



“Endogenous Market Structures and Globalization”

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Quality, Trade and the Moving Window: The Globalisation Process

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Abstract

The globalisation process is analysed in a model where firms differ in productivity and quality. A lower bound to quality emerges, below which firms cannot sell, however low their (local) wage rate. The range of quality levels between the maximum and this lower bound shifts upwards when trade is liberalized (the ‘moving window’). The initial phase of globalisation, associated with trade liberalization, in an initially segmented (but not autarkic) world, may reduce welfare in countries with intermediate levels of capability, but these countries may be the most important gainers as capabilities are transferred in subsequent phases.

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1 Introduction

This paper analyses the globalisation process by reference to a model in which firms differ in respect of both productivity and quality ('capability'). The model is of a kind that 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 structure. The main argument in favour of these models is that they lead to empirically successful predictions regarding the levels of market concentration found in different industries, and in particular they account for the fact that certain industries are highly concentrated even at the global level¹ (for a review of the literature, see Sutton (2007)). The main novelty of this paper, relative to the I.O. literature, lies in extending this kind of analysis to a general equilibrium setting.

This class of models is characterized by two key properties: Consumers choose which firm's product to buy on the basis of the price-quality combinations on offer, and:

- (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 has a product of higher quality than its rivals' (and the same unit cost of production), then it will retain some strictly positive level of market share, even in the limit where the number of its lower 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 when the price of its rivals' lower quality products falls to the common level of unit variable cost, customers will still be willing to pay a strictly positive price premium for the high quality good³.

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 (the 'non-convergence' theorem). 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))⁴.

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 assume throughout that each firm's variable cost of production comprises two elements: the cost of labour input, and the cost of bought-in materials (raw materials, intermediate inputs, and components). In the absence of this 'materials cost', quality and productivity are isomorphic in this partial equilibrium setting; it is through this feature that they come to operate in different ways. 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)⁵.

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

- I. The impact phase (Trade liberalization): Here, we take all firms' levels of productivity and quality as fixed. The effect of trade 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 wage adjustments can or can not compensate for (poor) levels of productivity and quality (Section 3).

We assume, crucially, that the materials input is independently tradeable. This leads to a key difference 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 (internationally tradeable) raw materials⁶ 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')⁷. One implication of this is that the initial 'impact' phase of the globalisation process can be welfare-reducing for intermediate-capability countries.

- II. The catch-up phase (Investment flows): The wage and capability differentials across countries in phase I creates a strong profit incentive for firms in low-wage countries to build capability and for those in high capability countries to transfer their high-level capabilities to low-wage countries. It is argued that this second phase of the process, operating through several channels, carries the main benefits of globalisation 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.
- III. The escalation phase (Capability building): Overlapping in time with phase II, this third phase involves the re-adjustment of firms to the global environment. The pre-globalisation levels of firms' investments in building their capabilities were predicated on access to a limited number of markets. Now that they have access to more markets, the optimal level of fixed and sunk outlays aimed at enhancing productivity and quality rises. The outcome of the resulting investment process hinges upon the degree to which catchup occurs in phase II; and it may involve a shakeout of firms in highly concentrated markets.

Finally, one caveat is in order: the gains from trade liberalization derive from several distinct channels, which include: (i) benefits of specialization that reflect differences in factor endowments, i.e., classical ‘comparative advantage’, 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; it is worth noting that, in so doing, we understate 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 strictly positive sales ('active firms') must have the same (equal lowest) price-quality ratio, we may write

$$\frac{p_i}{u_i} = \lambda, \text{ for all } i \text{ such that } x_i > 0$$

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

Firm i sets x_i to maximize

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

taking $x_1, \dots, x_{i-1}, x_{i+1}, \dots, x_n$ as given. (All fixed costs are sunk, and do not enter π_i).

A routine calculation (following Sutton (1998), Appendix 14.1) 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: for any firm i with positive output at equilibrium (an 'active firm'):

$$\frac{p_i}{u_i} = \frac{1}{n-1} \sum_{j \text{ st } x_j > 0} k_j \quad (1)$$

and its (quality adjusted) output is

$$u_i x_i = S \frac{n-1}{k_i} \left\{ 1 - (n-1) \frac{k_i}{\sum_{j \text{ st } x_j > 0} k_j} \right\} \quad (2)$$

so long as the term in $\{\cdot\}$ is non-negative, and zero otherwise. In the former case, firm i 's equilibrium profit equals

$$\pi_i = p_i x_i - (w c_i + p_0 \mu) x_i = \left\{ 1 - (n-1) \frac{k_i}{\sum_{j \text{ st } x_j > 0} k_j} \right\}^2 \cdot S. \quad (3)$$

and n denotes the number of firms that are active at equilibrium.

