized outcome. They note that if (7) holds, then output given by (5) must be profitable, i.e. there is no Big Push. Other assumptions must be introduced to obtain coordination failure, i.e. a dual labor market (as in the MSV paper), or income elastic demand (Fafchamps and Helms, 1996). Our model though is not concerned with the Big Push, but does exploit the fact that, in this framework, market size can determine the equilibrium choice of technology.

3.2. Differentiated scale economies

From here we depart from the MSV formulation by assuming heterogeneity in the technology in the modern sector. Let $f(i)$ and $c(i)$ be functions defined in $[0, N]$, both continuous in their domain, c a strictly decreasing function, such that $f(0) = 0$ and $c(0) = 1$. That is, industries are labeled in such a way that, as their index approaches N, their marginal product strictly rises from a minimum value of unity. Moreover, let the break-even output rise with the index, i.e. for $i, j \in [0, N]$, $i > j$, and the unit wage,

$$\frac{f(i)}{1-c(i)} > \frac{f(j)}{1-c(j)}. \qquad (8)$$

Condition (8) implies that $f(i) > f(j)$, or fixed costs rise monotonically as i approaches N, beginning from a minimum value of zero. The assumptions capture in an intuitive way the increasing degree of scale economies denoted by i. As i increases, output must be larger in order to realize lower marginal costs in modern production; hence we associate a larger i with an increasing industry scale.

The analysis on traditional and modernized outcomes carries over. As with (7), the entry condition for the modern producer is

$$L/N > \frac{f(i)}{1-c(i)}. \tag{7'}$$

The extent of modernization at equilibrium may therefore only be partial. Let $B \in [0, N]$ denote the *border industry*, such that entry by modern producers is observed in industry *j*, $j \in [0, B]$, and entry is not observed in industries *i*, $i \in (B, N]$. *B* demarcates the smaller scale industries (denoted by *j*) from the larger scale industries (denoted by *i*). We may associate the *j* industries with "light manufacturing" and the *i* industries with "heavy manufacturing". As labor endowment rises in a closed economy, we would observe a smooth procession into modern production from the smaller scale to the larger scale industries. At the extremes, $B = N$ denotes a fully modernized outcome, while $B = 0$ denotes a traditional outcome.

Output in the traditional outcome is the same as in the original MSV formulation. However calculation of output under the nontraditional outcome must be modified. Given *B* obtained using (7'), full employment implies

$$\int_0^B [f(j) + c(j)q(j)]dj + \int_B^N q(i)di = L \tag{8}$$

Define cumulative functions $F(B) = \int_0^B f(j)dj$, $C(B) = \int_0^B c(j)dj$ for fixed and marginal costs, respectively; both cumulative functions are continuous and continuously differentiable in $[0, N]$. With output symmetric at *q*, then the nontraditional outcome has the following output:

$$q = \frac{L - F(B)}{C(B) + N - B} \tag{9}$$

If $L/N > F(N)/(1-c(N))$, fully modernized equilibrium holds. For this special case, (9) becomes

$$q = \frac{L - F_T}{C_T} \qquad (9')$$

where $F(N) = F_T$ and $C(N) = C_T$.

3.3. The case of trade

We now turn to the main case, where two economies or regions trade. Regions may represent countries or subnational units (urban versus rural). The regions are similar in every respect except for their labor endowment, which is our way of capturing differences in market size. Label the larger region as North, the smaller region as South; to distinguish the two regions (where relevant), an asterisk is used for North.

Let the two economies be open to interregional trade and migration. Trade must be balanced. Labor moves only in response to a difference in real wages between regions. Finally, as in the closed economy case, there is an initial period characterized by autarky and traditional production; trade (and possible entry by modern producers) occurs only in the second period.

The case of trade confronts us with a novel situation: there is a potential duopoly (rather than merely a potential monopoly) in each industry, i.e. a modern producer from each region. We impose additional structure in the case of trade with the following assumptions:

a) In a duopoly, modern producers behave as Bertrand competitors.
b) Consumers in either region purchase only from the duopolist setting a lower price.

c) In an industry where duopolists set the same price, then consumers will consume foreign output only after consuming all of domestic output.

d) When real wages are identical across regions, and a modern producer is expanding its output, it obtains additional workers from the domestic market. Domestic workers will move from the modern producer with the lower marginal product to the producer with the larger marginal product.

