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Quality, Trade and the Moving Window: Competitiveness and the Globalization Process

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Abstract

This paper analyses the globalization process by reference to a model in which firms and countries differ both in productivity and quality. This model is representative of a class of models popular within the Industrial Organization literature, that have proved successful in explaining cross-industry differences in market structure. The model, and its implications, differ fundamentally from those of monopolistic competition (Dixit-Stiglitz-Krugman) type that are now standard in the Trade literature. One implication of the present model is that there is a lower bound to quality below which firms cannot sell, however low the (local) wage rate they face. Another implication is that the range ('window') of quality levels between the current maximum level and this lower bound shifts upwards when trade is liberalized. A third set of implications throw new

light on the ‘competitiveness’ debates of the 1990s.

1 Introduction

This paper explores a model of trade in which firms differ in respect of both productivity and quality. The model is standard within the Industrial Organization literature but differs in important ways from models such as the CES type models of Dixit-Stiglitz (1977), Krugman (1978), and Fujita, Krugman and Venables (1999) that are standard in the trade literature.

The model of product market competition on which the present analysis rests is one of a broad class of models that are used in the modern literature on market structure¹. This class of models is characterized by two key properties: consumers choose which firms product to buy on the basis of the price-quality combinations on offer, and

¹The CES models and related models arise as special limiting cases of the general class of models, within which certain results central to the present paper vanish. The main argument in favour of the type of model used in the present paper is that it leads to empirically successful predictions regarding the levels of market concentration found across different industries; while appealing to a special ‘limiting case’ models such as DSK does not. Indeed the latter kind of model cannot be reconciled with the fact that many industries remain concentrated even in very large (global) markets. (For a review of the literature, see for example Sutton (2007)). This contrasts with a CES setting, in which each customer does not choose a single preferred product, but spreads his or her purchases over all products, buying more (or less) of the product depending on its price-quality combination, so that as the number of product varieties becomes arbitrarily large, the market share of each variety, including the highest quality variety, shrinks to zero.

- (i) any firm can choose to improve its level of productivity and/or quality by spending fixed and sunk costs outlays ('R&D')².

- (ii) If one firm's product has a quality level superior to, (and the same unit cost of production as) its rivals, then it will retain some (strictly positive, minimal) level of market share, even in the limit where the number of low quality rivals becomes arbitrarily large. In other words, 'high quality goods cannot be squeezed out by low-quality goods'. This can be shown to be equivalent to saying that, even as a low quality rival's prices fall to the level of unit variable cost, customers will still be willing to pay a strictly positive price premium for the high quality good.

It is well known from the I.O. literature that, within such a setting, there will be some lower bound to market concentration, no matter how large the market becomes. This happens because increases in market size induce an increase in fixed and sunk outlays by currently active firms, rather than inducing the entry of new firms (Sutton, (1991, 1998)).

This equilibrium level of concentration is, in general, consistent with the existence of an arbitrarily large number of firms, so long as some given fraction of consumers ignore quality, and buy on the basis of price alone. In the present

²If quality improvements are associated, not fixed and sunk outlays, but rather with a rise in variable costs (labour and raw material inputs), then 'quality competition' is precisely analogous to competition in product variety of the Hotelling kind (i.e. to 'horizontal' product differentiation). This kind of setup is captured, for example, in Rosen (1978); for a discussion, see Sutton (1991), Chapter 3.

paper, we simplify matters by letting all consumers have identical tastes; under this assumption, the familiar propositions on the level of concentration emerge as statements about the equilibrium number of firms in the market.

The first step in the present analysis lies in examining, in a single-economy, partial equilibrium setting, how the effect of differences in quality and productivity affect firms' survival. We define a 'capability' index, which combines information about a firm's productivity and quality levels, and we show that, at equilibrium, there will be a range, or 'window', of capability, running from the highest level attained by any firm, down to a threshold level determined by the process of competition between surviving (i.e. active) firms. Firms with capabilities below the threshold will have zero output at equilibrium (i.e. be inactive) (Section 2).

The main body of the paper is concerned with analysing, in a multi-country general equilibrium setting, the effect of opening up trade between hitherto separated economies, each of which has many industries of this kind. We distinguish three phases, associated with distinct competitive mechanisms, as follows:

1. The 'impact' phase: Here, we take all firms' levels of productivity and quality as fixed. The effect of liberalization is to induce a selection effect across firms and countries, under which low capability firms suffer a shakeout. The key question of interest relates to the way in which the loss of some firms or industries in a country lowers its

wage rate relative to other countries, and the way in which this wage reduction can or can not compensate for (poor) levels of productivity and quality in other industries (Section 3).

The central message relates to a contrast between productivity and quality. Differences in productivity can be fully offset by wage differences, in the manner of the conventional literature. Differences in quality can not: the cost of imported raw materials³ sets a floor to unit cost, and so price, independent to the local wage rate; and it follows from this that there is, at equilibrium, a floor to the firm's quality level below which it cannot survive even in a very low-wage economy (The 'quality window')⁴.

This phenomenon runs counter to one of the central arguments in the 'competitiveness debate' in the 1990s; in the models considered here, it is *not* the case that *absolute* levels of firms' capability translate into countries real wage and welfare levels⁵. Rather, *relative* quality

³More generally, materials or component inputs that are internationally traded.

⁴It is worth noting that a (loose) analogy exists between the way competition in quality works in present model, and in the O-Ring model of Kramer (1999). The O-Ring model rests on a special assumption as to how the quality of a component inputs determine the quality of the final product. Here, we make no assumptions of this kind; all that is needed is the notion that a consumer is willing to pay, for any given quality gap over rival products, some corresponding positive price premium, independently of the number of low quality alternatives offered.

⁵This is in contrast to the models underlying the case made by Krugman (1994,1999), where a country's fortunes depend only on its own (absolute) productivity level. It is worth noting that 'relative productivity' effects arise in traditional models via 'terms of trade effects', a channel explicitly assumed to be inoperative in Krugman's discussion.

levels matter, not only at the (uncontroversial) level of the firm, but at the level of countries too.

An implication of this is that the initial ‘impact’ phase of the globalization process can be welfare-reducing for intermediate-capability countries.

2. The transfer phase: The wage and capability differentials across countries in phase 1 creates a strong profit incentive for firms to transfer of high-level capabilities to low-wage countries. In Section 4, we examine the impact of such transfers, which can occur through various routes. The central argument of this paper is that it is this second phase of the process which carries the main benefits of globalization to mid-level economies such as China, India and the Eastern European countries. The determinants of the speed and effectiveness of this process, it is argued, are only partially understood. Such research as is available suggests (i) that the speed and effectiveness of the process varies widely across industries, and that (ii) one systematic influence that plays a major and general role relates to the vertical transfer of capabilities within the host (low-wage) economy through the supply chain of multinational producers.
3. The escalation phase: Overlapping in time with phase 2, this third phase involves the re-adjustment of firms to the global environment. Their pre-globalization levels of investment in building their productivity and quality levels were predicated on access to a limited number

of markets. Now that they have access to wider markets, the optimal level of fixed and sunk outlays aimed at enhancing productivity and quality rises. Just as the bound to the number of firms in the pre-globalization setup reflected the fact that firms' equilibrium outlays on productivity and quality enhancement raised the costs of competing in the domestic market, so too will renewed escalation of fixed and sunk outlays induce a new shakeout of firms in the globalized market. (Section 6)⁶

Finally, one caveat is in order: the gains from trade liberalization derive from several distinct channels, which include: (i) benefits of specialization that reflects differences in factor endowments, i.e., classical 'comparative advantages', and (ii) benefits of 'scale and variety; associated with 'horizontal' product differentiation, as captured by the now-standard monopolistic competition models, following Krugman (1978). In the present paper, both these channels are omitted, the first by eliminating differences in factor endowments, and the second by using a 'pure vertical product differentiation' setting. The reason for adopting these two simplifications is to focus attention on what is novel here, at the cost

⁶We may illustrate the mechanisms in phases 1 and 3 above in a single country by examining the quality (or capability) window in a setting where a new (high-level) entrant arrives in an industry: the arrival causes equilibrium prices to fall, thus raising the lower bound required for survival ('Shakout'; mechanism 1). The now narrower (capability or quality) gap between active firms raises the marginal returns from investment in capability building; so that some (or all) firms move upwards, thus (possibly) raising the highest level of capability attained (the 'moving window'). Essentially, the mechanism of phase 1 relates to the upward movement at the bottom of the window, while the mechanism in phase 3 is associated with the upward movement of the top.

of understating the gains from trade.