(It is easy to see that in the case where productivity is equal across all firms, this profit function reduces to a special case in which the k_i, k_j are replaced by $1/u_i, 1/u_j$; this will be useful in what follows (Section 5)).

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 level, it is convenient to focus on a setting in which there are $n+1$ firms; of these n are ‘active’, while the $(n+1)$ th firm is on the margin of viability, i.e. the value of x_{n+1} , defined by (2), is zero. Re-writing equation (2) for firm $(n+1)$ and setting the bracketed term on the r.h.s. to zero, we have $k_{n+1} = (\sum_{j=1}^{n+1} k_j)/n$, or on re-arranging,

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

where $\bar{k} = (\sum_{j=1}^n k_j)/n$ denotes the industry average value of the effective cost 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: Consider a potential entrant whose level

of capability is low, but which enjoys privileged and exclusive access to some source of ‘low cost labour’. To what extent can this access allow the firm to reach the threshold of viability defined by (4)? Noting that $k_{n+1} = (wc_{n+1} + p_0\mu)/u_{n+1}$, it follows that the schedule in $(1/c, u)$ space corresponding to equation (4) takes the form of a right-angled hyperbola

$$u_{n+1} = \frac{1}{k} \frac{n-1}{n} \left(\frac{w}{1/c_{n+1}} + \mu p_0 \right).$$

The horizontal asymptote 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. 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 where the wage rate faced (exclusively) by a potential entrant falls to zero, the schedule collapses to zero in $1/c$, but is bounded away from zero in u .*

Insert Figure 1 about here

Figure 1: The threshold of viability in $(1/c, u)$ space. The wage at which firm $n + 1$ (alone) can hire labour is denoted w . The dashed curve indicates the limiting form of the schedule as $w \rightarrow 0$.

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 unit 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 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.

This idea is central to the argument that follows; one task of the next section is to extend this idea to a setting of general equilibrium in a multi-country model.

Throughout this ('short run') discussion, we have taken the capabilities of the firms as given. We continue to do this in the next section, where we discuss the initial

(or ‘impact’) effect of trade liberalization. In the long run, however, capabilities are determined by the fixed and sunk outlays incurred by each firm (‘product- and process-innovation’). We defer until Section 5, in which we turn to firms’ long-run adjustment to globalisation, the discussion of the determinants of the equilibrium number of firms in each market. There, we introduce a model in which countries differ in an efficiency parameter that affects their respective costs of capability building; at equilibrium, the number of firms in each industry will be the same in each country, but their (common) level of capability will differ from one country to another. With this in mind, we begin the short run analysis that follows by looking at two countries that differ in respect of firms’ capability levels.

3 Globalisation: The Impact Effect

We consider a model with two countries, labelled A and B , each of which 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 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 partial equilibrium model above. Of the m final goods industries in each country, r ,

indexed as $1, \dots, r$, 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 of each of these goods is the same in both countries, and we denote this number by n_1 . Our focus of interest will lie in the case where n_1 is large⁸.

We will assume throughout that the number of industries m is fixed, and is ‘large’. This allows us to treat firms as price takers in labour markets, and to assume that each firm takes total consumer demand as fixed when choosing its output level (see Section 5 below). Our main focus of interest will lie in the case where most goods are ‘quality’ goods, i.e. r/m is small.

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 labour 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 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 .

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

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

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

The Pre-Globalisation Equilibrium

We represent the pre-globalisation setting by supposing 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 partition¹¹. 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 . Note that the unit cost of goods $1, \dots, r$ in country A is $w_A c_1 + w_C \mu$, where w_C denotes the wage in the ‘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 on substituting for k_i, k_j in (1) and (2) and noting that expenditure on industry i ’s products equals S/m , that equilibrium prices p_1 and quantities x_1 (for goods $1, \dots, r$) and p_u and x_u (for goods $r + 1, \dots, m$) satisfy

$$\begin{aligned}
 p_u &= \frac{n}{n-1} (w_A c_A + w_C \mu); & p_1 &= \frac{n_1}{n_1-1} (w_A c_1 + w_C \mu) \\
 x_u &= \frac{S}{m} \frac{n-1}{n^2} \frac{1}{w_A c_A + w_C \mu}; & x_1 &= \frac{S}{m} \frac{n_1-1}{n_1^2} \frac{1}{w_A c_1 + w_C \mu}.
 \end{aligned} \tag{8}$$