Assumption a) is based on Mas-Collel, Winston, and Greene (1995) and is a fairly common simplification. Assumption c) is highly plausible: it suggests the presence of a tiny transport cost, which is negligible whenever prices are discretely different, and matters only when prices are identical. Assumption d) implies likewise the presence of miniscule frictions in the movement of labor across regions, which matter only when real wages are equal. The movement from low to high marginal product industries is motivated by the following: for a modern producer of good *i* in South,

$$\frac{d}{dw}\left(\frac{d\pi(i)}{dq(i)}\right)=-c(i).$$

(A counterpart expression holds in North.) That is, a given wage increase involves a smaller profit reduction for the larger scale industry. Hence the larger scale producer is able to exert a greater upward pressure on wages. Note that actual wage increases need not occur, as workers move even in the absence of discrete wage changes.

3.4. Equilibrium in the case of trade

The foregoing provides all the conditions needed to derive *trade equilibrium*, i.e. an equilibrium in which exports and imports are positive. In this sub-section the properties (including welfare aspects) of such an equilibrium are described, as well as more technical issues such as existence and uniqueness.

Proposition 1. A trade equilibrium is characterized by the following:

(i) Labor supply in each region remains fixed at the original endowment.

(ii) There is a border industry *B*, $0 \leq B < N$, such that the set of all industries *j*, $j < B$, are produced only in South, while the set of all industries *i*, $i > B$ are produced only in North.

(iii) Prices in industries *i* and *j* as well as wages are set at unity.

(iv) Total income equals total spending in both regions and consumption is symmetric in output within each region.

(v) South is an exporter of the *j* industries, while North is an exporter of the *i* industries.

(vi) The common output *q* and the border industry *B* is determined by the following condition:

$$q = \frac{L - F(B)}{C(B)} = \frac{L^* - [F_T - F(B)]}{C_T - C(B)}. \tag{P1}$$

The proof of Proposition 1 is simple but rather lengthy and is relegated to the Appendix. The proposition describes an equilibrium which conforms to the stylization: North and South are engaged in interindustry trade, with (near) complete specialization in their respective producing industries. South specializes in and exports smaller scale industries, while North specializes in and exports larger scale industries. The demarcation between the two types of industries is set by a border industry *B*. Only border industry *B* has an output that may differ from that given by (P1).

Note that the two regions start out with autarky under traditional production, hence the equilibrium trade pattern (i.e. the direction of trade, the value of *B*, and industry output) is entirely endogenous to the model. Moreover, even though migration is permitted, it never occurs; rather, specialization and output trade replace factor movement. One interpretation of this would be to regard the goods market as adjusting faster than the labor market.

A graphical illustration will help fix ideas. Figure 1 plots the industry index on the horizontal axis, and industry output on the vertical axis. Producing industries in South are read from left to right, with the curve labeled q being the graph of symmetric industry output as a function of the number of producing industries. Curve q is decreasing from left to right, as fixed labor endowment must be distributed to more and more producing industries. Meanwhile a counterpart graph for North is the curve labeled q^*, with producing industries in North read from right to left. The q^* curve is likewise decreasing from right to left. The border industry *B* is obtained at the intersection of the two curves, at which $q^* = q$, consistent with (P1).

[INSERT FIGURE 1 HERE]

Based on Figure 1, an intersection of the q-curve and q^*-curve occurs only once; that intersection is possible whenever the left vertical intercept of the q-curve is above that of the q^*-curve. This suggests a result on existence and uniqueness expressed in Proposition 2.

Proposition 2. If a trade equilibrium exists, then it is unique in the following sense: the border industry *B* is unique, and the output of any set of industries with a positive measure is given by (P1). Moreover, a trade equilibrium exists if

$L > (L^* - F_T)/c_T$.