2 Product Market Equilibrium

To ease exposition, we first describe product market equilibrium in a one-country, partial equilibrium setting. This allows us to introduce some basic features of the model with a minimum of notation; these features will carry over immediately to the multi-country, general equilibrium version of the model in the next section.

We consider a single industry in which n firms each offer a single product. Firms, and their respective products, are indexed by i . Firm i is characterised by a ‘productivity’ parameter c_i , representing the number of units of labour input required per unit of output, and a ‘quality’ parameter u_i . We refer to the pair (u_i, c_i) as firm i 's ‘capability’. All firms face a common wage rate w and a price per unit of raw materials (or intermediate inputs) p_0 . Firm i has unit variable cost (i.e. a constant marginal cost) equal to the sum of a wage cost wc_i and a cost of materials (or intermediate inputs) $p_0\mu$, where μ represents the quantity of materials input per unit of final output. Total consumer expenditure, denoted S , is wholly devoted to the consumption of this good. All consumers have the same utility function $\bar{U} = ux$, where u denotes quality and x is the quantity consumed. It follows that the consumer chooses (only) the good(s) with the lowest price-quality ratio. We seek a Nash equilibrium in quantities (Cournot equilibrium). This is computed as follows:

since all goods commanding positive sales must have the same (equal lowest) price-quality ratio, we may write

$$\frac{p_i}{u_i} = \lambda, \quad \text{all } i$$

whence if x_i denotes the output of firm i , we have

$$\sum p_j x_j = \lambda \sum u_j x_j = S$$

whence $\lambda = S / \sum u_i x_i$ and $p_i = u_i S / \sum u_j x_j$.

Firm i sets x_i to maximize

$$\begin{aligned} \pi_i &= p_i x_i - (w c_i + p_0 \mu) x_i \\ &= u_i S / \sum u_j x_j - (w c_i + p_0 \mu) x_i \end{aligned}$$

taking $x_i, \dots, x_{i-1}, x_{i+1}, \dots, x_n$ as given.

A routine calculation (following Sutton (1998), pp. xxx-xxx) yields the Nash equilibrium solution for the firms' outputs and prices, given their capabilities. It is convenient to adopt the shorthand notation k_j to represent the ("effective cost") indicator, $(w c_j + \mu p_0) / u_j$, and to express the solution in terms of quality adjusted prices and outputs as follows:

$$\frac{p_i}{u_i} = \frac{1}{n-1} \sum_{j=1}^n k_j \tag{1}$$

$$u_i x_i = S \frac{n-1}{k_i} \left\{ 1 - (n-1) \frac{k_i}{\sum_{j=1}^n k_j} \right\} \quad (2)$$

Firm i 's equilibrium profit equals

$$\pi_i = p_i x_i - (w c_i + p_0 \mu) x_i = \left\{ 1 - (n-1) \frac{k_i}{\sum_{j=1}^n k_j} \right\}^2 \cdot S \quad (3)$$

It follows immediately from inspection of (2) that there is a critical level of (u_i, c_i) which a firm must attain in order to command positive sales at equilibrium. In characterizing this condition, it is convenient to focus on a setting in which there are $n+1$ firms; of these n are 'active' in the sense of producing positive output at equilibrium, while the $(n+1)$ th firm is on the margin of viability, i.e. the equilibrium value of x_{n+1} is zero. Re-writing equation 2 for $(n+1)$ firms and setting the r.h.s. to zero, we have on re-arranging:

$$k_{n+1} = \frac{n}{n-1} \cdot \frac{\sum_{j=1}^n k_j}{n} \quad (4)$$

where the final ratio on the r.h.s. is the average value of the 'effective cost' indicator for the n active firms. Thus the condition for the viability of the marginal entrant to the industry is that its effective cost indicator should not

exceed that of the industry average value by more than the factor $n/(n - 1)$.

It will be of interest in what follows to ask: to what extent can a fall in w raise a firm with a given capability to the threshold of viability defined by (4)? Noting that $k_{n+1} = (wc_{n+1} + p_o\mu)/u_{n+1}$, it follows that the schedule in $(1/c, u)$ space corresponding to equation (4) takes the form of a right-angled hyperbola

$$u_{n+1} = \frac{1}{a} \frac{n-1}{n} \left(\frac{w}{1/c_j} + \mu p_0 \right)$$

where $a = \left(\sum_{j=1}^n k_j \right) / n$ denotes the industry average value of the effective cost ratio. The horizontal asymptote $\mu p_0 / a$ denotes a level of quality below which the firm is non-viable, however low the wage rate it faces: in the limit $w \rightarrow 0$ the schedule collapses to the form indicated in Figure 1.

Once we turn to a multi-country setting, it will be of interest to ask: to what extent can low domestic wages render low-capability firms viable? What Figure 1 suggests, and what will emerge as a basic result in the general equilibrium setting of Section 3, is that low wages can always fully compensate for any deficiency in productivity (the threshold collapses to $1/c = 0$ as $w \rightarrow 0$) but not for deficiencies in quality (the threshold remains strictly positive in the limit). The intuition is as follows: poor (labour) productivity is reflected in high unit labour cost, but labour cost falls to zero with w whatever the value of c . On the other hand, poor quality can be offset by low prices, but so long as the

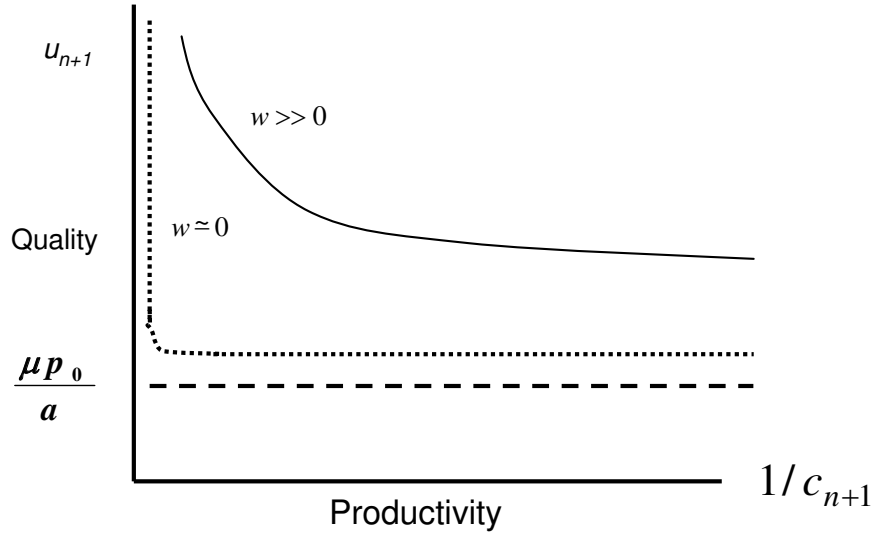


Figure 1: The threshold of viability in $(1/c, u)$ space. The dotted line indicates the limiting form of the schedule as $w \rightarrow 0$.

firm must purchase some inputs from outside, its unit cost is bounded away from zero even when $w = 0$; and if the quality level falls so low that it cannot support the price of $p = \mu p_0$ that covers its unit material cost, then the product is non-viable. We may sum this up as:

Proposition 1 (*The short run threshold*). *For any set of n firms with capabilities $(1/c_i, u_i)$ there is a region in $(1/c, u)$ space below which no firm (or potential entrant) can achieve viability. In the limit $w \rightarrow 0$, the schedule collapses to zero in $1/c$, but is bounded away from zero in u .*

Proposition 1 is central to the argument that follows; the main task of the next section is to extend this proposition to a setting of general equilibrium in

a multi-country model. Before continuing, however, we digress briefly in order to complete our characterization of product market equilibrium, by posing a question that will play an important role in our discussion of the globalization process (Section 4): what determines the number of firms that will enter the industry in the long run? In particular, how does this number vary with the size of the market S ?

So far, we have taken firms' capabilities as given; this is appropriate in a 'short run' setting. But in the long run, firms may invest in fixed and sunk outlays, whether through product or process innovation, to improve their levels of u and $1/c$. This leads to the question: suppose all firms face some common schedule $F(1/c, u)$, then (a) how many firms will enter the market at equilibrium, and (b) what can we say about their levels of $(1/c, u)$?