Substituting from the price equations in (8) into (7), 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

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

Equilibrium in the labour market can be analysed as follows: 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 labour demand satisfies

$$L_C^D = (m-r)n\mu x_u + rn_1\mu x_1$$

$$L_A^D = (m-r)nc_A x_u + rn_1c_1 x_1.$$

From the individual labour supply function (6) above, we have

$$L_A^S = Nl_A^s = N \frac{w_A}{m} \left(\frac{u}{p_u} \right)^{\frac{m-r}{m}} \left(\frac{1}{p_1} \right)^{\frac{r}{m}}$$

$$L_C^S = \frac{1}{2} Nl_C^s = \frac{1}{2} N \frac{w_C}{m} \left(\frac{u}{p_u} \right)^{\frac{m-r}{m}} \left(\frac{1}{p_1} \right)^{\frac{r}{m}}.$$

The four equations in (8), together with the labour market clearing conditions $L_A^S = L_A^D$ and $L_C^S = L_C^D$ determine the unknowns $p_u, p_1, w_A, w_C, x_u, x_1$ and S up to a numeraire¹².

The relation between w_C and w_A is as follows: from the form of the labour supply functions (6) above, it follows that the ratio of labour supply in the first region of country C (whose population is $N/2$), and which we denote by L_C^S , to labour supply in country A, L_A^S satisfies

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

while the labour demand functions imply

$$\frac{L_C^D}{L_A^D} = \frac{(m-r)n\mu x_u + rn_1\mu x_1}{(m-r)nc_A x_u + rn_1c_1 x_1}. \quad (11)$$

Substituting for x_1 and x_u from (8), and equating (10) and (11), we have for the special case of interest in which $r = 0$ that

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

and so from (9) we have

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

and similarly

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

Trade Liberalization

We now open up free trade between A and B , and abolish the partition between the two parts of country C . There are no ‘trade costs’, or ‘costs of transport’. 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 $2n$ firms, and all goods incur a unit materials cost of $w_C\mu$, it follows from (1) and (2), and replacing S by S/m as before, that when all firms are active at equilibrium, the (quality adjusted) prices of goods $r + 1$ to m satisfy

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

while the prices of goods 1 to r satisfy

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

The corresponding (quality-adjusted) outputs are:

$$ux_u = \frac{S}{m} \frac{2n-1}{n} \cdot \frac{1}{\frac{w_{AcA}+w_C\mu}{u} + \frac{w_{BcB}+w_C\mu}{v}} \left\{ 1 - \frac{2n-1}{n} \frac{w_{AcA} + w_C\mu}{u \left[\frac{w_{AcA}+w_C\mu}{u} + \frac{w_{BcB}+w_C\mu}{v} \right]} \right\} \quad (16)$$

$$vx_v = \frac{S}{m} \frac{2n-1}{n} \cdot \frac{1}{\frac{w_{AcA}+w_C\mu}{u} + \frac{w_{BcB}+w_C\mu}{v}} \left\{ 1 - \frac{2n-1}{n} \frac{w_{BcB} + w_C\mu}{v \left[\frac{w_{AcA}+w_C\mu}{u} + \frac{w_{BcB}+w_C\mu}{v} \right]} \right\} \quad (17)$$

so long as the term in $\{\cdot\}$ on the r.h.s. expression is positive, in each case, and zero otherwise. (In the latter case, the corresponding firms are inactive at equilibrium). The output of good 1 produced in country A is

$$x_{1A} = \frac{S}{m} \frac{2n_1-1}{n_1} \cdot \frac{1}{(w_{Ac1} + w_C\mu) + (w_{Bc1} + w_C\mu)} \left\{ 1 - \frac{2n_1-1}{n_1} \frac{w_{Ac1} + w_C\mu}{(w_{Ac1} + w_C\mu) + (w_{Bc1} + w_C\mu)} \right\}$$

$$x_{1B} = \frac{S}{m} \frac{2n_1-1}{n_1} \cdot \frac{1}{(w_{Ac1} + w_C\mu) + (w_{Bc1} + w_C\mu)} \left\{ 1 - \frac{2n_1-1}{n_1} \frac{w_{Bc1} + w_C\mu}{(w_{Ac1} + w_C\mu) + (w_{Bc1} + w_C\mu)} \right\} \quad (18)$$

so long as the term in $\{\cdot\}$ on the r.h.s. expression is positive, and zero otherwise; and similarly for country B .