The proof is again left to the Appendix. The foregoing existence condition appears mild: it simply requires that the representative industry's output in a fully modernized outcome in North remains smaller than the *total* output under a traditional outcome in South. The number of industries should be sufficiently large, relative to the endowment differences between the trading regions.

Meanwhile, "uniqueness" of equilibrium extends to any positive measure set of industries; in particular, the output of industry *B* is not determinate. From the Appendix, it can be shown that industry *B* may be a monopoly of a North modern producer, or a monopoly of a South modern producer, or a duopoly by modern producers supplying the same output and pricing at average cost. However the output of a single industry is too small to matter significantly for the overall pattern of resource allocation.

3.5. Comparative statics

Does an increase in the labor endowment in a region increase the number of industries exported by that region? An affirmative answer implies that market size determines the scope of specialization across regions. These questions are best answered by comparative statics analysis of the effects of changes in L and L^* on equilibrium *B.*

Proposition 3. At the equilibrium described in Proposition 1, $\frac{dB}{dL} > 0$ and $\frac{dB}{dL^*} < 0$.

Proof. Define

$$g(B, L, L^*) = \frac{L - F(B)}{C(B)} - \frac{L^* - [F_T - F(B)]}{C_T - C(B)} = 0 .$$

Then g is continuous, with continuous partial derivatives. From the Appendix we obtain $\frac{\partial q}{\partial B} < 0$ and $\frac{\partial q^*}{\partial B} > 0$; hence the implicit function theorem holds at a trade equilibrium. Therefore there exists a continuously differentiable function $B = B(L, L^*)$ in the neighborhood of equilibrium, By total differentiation,

$$\frac{dB}{dL} = \frac{\partial B}{\partial L} = \frac{\partial q / \partial L}{\partial q^* / \partial B - \partial q / \partial B}.$$

Given $\partial q / \partial L = 1 / C(B) > 0$, and the derivatives with respect to B (see Appendix), then the sign of the foregoing is positive. Furthermore, $\partial q^* / \partial L^* = 1 / (C_T - C(B)) > 0$. Hence,

$$\frac{dB}{dL^*} = \frac{\partial B}{\partial L^*} = \frac{\partial q^* / \partial L^*}{\partial q / \partial B - \partial q^* / \partial B} < 0 \text{. QED}$$

The results of Proposition 2 are highly intuitive. A larger endowment in South enables it to produce a wider range of smaller scale industries, while a larger endowment in North enables it to produce a wider range of larger scale industries. We can illustrate the impact of an increase in L using Figure 2. The increase in L leads to a rightward shift in the q curve; likewise the border industry moves to the right as indicated by the arrow. A similar figure can represent an increase in L^* (not drawn), where it is the q^* that is shifted upward, moving the border industry to the left.

3.6. Extensions

The model can be extended in several directions. We have considered only the special case in which all increasing returns production is undertaken even in autarky, where only two regions trade, and where demand is symmetric. In particular, introducing many economies and nonhomothetic preferences is a prerequisite to an empirical test of the foregoing model.

Other extensions are of interest in broadening the model's implications to wider concerns of development and organization. First, a dynamic version of the model would incorporate a story on capital accumulation and technological change: questions regarding industrial formation, dynamic comparative advantage, and growth trajectories can be addressed within a framework that emphasizes the role of domestic market size. Second, the model should include vertical differentiation of industry, not only to analyze agglomeration issues, but also to illuminate issues of industrial organization. For example, rural-based manufacturers often act as subcontractors of urban-based firms who could have alternatively organized production within a vertically integrated set-up (Hayami, 1998). The interplay of organization, geography, and trade form a rich tapestry for in-depth research into the dynamics of industrial diffusion.

4. Conclusion

A pronounced pattern in interindustry manufacturing trade is the specialization of developing regions in the lighter industrial goods, and the developed regions in the heavier industrial goods. Regions here can be taken as countries or subnational urban and rural units. This paper sets out to find an explanation of this pattern.