We proceed, following Sutton (1991, 1998), by assuming that the firm can attain a capability $u, 1/c$ by incurring a fixed and sunk cost

$$F(u, 1/c) = u^\beta + c^{-\gamma}$$

where the elasticity parameters β and γ measure the effectiveness of product and process innovation respectively. We model this process as a 3-stage game. In stage 1, each of a number of potential entrants chooses either not to enter; or else it chooses to enter, paying a setup cost corresponding to the fixed and sunk outlay required to establish a plant of some minimal level of capability $(u_0, 1/c_0)$. In stage 2, having observed the number of firms that have entered, each firm chooses its level of u ($\geq u_0$) and c ($\leq c_0$), and it incurs the incremental

cost $F(u, 1/c) - F(u_0, 1/c_0)$ accordingly. In stage 3, capabilities are given, and firms compete à la Cournot as described above. Equilibrium is characterised as a (sub-game) perfect equilibrium of this 3-stage game.

An increase in market size might in principle lead either to a rise in the number of firms, or to a rise in the fixed outlays incurred by each firm, or both. A well known result is that the latter effect dominates: an indefinite rise in S will not lead to a fragmented market structure. Rather, the level of concentration (measured in the present ‘symmetric’ setting by the reciprocal of the number of firms) will remain bounded as the size of the market increases. This result is stated as:

Proposition 2 *The equilibrium value of n lies between two limiting values, \underline{n} and \bar{n} , for all S . For $S \rightarrow 0$, it approaches a value \underline{n} defined implicitly by*

$$\underline{n} + \frac{1}{\underline{n}} - 2 = \frac{1}{2} \frac{1}{\frac{1}{\beta} + \frac{1}{\gamma}}.$$

In the limit $S \rightarrow \infty$ it converges to an asymptotic value \bar{n} , defined implicitly by the equation

$$\bar{n} + \frac{1}{\bar{n}} - 2 = \frac{1}{2}\beta.$$

Proof: Appendix 1

Remark: The intuition is as follows: as $S \rightarrow \infty$, firm i 's spending to reduce c_i will lead to wc becoming small relative to μp_0 , and the returns from further

innovation become increasing unattractive as unit production costs approach their minimal level μp_0 . Increases in S , however, continue to induce spending on raising u ; and so increases in market size are accompanied, in the limit, not by a rise in firm numbers, but a rise in fixed outlays on quality improvement; and the limiting value of n now depends only on β , i.e., the effectiveness of product innovation, as measured by $1/\beta$. A high degree of effectiveness, i.e., a low value of β , is associated with a strong response of spending to increases in market size, leading to a low number of firms at equilibrium⁷.

3 Globalization. Phase I: The Impact Effect

We consider a model in which two countries, labelled A and B , each has m ‘final goods’ industries of the kind described in the preceding section. A third country, labelled C , supplies a raw material to firms in A and B which is used in

⁷A useful way of summarizing and interpreting the ideas in propositions 1 and 2 is by thinking of a range or ‘window’ of capability levels, running from the highest k_j down to the threshold level of k defined by equation (4). Once the number of firms in the market reaches the maximal level, specified by Proposition 2, the entry of a new firm above the threshold level of k specified by (4) induces two effects. First, it raises the threshold level for future entry (the bottom of the window; this can be seen by inspection of Equation (4)). Second, it affects the incentives for all active firms to make additional investments to rise their capability levels, and while a specific single entry need not necessarily lead to a rise in the maximum capability level, it can be shown that a series of such entries will necessarily raise the maximum level (which defines the top of the ‘window’). As a sequence of potential entrants attempt to meet existing standards of quality (and productivity), these standards move ahead (the ‘moving window’). This process is central to the analysis of the globalization process in the next section.

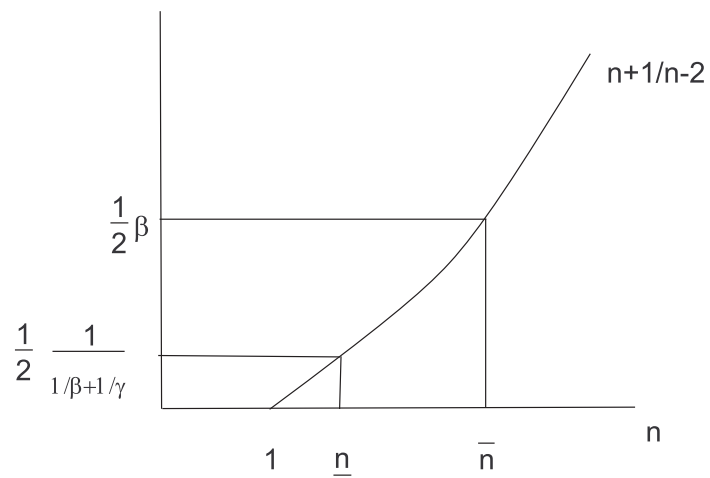


Figure 2: Market Size and Firm Numbers. The equilibrium value of n rises monotonically with market size S , increasing from an initial value \underline{n} to an asymptotic value \bar{n} as $S \rightarrow \infty$. The values \underline{n} and \bar{n} are illustrated.

the production of all final goods. Our focus of analysis will be on the question of how country B 's relative wage rate and level of welfare vary, as the capabilities of its firms change, holding constant the capabilities of A 's firms.

The product markets in countries A and B are identical to those considered in the one-country model above. Of the m final goods industries in each country, r , labelled $1, \dots, r$, are 'commodity' products, for which productivity and quality are uniform across all firms and countries. We label their quality as 1 and the number of units of labour required per unit of output as c_1 . We assume the number of (potential) producers each of these good to be the same in both countries, and we denotes this number by n_1 . Our focus of interest will lie in the case where n_1 is large⁸.

We denote by u_A the (common) quality level attained by all firms in Country A in the production of goods $r+1$ to m ; and by c_A the (common) number of labor units needed per unit of output. The corresponding quality and productivity parameters for country B are denoted v and c_B . We denote by n the number of (potential⁹) producers of each of these goods, in each country.

The production of a unit of any of these goods requires μ units of an (internationally traded) raw material for each unit of labour input. This raw

⁸In terms of the model introduced in the preceding section, this is motivated as follows: when fixed and sunk outlays are ineffective in improving productivity and quality ($\beta \rightarrow \infty, \gamma \rightarrow \infty$), we can treat entrants as facing a constant ('exogenous') setup cost to enter the industry. As the size of the economy increases, the number of firms rises indefinitely.

⁹Some of these firms may be inactive at equilibrium.

material is supplied from country C . We assume that the number of producers of this intermediate good in country C is large, and each of these firms can produce one unit of raw material using one unit of labour input; at equilibrium, this will imply that the price of the raw material input equals the wage rate in country C . We return to the description of country C in the next section.

Each country comprises a population of identical individuals ('workers'), which we assume –to ease notation– to be the same in all three countries, and which we denote by N . We assume that all profit receipts accrue to a separate group of 'owners'. Each individual ('worker') is characterized by a utility function of the form

$$U = \prod_{i=1}^m (u_i x_i)^{1/m} - \frac{1}{2} \ell^2 \quad (5)$$

For the 'owners', the utility derived from consumption of goods is the same, but ℓ is fixed to be zero in (5). It follows that each of the N workers supplies an amount of labour ℓ , where

$$\ell = \frac{w}{m} \prod_{i=1}^m \left(\frac{u_i}{p_i} \right)^{1/m} \quad (6)$$

w is the (local) wage rate, and u_i, p_i are the qualities and prices of the goods available to them. We use as our welfare indicator the utility of the individual ('worker')¹⁰, which, using (5) and (6), equals

¹⁰Since this is a free entry model, where gross ('final stage') profits coincide

$$U = \frac{1}{2} \left(\frac{w}{m}\right)^2 \prod_{i=1}^m \left(\frac{u_i}{p_i}\right)^{2/m} \quad (7)$$

In what follows, we examine equilibrium, first under pre-globalization, and then under free trade.

A Preliminary Remark: Representing ‘Pre-Globalization’

An important modelling issue arises in respect of how ‘pre-globalization’ is represented in the present setting. One way of proceeding is to let A and B have no effect on each other either directly or indirectly. We can represent this state of affairs by partitioning the material producing country C into two halves; ‘Eastern C ’ can buy final goods and sell material input in Country A , while ‘Western C ’ buys and sells in B ; and no (direct or indirect) arbitrage in final goods between A and B is allowed. If we proceed in this way, then when we move to a ‘free trade’ setting in which the two halves of country C are integrated and trade in final goods between all countries is allowed, then the ‘low quality’ producer B loses its privileged access to ‘Western C ’, and must compete in the open market for materials. The effect of this change in its sourcing conditions is conflated with the effects of competition in ‘quality goods’ between A and B .