Finally, we note that under liberalization, consumers in all countries face the same quality-price ratios, so that labour supply satisfies

$$L_A^S = N \frac{w_A}{m} \prod_i \left(\frac{u_i}{p_i} \right), \quad L_B^S = N \frac{w_B}{m} \prod_i \left(\frac{u_i}{p_i} \right), \quad L_C^S = N \frac{w_C}{m} \prod_i \left(\frac{u_i}{p_i} \right)$$

whence L_A^S , L_B^S and L_C^S stand in the same ratio as w_A , w_B and w_C , viz.

$$L_A^S : L_B^S : L_C^S = w_A : w_B : w_C.$$

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. To ease notation, we write

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

as \mathbb{N}' . We focus, as before, on the limiting case where $r = 0$. Since each unit of output in A or B requires $c_A (= c_B)$ units of local labour and μ units of materials, we have

$$L_C^D = 2(\mu/c_A)L_A^D = 2(\mu/c_B)L_B^D$$

whence $w_C = 2(\mu/c_A)w_A = 2(\mu/c_B)w_B$ and

$$w_A c_A + w_C \mu = w_B c_B + w_C \mu = w_A \left(c_A + 2 \frac{\mu^2}{c_A} \right)$$

It follows from (7) and (14) that, in the limiting case $r = 0$, we have, following the same argument as before, that $w_C = \mu/c_A = \mu/c_B$ and

$$U_A = \frac{\mathbb{N}'}{2m^2} \left(\frac{u}{c_A + 2\mu^2/c_A} \right)^2; \quad U_B = \frac{\mathbb{N}'}{2m^2} \left(\frac{v}{c_B + 2\mu^2/c_B} \right). \quad (20)$$

The only difference with the pre-globalisation 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 ‘price’ effect is analogous to the effect of liberalization in the standard Dixit-Stiglitz-Krugman CES framework; but an important difference is that, in the present setting, all fixed costs are sunk, and liberalization does not induce exit, but leads to a fall in profits).

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 zones. In the first zone, A and B both produce the full range of goods, but now $w_B < w_A$. In the second zone, A ceases to produce the (‘commodity’) good 1,

while B continues to produce all goods. In the third zone, B ceases to produce goods $r + 1$ to m , and it continues to be the sole producer of the ('commodity') good 1.

On our assumption that n_1 is large, an arbitrarily small difference in wage rates suffices to shift all production of the commodity goods to country B , so zone 1 is narrow in the sense that for some v slightly below u we enter zone 2; this can be seen from inspection of equation (18).

Equilibrium in Zone 2

In zone 2, the (quality-adjusted) prices of goods $r + 1$ to m are given by equation (14), and the quality adjusted outputs are given by equations (16), (17). 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 that¹³

$$x_{1B} = \frac{S}{m} \frac{n_1 - 1}{n_1^2} \frac{1}{w_B c_1 + w_C \mu} \quad (21)$$

The solution in zone 2 is set out in the Appendix. As v/u falls, the wage ratio w_B/w_A falls, and the welfare level U^B declines. The key feature of the results is that, for $\mu > 0$, there is a critical value of v below which B 's output of quality goods falls to zero, so that we enter zone 3. Before examining this 'quality threshold', we complete our description of the model by examining zone 3.

Equilibrium in Zone 3

In zone 3, the equation describing the quality adjusted 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 from (1) and (2) that

$$p_u = \frac{n}{n-1}(w_A c_A + w_C \mu) \quad (22)$$

$$x_u = \frac{S}{m} \frac{n-1}{n^2} \frac{1}{(w_A c_A + w_C \mu)} \quad (23)$$

which replace equations (14) and (16) above. Products 1 to r are produced in country B only, whence their prices and outputs equal

$$p_1 = \frac{n_1}{n_1-1}(w_B c_1 + w_C \mu) \quad (24)$$

$$x_{1B} = \frac{S}{m} \frac{n_1-1}{n_1^2} \frac{1}{(w_B c_1 + w_C \mu)} \quad (25)$$

as in (21) above.