The most common explanation applies factor proportions theory. The light-heavy dichotomy is interpreted as a distinction between labor-intensive versus capital-intensive industries; the developing region is distinguished by its labor-abundance, and the developed region by its capital abundance. Factor proportions theory however is empirically wanting; this motivates the search for alternative explanations, particularly in in new generation models of trade and economic geography.

A promising hypothesis from new generation models is the "home market effect", in which large domestic demand imply domestic specialization in the industry subject to increasing returns. A major drawback to these models however is their restrictive representation of variations in scale economies across industries. Differences in technology is limited to the dichotomy between the increasing returns and the constant returns sector, with homogenous technology within each sector. Further differentiation of technology renders the standard Dixit-Stiglitz monopolistic competition framework intractable.

Instead, this paper proposes an alternative model of increasing returns and imperfect competition to address this difficulty. Our model identifies patterns of specialization on the basis of domestic market size; light and heavy manufactures are distinguished by an intuitive indicator of scale economies, and the light manufactures are flexibly characterized as increasing returns industries in their own right. The result is a highly tractable model which provides an explanation of the stylized fact.

The increasing returns revolution was made possible by the discovery of an imperfect competition model distinguished by its simplicity and its consistency with major stylized facts. The models that pioneered this breakthrough adopt the monopolistic competition framework. While our paper departs from this particular framework, it is motivated by precisely the same drive towards explanatory power and simple formalization. It therefore offers, as it were, a new variation on a familiar theme.

Appendix

Proof of Proposition 1.

STEP 1. At a trade equilibrium, industries can be divided into three sets: that is, for $i, j, k \in [0, B]$, let T = {i: such that industry i is a monopoly of a North modern producer}, U = {j: such that industry j is a monopoly by a South modern producer}, V = {k: industry k is duopoly}.By definition these sets are disjoint. Note that an industry in which traditional producers supply output cannot be in equilibrium as autarky equilibrium already involves entry by a domestic modern producer. Hence $T \cup U \cup V = [0, N]$.

Industries i and j, being monopolies, set a limit price of one. Industries k meanwhile by Assumption a) set a price closest to marginal cost without incurring losses. This entails average cost pricing; at equal prices, then average costs must be equal, which implies equal output for both North and South producers. Hence, however industries are allocated to sets T, U, and V, prices in both regions are identical. Nominal wages are also kept at unity by the presence of a traditional sector. Hence, real wages are also identical across regions, such that labor does not migrate. This establishes Property (i).

STEP 2. Suppose $V = [0, N]$. Then by Step 1, output in each region must be equal in all industries, which is not possible as labor supply at equilibrium is smaller. Hence, T and U are non-empty sets. Moreover, industries i and j must set a unit price; under symmetric demand (in both regions), then the output of each industry i and j must be equal. Let q denote this common output.

STEP 3. Consider the North modern producer in industry N. This producer can always exceed the output of its South counterpart, because it can draw labor away from smaller scale industries but itself is not subject to labor withdrawal. If so, then its average costs can always be lower than that of its competitor, such that the South modern producer is absent at equilibrium. Hence, $N \in T$, and industry *N* sets a unit price. Note that the argument in Step 2 implies that *N* cannot be the only industry produced in North.

STEP 4. Suppose there is an industry *i* and *h* such that *h* > *i* and $h \notin T$. Then the North modern producer in *h* can enter and exceed the output of its South competitor by drawing labor away from industry *i*. Hence at equilibrium there can be no such industry *h*. Hence, if we let $B = \inf V$, then $(B, N] \subset T$.

STEP 5. Suppose there exist $k, k' \in V$. Then the same argument as in Step 4 allows us to rule out $k > k'$; hence if *V* is non-empty, it must be a singleton. Furthermore appealing to Step 4, *B* < *N*. The previous steps imply that $[0, B) = U, (B, N] = T$, for some 0 < *B* < *N*. Thus Property (ii) is established.

STEP 6. By Step 2, prices of *i* and *j* are all unity; moreover, wage remains at unity for all industries given the traditional sector. Hence Property (iii) follows. Property (iv) meanwhile follows from utility maximization. Property (ii) and (iv) immediately imply Property (v). Finally, full employment in each region, as well as equality of output from Step 2, lead to (P1).