An alternative way of proceeding is to let the materials producing country C be integrated, so that A and B must compete for raw materials in C , both before and after globalization. In this setting, A and B have an effect on each other

with fixed and sunk outlays (i.e. zero net profits), up to ‘integer effects’, this seems a reasonable welfare indicator.

even before liberalization, but we can isolate the effect of liberalizing trade in final goods between A and B from other effects. One caveat is in order, however: if the inhabitants of C value quality, i.e. have the same utility function (5) as inhabitants of A and B , then the high quality producer A gains an advantage, not only in competing in the supply of final goods –the focus of our present interest– but also in regard to the terms of trade it enjoys in the sourcing of raw materials¹¹ In order to exclude this latter effect, we will, when adopting this second approach, provide the citizens of country C with a modified utility function where the quality indicators u_i are set to unity. In other words, we here place A and B on an equal footing with respect of materials sourcing by ensuring that each can acquire materials from C in exchange for the final goods they produce, on the same terms.¹²

It turns out that the results of interest in what follows are the same under both these representations; in what follows we adopt the first representation (i.e. a partitioned Country C). In Appendix 2, we note how the equations of the model change if we adopt the second representation (i.e. an integrated country C)

¹¹To see this point, suppose $v \ll u$ so that citizens of C chose to buy all their ‘quality’ goods from A , however low the relative wage in B . Then, as $r/m \rightarrow 0$, a balance of trade constraint between B and C will drive the level of activity in B , in the pre-globalization setup, to zero.

¹²Each of these representations may be more appropriate in certain empirical settings. The first representation is arguably a good model of pre-1990 Soviet bloc countries. The second representation assumes that there are some countries supplying raw materials in which, whether because income levels are low or otherwise, consumers are willing to pay a price premium for higher quality products.

The Pre-Globalization Equilibrium

We assume, then, that no trade is possible between countries A and B ; that Country C is partitioned, so that half of the workers in country C can buy from firms in country A alone, while the other half can buy from firms in country B only; and there is no movement of labour or goods (arbitrage) across the partition. We assume that the inhabitants of C have the same utility function (5) as those of countries A and B .

Consider equilibrium in country A . Bearing in mind that the price of goods $1, \dots, r$ in country A is $w_{AC} + w_C\mu$, where w_C denotes the wage in the first ‘region’ of C attached to the A market. Similarly the unit cost of production of goods $r + 1, \dots, m$ is $w_A c_A + w_C\mu$. It follows that equilibrium prices p_1 and quantities x_1 (for goods $1, \dots, r$) and p_u (for goods $r + 1, \dots, m$) satisfy

$$\begin{aligned}
 p_u &= \frac{n}{n-1}(w_{AC} + w_C\mu); & p_1 &= \frac{n_1}{n_1-1}(w_{AC_1} + w_C\mu) \\
 x_u &= \frac{S}{m} \frac{n-1}{n^2} \frac{1}{w_{AC} + w_C\mu}; & x_1 &= \frac{S}{m} \frac{n_1-1}{n_1^2} \frac{1}{w_{AC_1} + w_C\mu} \quad (8)
 \end{aligned}$$

and the level of welfare in country A is

$$U_A = \frac{1}{2} \left(\frac{w_A}{m} \right)^2 \prod_{i=1}^m \left(\frac{u_i}{p_i} \right)^{2/m}.$$

Substituting from the price equations, and writing the expression

$$\left[\frac{(n-1)}{n}\right]^{2(m-r)/m} \cdot \left[\frac{(n_1-1)}{n_1}\right]^{2r/m}$$

as \mathbb{N} to ease notation, we have

$$U_A = \frac{1}{2} \left(\frac{w_A}{m}\right)^2 \mathbb{N} \left(\frac{u}{w_A c_A + w_C \mu}\right)^{2(m-r)/m} \left(\frac{1}{w_A c_1 + w_C \mu}\right)^{2r/m} \quad (9)$$

The relation between w_C and w_A is as follows: from the form of the individual labour supply function (6) above, it follows that the ratio of labour supply in the first region of country C, denoted L_C^D , to labour supply in country A, L_A^D satisfies

$$\frac{L_C^S}{L_A^S} = \frac{1}{2} \frac{w_C}{w_A}. \quad (10)$$

Since each unit of final good produced in A requires μ units of material (and so μ units of labour from C), and either c_1 or c_A units of labour from A (for goods $1, \dots, r$ and $r+1, \dots, m$ respectively), it follows that the ratio of labour demand in the first region of C , labelled L_C^D , to labour demand in A , L_A^D , satisfies

$$\frac{L_C^D}{L_A^D} = \frac{(m-r)n\mu x_u + rn_1\mu x_{1A}}{(m-r)nc_A x_u + rn_1c_1 x_{1A}}. \quad (11)$$

Substituting for x_{1A} and x_u from (8), and equating (10) and (11), and taking

the limit $r/m \rightarrow 0$, we have

$$\frac{w_C}{w_A} \rightarrow 2 \frac{\mu}{c_A}$$

and so from (9) we have

$$U_A \rightarrow \frac{\mathbb{N}}{2m^2} \left(\frac{u}{c_A + 2\mu^2/c_A} \right)^2 \quad (12)$$

and similarly

$$U_B \rightarrow \frac{\mathbb{N}}{2m^2} \left(\frac{v}{c_B + 2\mu^2/c_B} \right)^2. \quad (13)$$

Trade Liberalization

We now open up free trade between A and B , and abolish the partition between the two parts of country C . Each (final) good is now sold in a single ‘international’ market, and since each of goods 1 to r is sold by $2n_1$ firms, and each of goods $r+1$ to m is sold by n firms, and all goods incur a unit materials cost of $w_C\mu$, it follows that the prices of goods $r+1$ to m satisfy

$$\frac{p_u}{u} = \frac{p_v}{v} = \frac{n}{2n-1} \left[\frac{w_A c_A + w_C \mu}{u} + \frac{w_B c_B + w_C \mu}{v} \right] \quad (14)$$

and

$$p_1 = \frac{n_1}{2n_1-1} [(w_A c_1 + w_C \mu) + (w_B c_1 + w_C \mu)] \quad (15)$$

while the (quality-adjusted) outputs are:

$$ux_u = \frac{S}{m} \frac{2n-1}{n} \cdot \frac{1}{\frac{w_A c_A + w_C \mu}{u} + \frac{w_B c_B + w_C \mu}{v}} \left\{ 1 - \frac{2n-1}{n} \frac{w_A c_A + w_C \mu}{u \left[\frac{w_A c_A + w_C \mu}{u} + \frac{w_B c_B + w_C \mu}{v} \right]} \right\} \quad (16)$$

$$vx_v = \frac{S}{m} \frac{2n-1}{n} \cdot \frac{1}{\frac{w_A c_A + w_C \mu}{u} + \frac{w_B c_B + w_C \mu}{v}} \left\{ 1 - \frac{2n-1}{n} \frac{w_B c_B + w_C \mu}{v \left[\frac{w_A c_A + w_C \mu}{u} + \frac{w_B c_B + w_C \mu}{v} \right]} \right\} \quad (17)$$

so long as the r.h.s. expression is positive, in each case, and zero otherwise. The output of good 1 produced in country A is

$$x_{1A} = \frac{S}{m} \frac{2n_1-1}{n_1} \cdot \frac{1}{(w_A c_1 + w_C \mu) + (w_B c_1 + w_C \mu)} \left\{ 1 - \frac{2n_1-1}{n_1} \frac{w_A + w_C \mu}{(w_A c_1 + w_C \mu) + (w_B c_1 + w_C \mu)} \right\} \quad (18)$$

so long as the r.h.s. expression is positive, and zero otherwise; and similarly for country B .