The labour supply equations, following the same argument as before, imply in this

zone that

$$\frac{L_S^A}{L_S^B} = \frac{w_A}{w_B} = \frac{L_D^A}{L_D^B} = \frac{m - r}{r} \frac{c_A}{c_1} \frac{nx_u}{n_1 x_{1B}} \quad (26)$$

which on substituting for x_u, x_1 from (23), (25) implies, in the limit $n_1 \rightarrow \infty$,

$$\frac{w_A}{w_B} = \frac{m - r}{r} \frac{c_A}{c_1} \frac{n - 1}{n} \frac{n_1}{n_1 - 1} \frac{(w_B c_1 + w_C \mu)}{(w_A c_A + w_C \mu)} \quad (27)$$

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

$$L_C^D = \mu \left(\frac{1}{c_A} L_A^D + \frac{1}{c_1} L_B^D \right)$$

and since

$$L_A^D : L_B^D : L_C^D = L_A^S : L_B^S : L_C^S = w_A : w_B : w_C$$

we have

$$w_C = \mu \left(\frac{w_A}{c_A} + \frac{w_B}{c_1} \right).$$

Substituting in (27), re-arranging, writing the wage ratio w_B/w_A as ω and letting¹⁴ $n_1 \rightarrow \infty$, we obtain

$$\frac{1}{\omega} = \frac{m - r}{r} \cdot \frac{n - 1}{n} \cdot \frac{c_A}{c_1} \cdot \frac{\frac{\mu^2}{c_A} + \omega(c_1 + \frac{\mu^2}{c_1})}{(c_A + \frac{\mu^2}{c_A}) + \omega \frac{\mu^2}{c_1}}$$

which reduces to the quadratic

$$\left(c_1 + \frac{\mu^2}{c_1}\right)\omega^2 + \frac{\mu^2}{c_A}\left(1 - \frac{r}{m-r} \frac{n}{n-1}\right)\omega - \frac{r}{m-r} \cdot \frac{n}{n-1}c_1\left(1 + \frac{\mu^2}{c_A^2}\right) = 0.$$

Our focus of interest lies in the case where r/m is small. Recall that $n \geq 2$ and note that the second coefficient is therefore positive for $r < m/3$; and that the first and third coefficients are positive and negative respectively. The value of the wage ratio ω is defined by the (single) positive root. The third coefficient, and so the value of ω , falls to zero in the limiting case where $r = 0$. This property will be important 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 (17), that

$$\frac{(w_{ACA} + w_C\mu)}{(w_{BCB} + w_C\mu)} \cdot \frac{v}{u} > \frac{n-1}{n}.$$

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

$$\frac{w_A c_A + \mu^2 \left(\frac{w_A}{c_A} + \frac{w_B}{c_1} \right)}{w_B c_B + \mu^2 \left(\frac{w_A}{c_A} + \frac{w_B}{c_1} \right)} \cdot \frac{v}{u} > \frac{n-1}{n} \quad (28)$$

It is important to note the asymmetry between the quality parameters (u, v) and the productivity parameters (c_A, c_B) in expression (28); and to note that this asymmetry disappears in the special case $\mu = 0$, when (28) can be expressed as a condition on the capability ratio, viz.

$$\frac{v}{u} \cdot \frac{c_A}{c_B} > \frac{n-1}{n} \cdot \frac{w_A}{w_B} \quad (29)$$

To explore the asymmetry that arises in the case $\mu > 0$, we consider the limiting case of equation (28) when $w_B/w_A \rightarrow 0$. Here, (28) reduces to

$$\left(\left(\frac{c_A}{\mu} \right)^2 + 1 \right) \frac{v}{u} > \frac{n-1}{n} \quad (30)$$

Note that the l.h.s. expression is independent of c_B ; if $v = u$, then for any value of c_B , however high, this condition is satisfied; and so there is a wage ratio w_B/w_A 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 (30) implies that if the quality ratio v/u falls below the critical level

$$\frac{v}{u} \Big|_{crit} = \frac{n-1}{n} \frac{1}{1+(c_A/\mu)^2} \quad (31)$$

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 1¹⁵.