Proof of Proposition 2: *Uniqueness*

To demonstrate uniqueness in the sense of Proposition 2, it is enough to show that the output *q* and value *B* satisfying (P1) is unique. Differentiating the two terms of (P1) yield:

$$\frac{\partial q}{\partial B} = -\frac{f(B)C(B) + c(B)[L - F(B)]}{C(B)^2} < 0$$

$$\frac{\partial q^*}{\partial B} = \frac{f(B)[C_T - C(B)] + c(B)[L^* - F_T + F(B)]}{[C_T - C(B)]^2} > 0$$

Form the function $\tilde{q} = \dfrac{q(B)}{q^*(B)} = \tilde{q}(B)$, which is differentiable in $(0, N)$. Then B is a solution to (P1) if and only if $\tilde{q} = 1$. Differentiating $\tilde{q}$ yields

$$\frac{\partial \tilde{q}}{\partial B} = \frac{\dfrac{\partial q}{\partial B} q^* - \dfrac{\partial q^*}{\partial B} q}{q^{*2}} < 0,$$

i.e. $\tilde{q}$ is strictly decreasing in *B*. Hence $\tilde{q}$ is a one-to-one mapping, such that there is an inverse function $B = \tilde{q}^{-1}(\tilde{q})$. Then there is only one value for *B* for which $B = \tilde{q}^{-1}(1)$.

Proof of Proposition 2: *Existence*

To demonstrate existence, one needs to show that an allocation described by Properties (i) to (vi) is an equilibrium, and that under the condition stated, such an allocation exists.

STEP 1. At an allocation satisfying Properties (i) to (vi), all producers are maximizing profit, and all consumers are maximizing utility given prices. Moreover, the labor market is in equilibrium. If it can be shown that trade is balanced, then general equilibrium is established.

For South, let $x(j)$ and $m(i)$ respectively denote quantity of exports of industry *j* and of imports of industry *i*. Consumption in each of the *j* industries in South is given by $q - x(j)$, while consumption in North is $x(j)$; consumption in each of the *i* industries in South is $m(i)$, while that of North is $q - m(i)$. Symmetry implies that $x(j) = x$, for all *j* and $m(i) = m$, for all *i*. Total exports are therefore Bx, and total imports are $(N - B)m$.

By Property (v) of Proposition 1, $Bq = B(q-x)+(N-B)m$, or total income equals total spending in South. Likewise $(N-B)q = Bx+(N-B)(q-m)$, or total income equals total spending in North These imply $Bx = (N-B)m$, or that trade is balanced.

STEP 2. To demonstrate existence, it is enough to show that there is a value of *B* such that (P1) is satisfied, for at this allocation, imposing equality of income and spending, as well as symmetry of consumption, yields an equilibrium in the foregoing sense.

Consider the maximal value of $\tilde{q}$ achieved at $\tilde{q}(0)$; under the condition stated in Proposition 2,

$$\tilde{q}(0) = \frac{L}{L+(L^{*}-F_{T})/C_{T}} > 1.$$

Meanwhile the minimum value is reached at

$$\tilde{q} = \left(\frac{L-F_{T}}{L^{*}-f(N)}\right).\left(\frac{c(N)}{C_{T}}\right) < 1.$$

As function $\tilde{q}$ is continuous, then a value of *B* for which $\tilde{q}$ = 1 must exist.

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Table.
Per capita income and manufacturing export shares of selected countries, 1999

Country	GNP, $US (billions)	Manufacturing exports, $US (billions)	Share in total manufacturing exports (%)	
			Equipment and machinery[1]	Textiles and garments
China	980.2	172.1	51.7	25.0
Indonesia	119.5	26.2	31.3	26.3
India	442.2	25.2	12.4	36.9
Pakistan	64.0	7.5	5.0	86.7
Bangladesh	78.0	5.0	2.0	92.0
USA	8,351.0	575.3	86.0	3.1
Japan	4,078.9	392.7	96.2	1.8
Germany	2,079.2	452.0	66.6	4.3
UK	1,338.1	225.0	76.6	4.0
France	1,427.0	238.8	66.6	5.3

[1]Transport equipment and machinery, office machines and telecommunications equipment

Notes: 1. Export data for Bangladesh and India are 1998 figures, which are the latest available.
2. Data for China excludes Hong Kong and Taiwan.