We begin by remarking on the fully symmetric case, where $u = v$ and $c_A = c_B$. Note that in this case the expressions in $\{\cdot\}$ in (16), (17) and (18) reduce to $1/(2n)$ and $1/(2n_1)$ respectively, and that $w_C = 2\mu w_A = 2\mu w_B$, whence

$$w_A c_A + w_C \mu = w_B c_B + w_C \mu = w_A (c_A + 2\mu^2)$$

and so, writing

$$\left[\frac{(2n-1)}{n} \right]^{2(m-r)/m} \cdot \left[\frac{(2n_1-1)}{n_1} \right]^{2r/m} \quad (19)$$

as \mathbb{N}' , we have

$$U_A = \frac{1}{2} \left(\frac{w_A}{m} \right)^2 \prod_{i=1}^m \left(\frac{u_i}{p_i} \right)^{2/m} = \frac{1}{2} \left(\frac{w_A}{m} \right)^2 \mathbb{N}' \left(\frac{u}{w_A c_A + w_C \mu} \right)^{2(m-r)/m} \left(\frac{1}{w_A + w_C \mu} \right)^{2r/m} \quad (20)$$

In the limiting case $r/m \rightarrow 0$, we have, following the same argument as before, that $w_C = \mu/c_A = \mu/c_B$ and

$$U_A \rightarrow \frac{\mathbb{N}'}{2m^2} \left(\frac{u}{c_A + 2\mu^2/c_A} \right)^2. \quad (21)$$

The only difference with the pre-globalization case lies in the terms $\mathbb{N}' > \mathbb{N}$; this reflects the fact that there are now twice as many producers competing in the market for each good, so that prices fall, and our welfare measure rises. This is exactly analogous to the effect of liberalization in the standard Dixit-Stiglitz-Krugman CES framework.

We now turn to the asymmetric case, where $v \neq u$ and/or $c_B \neq c_A$. We take A as our point of reference, and examine the effect of reducing B 's capability relative to A 's. If we hold u and c_A constant, while lowering v and/or raising

c_B , we pass through three successive regimes. In the first regime, A and B both produce the full range of goods, but now $w_B < w_A$. In the second regime, A ceases to produce the ('commodity') good 1, while B continues to produce all goods. In the third regime, B ceases to produce goods 2 to m , and it continues to be the sole producer of the ('commodity') good 1.

If B 's capability is strictly lower, i.e. $v > u$ and/or $c_B > c_A$, then it is easily shown that w_B/w_A falls below unity; and in the case on which we focus, i.e. where n_1 is large, the condition for viability of good 1 in country A fails; this can be seen directly by inspection of the $\{\cdot\}$ term in equation (18) above. In other words, the existence of any gap in capability moves us immediately into regime II. For this reason, we begin in what follows with a study of regime II.

Equilibrium in Regime II.

In Regime II, prices are given by equations (14), and the quality adjusted outputs are given by equations (16), (17); and similarly for B . For the commodity good, however, we have $x_{1A} = 0$ and, noting that only a total of n_1 producers (those in B) now operate, it follows that

$$x_{1B} = \frac{S}{m} \frac{n_1 - 1}{n_1^2} \frac{1}{w_B c_1 + w_C \mu} \quad (22)$$

The solution in Regime II is cumbersome, and is not of direct interest in what follows. The details will be found in Appendix 2. Here we simply note that as v/u falls, the wage ratio w_B/w_A falls, and the welfare level U^B also

declines. When a critical value of v/u is reached, the output of B 's 'quality' goods falls to zero, and we enter Regime III.

Equilibrium in Regime III.

In Regime III, the equation describing output of products $r + 1$ to m in Country B , Equation (17) above, collapses to $vx_v = 0$. Since each of the goods $r + 1, \dots, m$ is produced only by its n producers in country A , we have

$$p_u = \frac{n}{n-1} (w_A + w_C \mu) c_A \quad (23)$$

$$x_u = \frac{S}{m} \frac{n_1 - 1}{n_1^2} \frac{1}{(w_A + w_C \mu) c_A} \quad (24)$$

which replace equations ((14) (17)) above. Products 1 to r are still produced in country B only whence their prices and outputs equal

$$p_1 = \frac{n_1}{n_1 - 1} (w_B + w_C \mu) c_A \quad (25)$$

$$x_{1B} = \frac{S}{m} \frac{n_1 - 1}{n_1^2} \frac{1}{(w_B + w_C \mu) c_1} \quad (26)$$

as in (22) above.

The labour supply equations, as before, imply that

$$\frac{L_S^A}{L_S^B} = \frac{w_A}{w_B} = \frac{L_D^A}{L_D^B} = \frac{(m-r) c_A n x_u}{rc_1 n_1 x_{1B}} \quad (27)$$

which on substituting for x_u, x_1 from (24), (26) implies, in the limit $n_1 \rightarrow \infty$,

$$\frac{w_A}{w_B} = \frac{m-r}{r} \frac{c_A}{c_1} \frac{n-1}{n} \frac{(w_B + w_C \mu) c_1}{(w_A + w_C \mu) c_A} \quad (28)$$

Since each unit of output in A (resp. B) requires c_A (resp. c_1) units of local labour and μ units of materials we have

$$D_L^C = \mu \left(\frac{1}{c_A} D_L^A + \frac{1}{c_1} D_L^B \right)$$

and since

$$S_L^A : S_L^B : S_L^C = w_A : w_B : w_C$$

we have

$$w_C = \frac{\mu}{c_A} w_A + \frac{\mu}{c_1} w_B.$$

Substituting in (28) and re-arranging we obtain a (quadratic) equation for the wage ratio w_B/w_A , denoted by ω , as follows:

$$\frac{r}{m-r} \left(1 + \mu^2 \left(\omega + \frac{1}{\gamma} \right) \right) = \omega \left(\omega + \mu^2 (1 + \gamma \omega) \right)$$

where $\gamma = c_A/c_1$. In the limit $r/(m-r) \rightarrow 0$ the (positive) root becomes zero, i.e., the wage ratio w_B/w_A goes to zero. This will be of importance in what follows.

Quality versus Productivity

We now turn to the critical values of v and c_B which, for given values of u and c_A , correspond to the boundary between zones II and III at which country B's

production of goods $r + 1, \dots, m$ becomes non-viable. A necessary and sufficient condition for $x_v > 0$ is, using equation (12), that

$$\frac{(w_A c_A + w_C \mu)}{(w_B c_B + w_C \mu)} \cdot \frac{v}{u} > \frac{n-1}{n}.$$

Writing $w_C = \mu \left(\frac{w_A}{c_A} + \frac{w_B}{c_1} \right)$ as before, this becomes

$$\frac{w_A c_A + \mu^2 \left(\frac{w_A}{c_A} + \frac{w_B}{c_1} \right)}{w_B c_B + \mu^2 \left(\frac{w_A}{c_A} + \frac{w_B}{c_1} \right)} \cdot \frac{v}{u} > \frac{n-1}{n} \quad (29)$$

It is important to note the asymmetry between the quality parameters (u, v) and the productivity parameters (c_A, c_B) in expression (29); and to note that this asymmetry disappears in the special case $\mu = 0$, when (29) can be expressed as a condition on the capability ratio

$$\frac{u}{v} \cdot \frac{c_B}{c_A} > \frac{n}{n-1} \frac{w_B}{w_A} \quad (30)$$

To explore the asymmetry that arises in the case $\mu > 0$, we consider the limiting case of equation (30) when $w_B/w_A \rightarrow 0$. Here, (30) reduces to

$$\left(\left(\frac{c_A}{\mu} \right)^2 + 1 \right) \frac{v}{u} > \frac{n-1}{n} \quad (31)$$

Note that the l.h.s. expression is independent of c_B ; for any value of c_B , however high, there is a wage w_B sufficiently low that will ensure the viability of v . Poor productivity can always be offset by a sufficiently low wage. On the other hand,

equation (31) implies that if the quality ratio v/u falls below the critical level

$$\frac{v}{u} \Big|_{crit} = \frac{n-1}{n} \frac{1}{1 + (c_A/\mu)^2} \quad (32)$$

then v is non-viable even if the wage ratio w_B/w_A falls to zero. This is the analogue in the present general equilibrium setting of the ‘quality window’ property illustrated in Figure 1.