Welfare

We begin by examining the (impact) effect of trade on country B’s welfare by looking at zone 3. Here, using the general expression (7) for the welfare indicator, we have

$$U_B = \frac{1}{2} \left(\frac{w_B}{m}\right)^2 \mathbb{N}' \left(\frac{u}{w_A c_A + w_C \mu}\right)^{2(m-r)/m} \left(\frac{1}{w_B c_1 + w_C \mu}\right)^{2r/m} \quad (32)$$

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

$$\frac{\mathbb{N}'}{2m^2} \left(\frac{w_B}{w_A}\right)^2 \left(\frac{u}{c_A + \mu^2\left(\frac{1}{c_A} + \frac{w_B}{w_A} \frac{1}{c_1}\right)}\right)^{2(m-r)/m} \left(\frac{1}{\frac{w_B}{w_A} c_1 + \mu^2\left(\frac{1}{c_A} + \frac{w_B}{w_A} \frac{1}{c_1}\right)}\right)^{2r/m}. \quad (33)$$

Now it follows from this expression that as r falls to zero (where we showed above that $w_B/w_A \rightarrow 0$) that $U_B \rightarrow 0$. Now, fix v/u at its critical level, $((n-1)/n)/(1+(c_A/\mu)^2)$, whence we are necessarily in zone 3, and note that at this level of v , the welfare score of B (in the case $r = 0$) in the pre-globalisation setting, given by (17), above, is strictly

positive. It follows that, for a region of v in the neighbourhood of the critical level, if r is sufficiently low the impact effect of liberalization reduces B 's welfare, as illustrated in Figure 2.¹⁶ (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).

Insert Figure 2 about here

Figure 2: The welfare indicator U_B as a function of B 's relative quality under Liberalization versus Pre-Globalisation. The case where r is small is shown.

The intuition is as follows: If v is close to zero, the economy's pre-globalisation 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 , however, the reverse is true. Here, as B 's citizens choose u over v , the fall in derived demand for their labour, and so in w_B/w_A , 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 result 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.

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 globalisation process; we now turn to the consequences of the outcome of this phase for the incentives that drive the second ('catch-up') phase.

4 The Second Phase: Catch-up

The outcome of phase I is to leave us with an open environment for trade and investment, in which high capabilities in country *A* co-exist with low wages in country *B*; phases II and III involve the playing out of the resulting incentives to marry high capabilities with low wages. The response within the corporate sectors of countries *A* and *B* involves several mechanisms. First, the increased selection pressures on *B*'s domestic firms, and their increased opportunities¹⁷ and consequent changes in their incentives to invest in capability building, can in some cases induce strong and effective responses¹⁸. Within the present model, these responses are part of the 'phase III' process. Second, the entry of (multinational) firms from *A* into *B*'s local economy has a two-fold effect, first in driving out low-capability rivals in final-goods markets, and secondly fostering capabilities among local firms who enter their supply-chains¹⁹. It is this 'transfer' process, whether accomplished via FDI, outsourcing, or otherwise, that constitutes 'phase II' in the present model. The effect on the welfare indicator U_B of this growth in *B*'s capabilities is represented by a rightward movement along the $U_B(v)$ schedule in Figure 2.

While this process carries the key gains from globalisation from the point of view of country *B*, the relative importance of the different 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 involved²⁰. No attempt is made here to offer any general characterization of this process; but some remarks are in order as to the general factors that will determine the degree of catch-up:

- (i) As transfer proceeds, the relative wage w_B/w_A rises, thus diminishing the incentive for further transfers, and so, given any positive cost of transfer, this process will halt at some intermediate level between B 's initial capability and that of A .
- (ii) A second factor relates to the idea of 'absorptive capacity' (Cohen and Levinthal (1990)), which posits that the cost of reaching capability level u is lower, according as v is higher. This seems a plausible assumption, though it will not necessarily hold in all circumstances²¹. Insofar as it does hold, the question arises: if there are several ' B -type' countries with different levels of v , which of these offers the best returns to transfers? A lower level of v is associated with a lower relative wage rate, so there are two countervailing considerations. The most favoured location might in principle lie, in terms of Figure 2, anywhere on the interior of the segment running from $v = u$ down to the critical level of v below which B 's relative wage reaches its minimum value. It is worth noting that countries with v below this critical value are strictly dominated as destinations; so that if the absorptive capacity relationship holds, this group of countries, which unambiguously benefit from the impact effect of liberalization, may not advance further during the transfer process.

Modelling the transfer process, in the light of points (i) and (ii) above, involves a complicated dynamic game, which lies beyond the scope of the present analysis ²² .