Source of basic data:
World Trade Organization, *International Trade Statistics*
United Nations Statistical Data

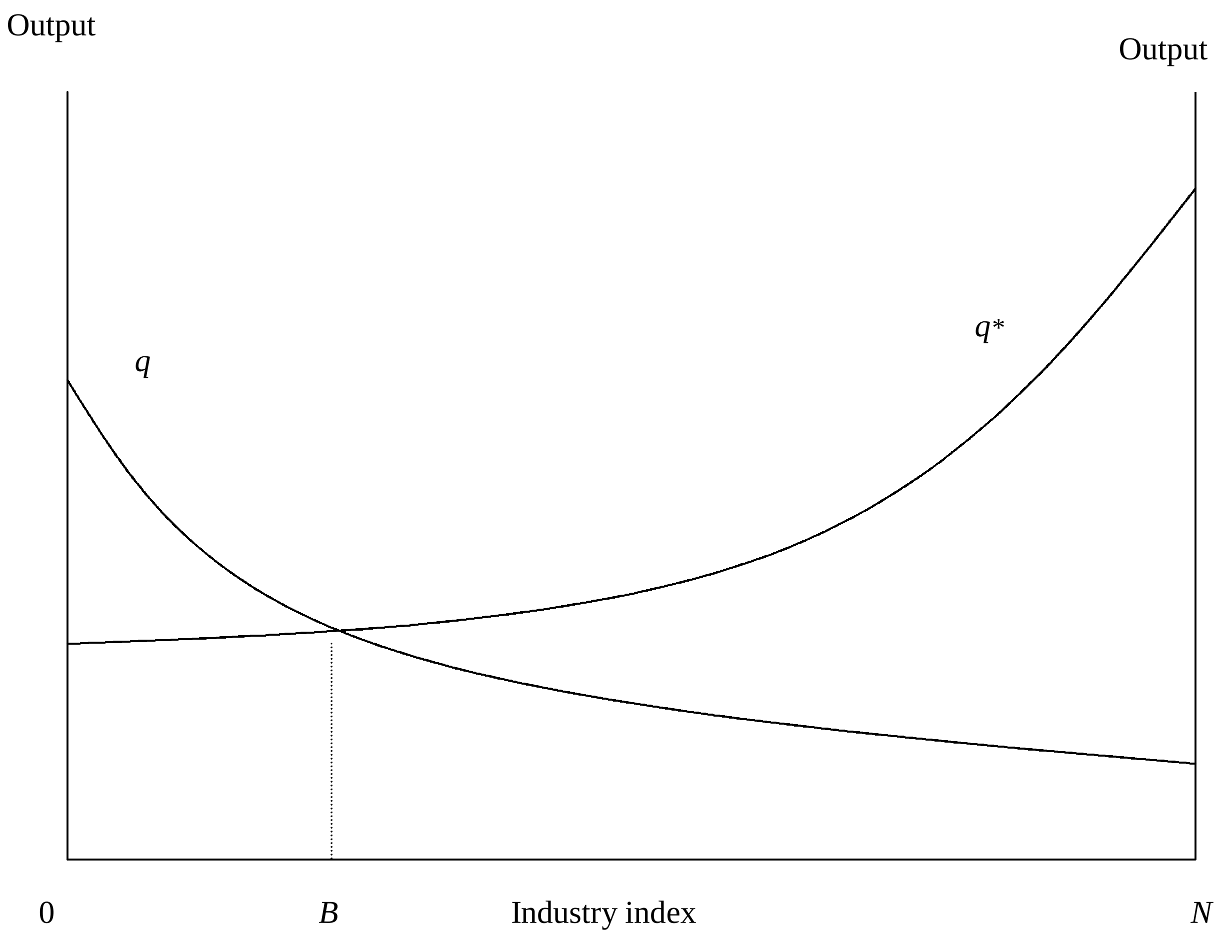

Figure 1.