Welfare

We begin by examining the (impact) effect of trade on country B’s welfare by looking at Regime III. Here, the general expression for the welfare indicator,

$$U_B^{III} = \frac{1}{2} \left(\frac{w_B}{m} \right)^2 \prod_{i=1}^m \left(\frac{u_i}{p_i} \right)^{2/m} \quad (33)$$

becomes

$$\frac{1}{2} \left(\frac{w_B}{m} \right)^2 \mathbb{N}' \left(\frac{u}{w_A c_A + w_C \mu} \right)^{2(m-r)/m} \left(\frac{1}{w_B c_1 + w_C \mu} \right)^{2r/m} \quad (34)$$

which on writing $w_C = \left(\frac{w_A}{c_A} + \frac{w_B}{c_1} \right) \mu$ becomes

$$\frac{\mathbb{N}'}{2m} \left(\frac{w_B}{w_A} \right)^2 \left(\frac{u}{c_A + \mu^2 \left(\frac{1}{c_A} + \frac{w_B}{w_A} \frac{1}{c_1} \right)} \right)^{2(m-r)/m} \left(\frac{1}{c_1 + \mu^2 \left(\frac{1}{c_A} + \frac{w_B}{w_A} \frac{1}{c_1} \right)} \right)^{2r/m}. \quad (35)$$

Now it follows from this expression that the limit $r/m \rightarrow 0$ (where we showed above that $w_B/w_A \rightarrow 0$) that $U_B^{III} \rightarrow 0$. Now, fix v/u at its critical level,

$((n - 1)/n)/(1 + (c_A/\mu)^2)$, whence we are necessarily in Regime III, and note that at this level of v , the welfare score of B (in the limit $r/m \rightarrow 0$) in the pre-globalization setting is given by (17) above and is strictly positive. It follows that, for a region of v in the neighbourhood of the critical level, we can find a value of r/m sufficiently low that the impact effect of liberalization reduces B 's welfare, as illustrated in Figure 3. (The relevant point of reference in traditional trade theory is as follows: within a 3 (or more) country model, a move from partial restrictions on trade to full liberalization is not necessarily welfare improving for all countries: the outcome depends on movements on terms of trade).

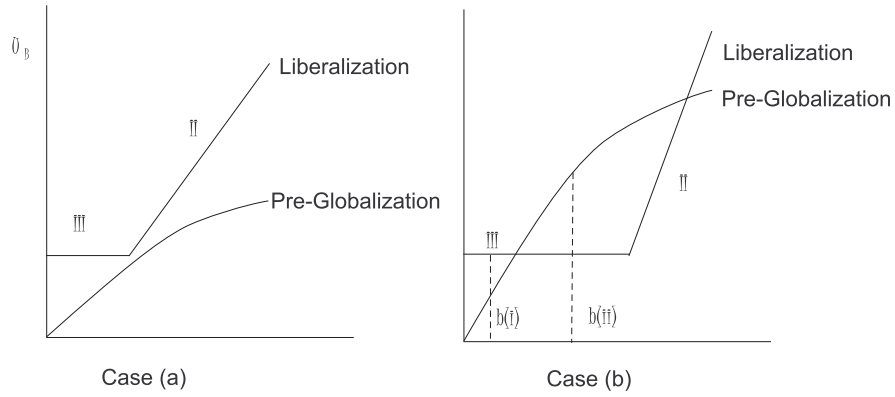


Figure 3: The welfare indicator U_B as a function of B 's relative quality under Liberalization versus Pre-Globalization (where productivity levels are equal), Panels (a) and (b) refer to the cases where r/m is large and small respectively. Cases b(i) and b(ii) relate to the corresponding zones in Figure 5.

The intuition is as follows: If v is close to zero, the economy's initial level of

activity, and welfare, is very low, and the benefit of gaining access to u outweighs the effects on real wages. For intermediate values of v/u , however, the reverse is true. Here, as B 's citizens choose u over v , the derived demand for their labour, and so w_B/w_A , falls to a degree that outweighs the benefit they derive from consuming u .

One way of looking at this outcome is to ask: what is the efficient use of resources in the global economy? It is inefficient, from a global perspective, to transform C 's raw material into the low quality good v , even if this can be done at zero cost (i.e. if $w_B \rightarrow 0$), as opposed to transforming it into a high quality product, at a cost that reflects A 's equilibrium wage rate. The result is that the derived demand for labour in B , which can only be used by B -firms in producing a product of low quality, falls to a degree that leads B 's citizens to be worse off. Their choices as consumers create a negative effect on their prospects as suppliers of labour.

It is worth noting some factors on which this results does not depend: it holds irrespective of the number of firms in each market, and in particular it holds when this number n is large, so that we are at the 'perfect competition' limit. Thus the result is not driven by 'fixed costs' (all fixed costs are sunk in the model) or on 'imperfect competition' in product markets.

A second candidate interpretation that might be suggested for B 's fall in welfare is that B has lost its privileged access to raw materials; but as noted earlier, this result remains true even if A and B compete for raw materials in an open market both before and after liberalization (Appendix 2).

What drives the result, rather, is the combination of the two key features of the model. The first is that the preference structure of consumers is of the type described in the Introduction, in which consumers will not purchase products offering an inferior quality/price ratio. The second is that the use of an internationally-traded raw material limits the degree to which the price of low-quality products can fall.

This ‘impact’ phase is, however, only the first step in the globalization process; we now turn to the consequences of the outcome of this phase for the incentives that drive the second (‘transfer’) phase¹³.

4 Phase II: The Transfer Effect

Motivation

The response to the outcome of Phase I within the corporate sector of Country *B* involves several mechanisms. The increased selection pressures on domestic firms, and their increased opportunities¹⁴ and consequent changes in their

¹³What is the impact effect on country *A*’s welfare? The schedule $U_A(v/u)$ is the mirror image of the schedule U_B , except at $v = u$ where the schedules coincide. At this point, U_A lies strictly above its pre-globalization level, reflecting the fact that the number of firms has risen from n to $2n$ in the combined economy, so prices are lower relative to wages (as reflected in the term $\mathbb{N}' > \mathbb{N}$). As v falls, U_A rises, reaching a (constant) maximum value in Zone III: it follows from inspection of Equation (34) that $U_A^{III}/U_B^{III} = (w_A/w_B)^2$. One implication of this is as follows: the impact effect of globalization is unambiguously beneficial to Country *A*; but as the second (‘transfer’) phase proceeds (i.e. v/u rises), these initial gains are partially eroded. (The fortunes of Country *A* in the third phase will depend on the degree of transfer, as discussed in the next section).

¹⁴Opportunities to communicate directly, with foreign buyers can of itself

incentives to invest in capability building, can in some cases induce strong and effective responses¹⁵. At the same time, the direct entry of multinational firms into the local economy has a two-fold effect, first in driving out low-capability rivals un final-goods markers¹⁶, and secondly fostering capabilities among local intermediate-goods suppliers who enter their supply-chains. This latter mechanism can in some industries generate a remarkably rapid and effective transition to ‘world class’ manufacturing standards. In China’s and India’s auto-component sectors, for example, first-tier¹⁷ suppliers, both domestic and foreign-owned, had attained ‘world-class’¹⁸ standards of quality and productivity by 2003, just 7-8 years after the entry of the major international car makers¹⁹ (Sutton (2003)). The reasons for the effectiveness of this capability transfer appear to be that (i) transfers of capability within a ‘vertical’ (i.e. supply chain) setting tend to be relatively effective in general²⁰ (see, for example,

induce major changes in product variety and design, as happened for example with many leading Chinese clothing suppliers in the 1990s (Brandt, Rawski and Sutton (2007)).

¹⁵Some striking recent examples include the turnaround of Bharat Forge (India) to become one of the top five global suppliers of specialist forgings, and the entry of Indian machine-tool maker Ace Designers to take over 70% of the domestic market for computer-controlled lathes.

¹⁶This ‘displacement effect’ on local firms was particularly strong in the Irish economy in the decade following the opening up of the economy in 1958 (McAleese (1971)).

¹⁷I.e. those directly supplying the car makers.

¹⁸As measured conventionally by the number of defective units per million supplied to the buyer over the course of a year; a defect rate of 100 parts per million was a good benchmark for global quality standards for the range of parts covered in Sutton (2003).

¹⁹India’s Suzuki-Maruti joint venture, and China’s Beijing Jeep venture predated this wave of entry in the mid-1990s.

²⁰This presumably reflects the close alignment of incentives: the auto-maker sees it as profitable in the long-run to have a number of high-quality, low-

the econometric study by Javorcic (2001)); and (ii) the auto sector is unusual in the degree to which a common set of high levels of productivity and quality have become standardized throughout the international industry, thus leading to an institutional structure²¹ in which transfers are facilitated.

The Effectiveness of Transfer

Whatever the relative importance of these several mechanism, the basic driver of change is that the configuration that emerges from Phase I involves high capabilities in Country *A* and relatively low wages in Country *B*, and so firms in Country *A* faces a strong incentives to combine their high capabilities with low wages, whether through foreign direct investment, outsourcing, or otherwise. The specific channels through which this is achieved will vary widely from one industry to another; and even within a single channel such as FDI, the speed and effectiveness will vary widely with the characteristics of the industry involved²².