In what follows, we focus on the outcome of the process, by considering welfare indicators U_A and U_B as v rises from its threshold value (where $w_B = 0$) to $v = u$. This involves examining how a rise in v , holding u constant, affects the relative wage and the utility indicators in zone 2 (Figure 2); the analysis, as noted earlier, is set out in the Appendix. Here we note the key results:

- (i) The wage ratio w_B/w_A and the welfare indicator U_B , rise monotonically with v .
- (ii) The behaviour of U_A during phase II reflects the interplay of two factors: first, the increased competition from B reduces price-cost margins, and this tends to raise U_A . Second, the increase in demand from B for raw material inputs changes the terms of trade between A and C , and this tends to reduce U_A .

It is worth noting the relation between remark (ii) and the ‘competitiveness’ debates of the late 1990s (Krugman (1999)). In a limiting case of the present model, where $\mu = 0$ and n is large, U_A is unaffected by v . This corresponds to the models proposed in Krugman (1999); in a ‘competitive’ limit case, and in the absence of terms of trade effects, a rival’s productivity (or quality) level may have no effect on domestic welfare so that B ’s catch-up leaves A unaffected. Once we move beyond this limit case, B ’s catch-up may have either a positive or a negative effect on U_A ; the details are set out in the Appendix. Here we briefly state the conclusions: Country A benefits unambiguously

from the impact phase, as we move from the pre-globalisation equilibrium to a fully open global economy. The gains which it makes in phase I, however, may be partially eroded in phase II, by virtue of changes in the terms of trade. Country B , on the other hand, though potentially losing in phase I, benefits unambiguously in phase II.

Both countries' fortunes in phase III will depend inter alia on the degree of catch-up that has occurred in phase II. It is intuitively obvious that if B 's initial capability is low and catch-up is weak, then B 's exclusion from the market resulting from phase I may be maintained in the third phase²³. The question we focus on below relates to the opposite scenario: what kind of final outcome will emerge in the situation where catchup is strong? To address this question, we focus on the 'full catchup' setting in which country B attains A 's levels of productivity and quality at the end of phase II. Given the increase in the size of the global market available to firms, it will now be profitable for at least some firms to make new investments in capability building; will this process lead to a 'shakeout' of firms, or will all $2n$ firms now present in each industry survive?

To motivate what follows, it is worth recalling the general ('non-convergence') property common to models of the present kind: if the countries were united ab initio into a (large) single market, so that all firms' initial investments were made in the light of this, then the number of firms entering each industry would be the same, independently of the size of the market. This suggests that we might expect some shakeout to occur among the $2n$ firms now active in each market. What makes matters more complicated

here, is that the fixed outlays incurred by firms in achieving their initial quality level v (and any fixed outlays incurred in a process of transfer of capabilities) are sunk; and this tends to work against shakeout.

5 The Third Phase: Escalation

In the third phase, firms re-assess the investments they had made in fixing their respective levels of quality and productivity, in the light of their newly acquired access to the larger, global, market. To analyze the third phase of the globalisation process, we need to backtrack in order to ask, what determined the initial number of firms in each industry, and their levels of quality (and productivity), i.e. the initial conditions from which we began our analysis of the impact effect of globalisation? The following analysis takes the framework introduced in Sutton (1991), Chapter 3, and extends it to the present general equilibrium setting. In the partial equilibrium setting, the level of industry demand facing the firms, parameterized by S , is taken as given. When we move to a general equilibrium setting, we appeal to the notion that there are many industries (m is large), so that each firm, in making its decisions as to what investment it should make in fixing its quality (or productivity) level, can take S , and so industry demand as given. However, the joint decisions made by all firms in all industries together determine²⁴, inter alia, the level of S . Hence we must, in a general equilibrium setup, solve jointly for the number of firms in each industry, the quality level(s) they choose, and the level of industry demand, represented by S .