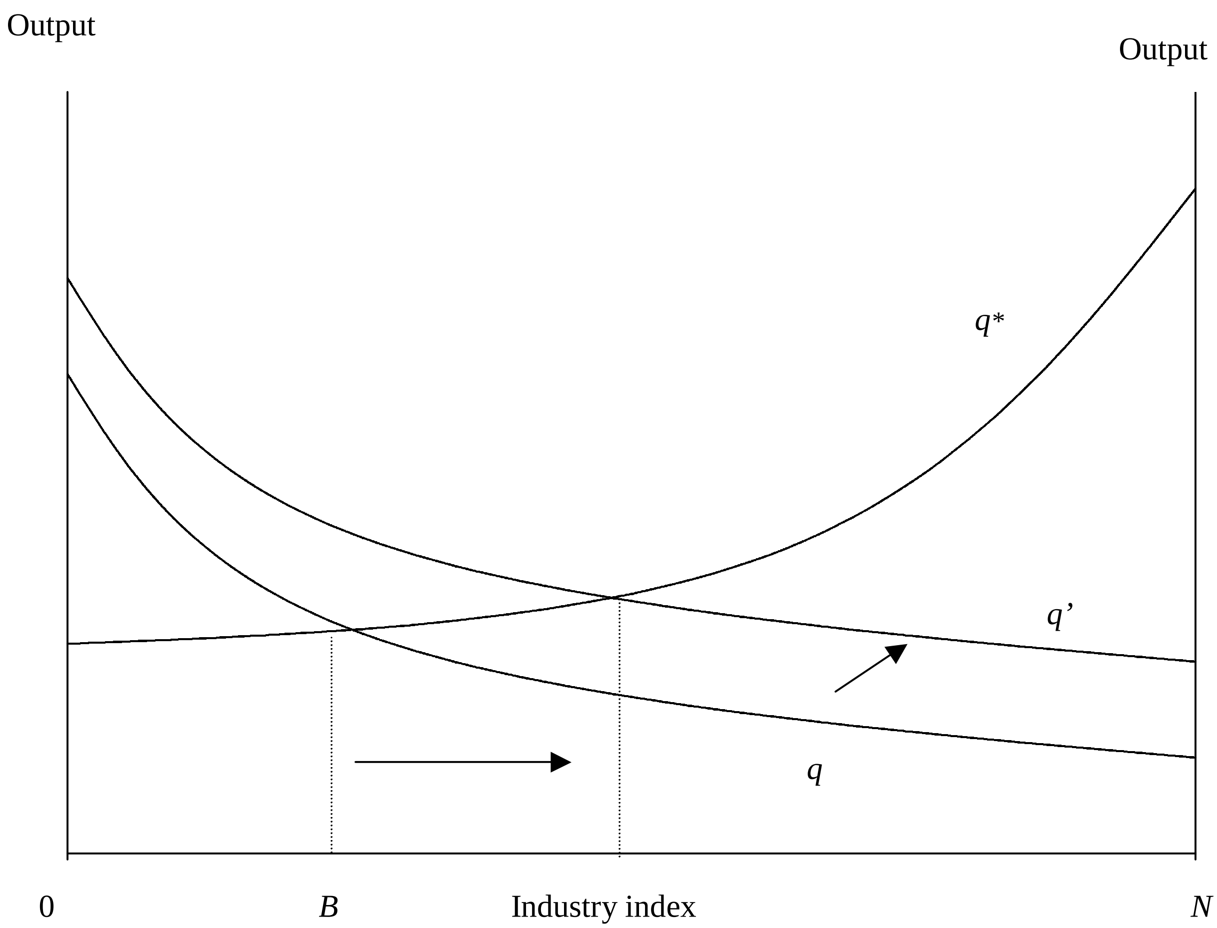

Figure 2.