Besides such industry-specific factors affecting the cost of transfer, there is a further, general, effect on the cost of transfer that has been noted in the extensive

cost suppliers for each (set of) component(s), while the supplier stands to gain from its enhanced capability in the context of future contracts with various car-makers. In practice, advise and incentivise its many suppliers, in a process that involves the back-and-forth movement of engineers and managers between the two firms.

²¹These practices have become so codified that independent specialist consulting firms have emerged, to whom car-makers can refer potential suppliers, in order to help them ‘get into the window’

²²The industry- (and firm-) specific factors include inter alia the intellectual property rights regime, and the balance of incentives between the firms in respect of transfers of know-how.

literature on ‘absorbative capacity’: the lower the level of initial capability, the higher the cost of achieving any absolute increment in capability. In other words, the cost of catchup is higher, according as v is lower.

These costs of catchup must be balanced against the benefits, in terms of the incremental profit achieved by a B -firm when its capability rises²³ It is this payoff which created the incentive for transfer, and this is higher, the lower the initial local wage level w_B . But as transfer proceeds, the relative wage rate w_B/w_A rises, thus diminishing the incentive for further transfers, and so, in general, for any positive cost of transfer, this transfer process will halt at some intermediate level between B ’s initial capability and that of A .

Another, more serious, concern arises from this characterization of costs and benefits: suppose the ‘absorbative capacity’ effect becomes so strong at very low levels of v , that costs of transfer outweigh benefits even though the local wage is correspondingly low. It may then follow that the lowest- v countries (to the left in Figure 6(b)), which benefitted in welfare terms from the impact effect of globalization, remain stuck at that level, and fail to gain from the ‘transfer phase’.

Given the complexity of the factors involved, it does not seem appropriate to attempt any general characterization of the mechanisms involved. Rather, we adopt here a ‘black box’ approach: we suppose that country B ’s capability level rises from $(1/c_B, v)$ to $(\max(1/c_B, k/c_A), \max(v, ku))$, where $k(\leq 1)$ represents the degree to which capability is transferred. (We suppress the arguments

²³This benefit rises with, inter alia, the size of domestic market.

of k here). The task of pinning down the institutional and industry-specific determinants of k remains a focus of continuing research.

The role of k in fixing the welfare impact of trade in Phase 2 can be seen by reference to the right hand panel of Figure 4: Country B gains relatively to pre-globalization if k, u exceeds the level of v at which the ‘free trade’ and ‘pre-globalization’ curves cross.

The level of k in turn determines the pre-conditions for Phase III: here, firms in both countries undertake incremental investments in capability building in order to take advantage of the enlarged size of the market open to them. The intuition here follows that of Section 2, Proposition 2: the larger the size of the market, the greater the marginal returns to investments in capability building; and the resulting incentives facing firms lead to a limit on the number of firms that can be active at equilibrium. In analysing Phase III. however, a new consideration arises: the initial number of firms operating in each industry in the combined economy $2n$ exceeds the number that would have entered had the market been unified ab initio (n). But these firms have already incurred sunk costs and have attained initial levels of capability, whether directly or by transfers. If we assume that the fixed and sunk cost required to advance from capability (c_1, u_1) to (c_2, u_2) equals $F(c_2, u_2) - F(c_1, u_2)$, where $F(c, u)$ is as defined in Section 2, then the question arises: how many of the $2n$ firms in the industry will make an incremental investment, and how many will remain active in the wake of these investments. In other words, will a ‘shakeout’ occur? The answer to this question turns crucially on the value of the transfer parameter k .

5 Phase III: Escalation

Summary: Section in Preparation

Phase III of the process involves the adjustment of firms' capability levels. We take the levels of capability emerging at the end of Phase II as initial conditions, and seek a Nash equilibrium in $(u, 1/c)$, as in Section 2.

The outcome depends crucially on the 'initial conditions' emerging from the transfer process of Phase II. We distinguish two limiting cases, corresponding 'zero transfers' and 'full transfers' respectively. In the 'zero transfer' case, we assume that country B's capability remains at its initial level. Here, if the initial capability gap is sufficiently wide, the only Nash equilibrium outcome is one in which firm in country A advance their capabilities to reflect the increased size of the global market, while those in country B do not invest; depending on their initial level of capability, they may or may not remain active.

In the 'full transfer' limit, we begin from initial conditions in which all $2n$ producers of each good $r + 1, \dots, m$ have the same level of capability. Here, the Nash equilibrium outcome is not unique. In general, there will be a set of Nash equilibria, which involve the survival of $N \leq 2n$ 'high capability' producers, with a 'fringe' of $2n - N$ firms who do not make any (incremental) investment in capability in Phase III. These 'fringe' firms may or may not remain active (i.e. have positive sales revenue at equilibrium). The equilibrium level of capability achieved by the high-level group varies inversely with the number of firms in this group: in equilibria with more firms, these firms have lower capability levels.

What can be said, in general, regarding the set of final equilibria emerging from Phase III? The answer turns on the parameter β (≥ 1) which measures the effectiveness of fixed and sunk outlays in capability building. Recall that a low value of β leads to a high level of market concentration, i.e. a small number of firms. In this setting, it turns out that shakeout necessarily occurs in Phase III: the number of firms making incremental investments in capability is strictly less than $2n$, and the remaining ‘fringe’ of non-investing firms are inactive (make zero sales) at equilibrium. When β is large, on the other hand, (so that market concentration is low, i.e. the initial number of firms is large), then shakeout does not occur. There will be Nash equilibria in which some or all firms make a (small) incremental investment, but any non-investing firms remain active at equilibrium. The welfare impact of Phase III investments varies with the degree of shakeout; higher levels of shakeout are associated with higher welfare gains.

6 Conclusions

The central message of this paper is that defences of globalization based on an appeal to the gains from trade per se are unconvincing; in a world in which quality matters, and intermediate goods are freely traded, a ‘middle group’ country may be a loser at this level. Yet, it is the ‘middle-group’ countries of Eastern Europe, along with China and India, who are best placed to be the most dramatic beneficiaries of this process, not because of trade liberalization per se, but because of the virtuous dynamic that follows as part of the general

package of liberalization of foreign direct investment and capability transfer. Understanding the determinants of the speed and effectiveness of these transfers, and of the effects of different policies on this process is of central importance. A useful way of focussing research effort in the several relevant subfields (F.D.I., outsourcing, multi-national activity, etc.) is to ask, how does this throw light on the industry- and country-specific determinants of the speed and effectiveness of transfer, and so on the value of k ?

The most worrying issues arise, not in the context of ‘middle-group’ countries, but in the case of the lowest income countries: here the impact effect of trade liberalization per se is positive (apart from transitional problems, distributional issues, etc.). The big issue here is one of ‘absorbative capacity’, (which is related, among other things, to the general ‘investment climate’). Here, the danger is that liberalization is not followed by an effective transfer of capability; and understanding the policy levers that might prove effective in mitigating the likelihood of such an outcome is probably the most important issue in the field of industrial development.

7 Appendix 1: The ‘Window’ Propositions

Proof of Proposition 2

The proof is similar to the proof set out in Sutton (1991), Chapter 3, for the ‘quality’ case.

From the profit function (3) we obtain, on differentiating with respect to k_i and setting $k_i = k_j = k$ (to characterize a symmetric Nash equilibrium), we obtain

$$\left. \frac{d\pi_i}{dk_i} \right|_{k_i=k} = -2 \frac{(n-1)^2}{n} \cdot \frac{S}{n^2} \cdot \frac{1}{k} \quad (\text{A1})$$

Recalling that $k_i = (wc_i + \mu p_0) / u_i$ we have

$$\frac{dk_i}{du_i} = -\frac{k_i}{u_i} \quad ; \quad \frac{dk_i}{dc_i} = \frac{c_i}{1 + \frac{\mu p_0}{wc_i}} \quad (\text{A2})$$

From (A1) and (A2), and the cost function $F(u, c) = u^\beta + c^{-\gamma}$, we may write the first order conditions

$$\frac{dF}{du_i} = \frac{d\pi}{du_i} \quad \text{and} \quad \frac{dF}{dc_i} = \frac{d\pi}{dc_i}$$

at a symmetric equilibrium, $u_j = u$ and $c_j = c, \forall j$, in explicit form, viz.

$$u^\beta = \frac{2}{\beta} \frac{(n-1)^2}{n} \frac{S}{n^2} \quad (\text{A3})$$

$$c^{-\gamma} = \frac{2}{\gamma} \frac{(n-1)^2}{n} \frac{S}{n^2} \cdot \frac{1}{1 + \frac{\mu p_0}{wc}} \quad (\text{A4})$$

Free entry implies a zero profit condition, which (ignoring integer effects) recalling that equilibrium profit per firm in a symmetric equilibrium equals S/n^2 (from (3)), takes the form

$$u^\beta + c^{-\gamma} = S/n^2 \quad (\text{A5})$$

Equations (A3), (A4) and (A5) characterize the equilibrium values of n , u and c as a function of S .²⁴

Note that the expression $1/(1 + \frac{\mu p_0}{wc})$ must lie between 0 and 1 for all c . It follows from (A3) and (A4) that total fixed outlays per firm at equilibrium satisfy

$$u^\beta + c^{-\gamma} = \frac{(n-1)^2}{n} \cdot \frac{S}{n^2} \cdot \frac{1}{2} \left\{ \frac{1}{\beta} + \frac{1}{\gamma} \frac{1}{1 + \frac{\mu p_0}{cw}} \right\} \quad (\text{A6})$$

Combining (A6) with the free entry condition (A3), and noting that $0 \leq 1/(1 + \frac{\mu p_0}{cw}) \leq 1$ for all $c \geq 0$ we obtain the bounds \underline{n} and \bar{n} , as specified in Proposition 2, as follows:

Note that for $S \simeq 0$, the free entry condition (A5) implies

²⁴Allowing for integer effects leads to the conclusion that the equilibrium number of firms is the integer part of n , as defined; and the equilibrium values of u and $1/c$ are then defined by (A3, A4, A5), where n is replaced by its integer part.

$$u \simeq 0, \quad 1/c \simeq 0,$$

whence

$$\frac{1}{\left(1 + \frac{\mu p_0}{cw}\right)} \simeq 1$$

and the first order conditions (A3), (A4) imply $n \simeq \underline{n}$. The case $S \rightarrow \infty$ is less straightforward. Here, the first order condition (A3), together with the fact that $n \leq \bar{n}$, implies that $u \rightarrow \infty$. It is also the case that, as $S \rightarrow \infty$, $1/c \rightarrow 0$; to see this, suppose the contrary, viz. that there is some value $c_0 > 0$ such that for any S_0 , we can find some $S > S_0$ at which $c \geq c_0$. Set $c = c_0$ in (A4), letting $S \rightarrow \infty$ and noting that $\underline{n} \leq n \leq \bar{n}$, we obtain a contradiction.

We can now show that as $S \rightarrow \infty$, $n \rightarrow \bar{n}$. To see this, combine the free entry condition (A5) with the first order condition for u , (A3), to obtain

$$u^\beta = \frac{2}{\beta} \frac{(n-1)^2}{n} \frac{S}{n^2} = \frac{2}{\beta} \frac{(n-1)^2}{n} (u^\beta + c^{-\gamma}) \quad (\text{A7})$$

whence

$$\frac{2}{\beta} \frac{(n-1)^2}{n} = \frac{u^\beta}{u^\beta + c^{-\gamma}} \quad (\text{A8})$$

where the expression on the r.h.s. equals the share of fixed outlays spent on u ('product innovation'). We may compute this share by dividing the first order condition (A4) by (A3) to obtain

$$\frac{c^{-\gamma}}{u^\beta} = \frac{\beta}{\gamma} \left(1 + \frac{\mu p_0}{wc} \right)$$

which implies that as $S \rightarrow \infty$, so that $c \rightarrow 0$, the share of spending on process innovation, $c^{-\gamma} / (u^\beta + c^{-\gamma})$, falls to zero, and so (A8) collapses to the defining equation for \bar{n} .

8 Appendix 2: The Regime II Equilibrium

Here we set out an explicit solution for the special case where $\mu = 0$, which takes a relatively simple form. (The remainder of this subsection can be skipped without loss of continuity). We introduce the symbol λ to represent the ratio

$$\frac{\frac{w_A c_A}{u}}{\frac{w_A c_A}{u} + \frac{w_B c_B}{v}}, \text{ whence } \frac{w_A}{w_B} = \frac{u/c_A}{v/c_B} \cdot \frac{1-\lambda}{\lambda}. \quad (36)$$

We begin by examining labour market equilibrium. We have:

$$\begin{aligned} L_A^D &= (m-r) c_A n x_u \\ L_B^D &= (m-r) c_B n x_v + r c_1 n_1 x_{1B} \end{aligned}$$

whence

$$\frac{L_B^D}{L_A^D} = \frac{c_B}{c_A} \cdot \frac{u}{v} \cdot \frac{v x_v}{u x_u} + \frac{r}{m-r} \frac{1}{c_A} \frac{n_1}{n} \cdot u \frac{x_{1B}}{u x_u}. \quad (37)$$

Substituting for $u x_u$, $v x_v$ and x_{1B} using (16), (17) and (22), we have, rearranging, and using (36) to eliminate λ , that at labour market equilibrium

$$\frac{w_B}{w_A} = \frac{L_B^S}{L_A^S} = \frac{L_B^D}{L_A^D} = \frac{c_B}{c_A} \cdot \frac{u}{v} \cdot \frac{\lambda - \eta(1 - \lambda)}{(1 - \lambda) - \eta\lambda} + a \frac{\lambda}{1 - \lambda} \frac{1}{1 - \lambda} \frac{\lambda}{(1 - \lambda) - \eta\lambda} \quad (38)$$

where η denotes $(n - 1)/n$ and $a = \frac{r}{m-r} \frac{n_1-1}{n_1} \frac{1}{2n-1}$

Substituting for w_A/w_B from (36) and re-arranging, we obtain a solution for w_A/w_B , which we write as ω :

$$\omega - \frac{1}{\omega} = \eta \left(k - \frac{1}{k} \right) - \frac{a}{k} \left(1 + \frac{\omega}{k} \right)^2. \quad (39)$$

This is the basic equation linking relative capability, $k = (u/c_A)/(v/c_B)$ to the relative wage rate $\omega = w_A/w_B$. In the limiting case where r/m is small, so that $r/(m - r)$, and so a , converges to zero, this assumes the very simple form

$$\omega - \frac{1}{\omega} = \eta \left(k - \frac{1}{k} \right). \quad (40)$$

Equations (38) and (39) are illustrated in Figure 3. Beginning from the symmetric solution ($u = v, c_A = c_B$) described above, ω rises monotonically with k through Regime II. Accompanying this rise in ω is a monotonic fall²⁵ in x_v , as can be checked directly from equation (17).

²⁵This relies on our assumption that $n \geq 2$, ie there are at least 2 producers of each good in each country. If $n = 1$, then x_v remains constant as k varies, i.e. viability is maintained. Here, we never reach zone III.

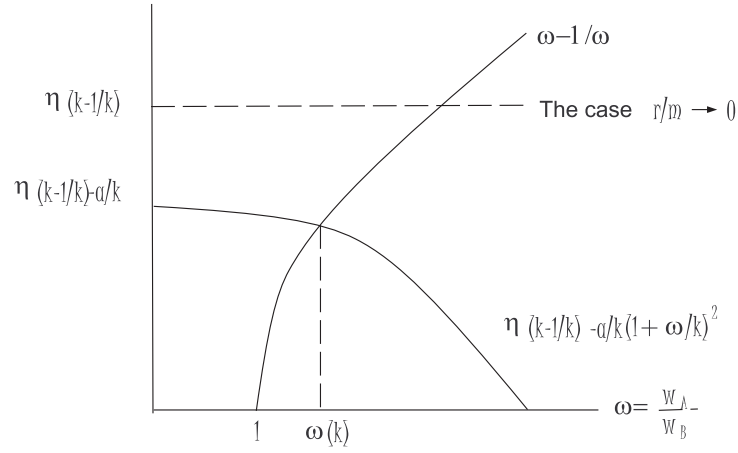


Figure 4: Relative Capability (k) and relative wages (ω) in Regime II. The case shown is where $k > 1$, $\omega > 1$ and $\omega(k)$ is the equilibrium wage ratio. A rise in k shifts the falling schedule upwards. In the limiting case $r/m \rightarrow 0$ the falling schedule becomes flat, as shown by the hatched line.

One focus of interest lie in characterizing the zone boundary at which x_v falls to zero. The effect of the fall in v (or rise in c_B) is partially offset by the concomitant fall in $w_B/w_A (= 1/\omega)$, and the point at which B 's products $r + 1, \dots, n$ are no longer viable depends on the strength of response of w_B/w_A . Before turning to the characterization of the zone boundary, however, it will be helpful to first characterize the regime III equilibrium.

9 References

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