We begin by introducing two simplifications, motivated by the analysis of phase I above. First, we confine attention to the limit case $r = 0$ (all goods are ‘quality goods’). Second, we focus attention on quality, rather than productivity, by fixing the level of labour input per unit of output to a constant level c for all firms in all industries, in both countries. Firms can set any level of quality u , above some minimal ‘threshold’ level of 1, by investing a fixed and sunk cost of $F(u)$, measured in units of labour input. We represent the fixed and sunk cost of achieving quality level u in country A , in the pre-globalisation setting, as $w_A F(u) = w_A \cdot au^\beta$, where $\beta(> 1)$ represents the elasticity of response of quality to R&D investment. It will be familiar to readers conversant with the I.O. literature that a lower value of β is associated with a smaller number of firms, i.e. the less costly it is to raise u , in this sense, the higher the level of market concentration at equilibrium²⁵. The parameter a is country specific, and will be affected by the endowment of communal know-how among the country’s firms; for country B , we represent the fixed cost as $w_B F(u) = w_B \cdot bu^\beta$. The effect of this, at equilibrium, will be that the number of firms in each industry, n , will be the same in countries A and B (since n will, in what follows, be shown to depend only on β , and not on a and b); but the equilibrium level of quality will depend on a , and we will have $v < u$ according as $b > a$, i.e. the more costly it is to raise quality, in this sense, the lower the equilibrium level of quality. We assume in what follows that ‘full catchup’ involves a transfer of access to knowhow, so that country B ’s fixed cost schedule changes from bu^β to au^β .

We now turn to the model. The setup is this: we model outcomes by reference to

the pure strategy subgame perfect equilibria of a 3-stage game (entry; quality choice; Cournot competition)²⁶. This is an atemporal setup, in that individuals are indifferent as to which stage they supply labour at, or consume at; their utility depends only on the labour input supplied and the quantities consumed, as specified by the (atemporal) utility function above. (It is useful intuitively, however, to think of the final stage as having some temporal duration, so that we can cut in at some point in time, with the ‘unanticipated shock’ of trade liberalization).

We begin by analysing the pre-globalisation level of quality in County A. In stage 1, each of a number of potential entrants decides either not to enter, or to enter and pay a setup cost $w_A F(1) = w_A a$. In stage 2, each firm that has entered chooses a quality level $u \geq 1$ and pays the incremental cost $w_A F(u) - w_A F(1)$, so that the overall fixed cost incurred by the firm is $w_A \cdot au^\beta$. Given the qualities u_1, u_2, \dots, u_n chosen by the n firms that have entered, each firm receives a gross profit in stage 3, given by the profit function (3) above. (Recall that the firm takes S as given; and that if c is the same for all firms, the profit function is independent of c , and μ , and simplifies to a form in which k_j is replaced by $1/u_j$). The first order condition for profit maximisation, at a symmetric pure strategy equilibrium where all firms choose u (and we are considering a possible deviation by i), is

$$\left. \frac{d\pi_i}{du_i} \right|_{u_{-i}=u} = \frac{d}{du_i} w_A F(u_i)$$

which on inserting the expressions for $F(u_i)$ and π_i , differentiating w.r.t. u_i , setting $u_i = u$, and multiplying across by u , becomes

$$\frac{2}{\beta} \frac{(n-1)^2}{n} \frac{S}{n^2} = w_A \cdot au^\beta \quad (34)$$

where S denotes total expenditure on A 's final goods, by individuals in A and C .

The profit function (3) collapses, in a symmetric equilibrium where all the u_i (and c_i) are equal, to $\pi_i = S/n^2$. Each firm has fixed outlay $w_a \cdot au^\beta$, whence it follows from inspection of (34) that free-entry implies that the number of firms entering is given by the largest integer satisfying

$$\frac{2}{\beta} \frac{(n-1)^2}{n} \leq 1 \quad \text{or} \quad 2\left(n + \frac{1}{n} - 2\right) \leq \beta. \quad (35)$$

This value of n is independent of S ; this is the standard ‘non-convergence property’ according to which increases in market size are associated, not with falling market concentration, but with a rise in fixed outlays by each firm. The equilibrium value of u is defined implicitly by

$$w^\beta = \frac{1}{a} \cdot \frac{S}{w_A} \cdot \frac{\varphi}{n^2}, \quad \text{where} \quad \varphi = \frac{2}{\beta} \frac{(n-1)^2}{n} \quad (36)$$

where n takes the (integer) value determined by (35) and $\varphi = 1$ when (35) holds as

an equality. (We assume here that S is large enough to support n firms each spending the minimal entry fee $w_A F(1) = w_a a$). (So far, the calculation follows the partial equilibrium model of Sutton (1991), Chapter 3).

It remains, then, to calculate S . To do this, we return to our analysis of short-run equilibrium (corresponding to the final stage of this 3-stage game) in Section 2 above, and consider labour supply to labour demand. Using (14) and (16), we have, on setting $r = 0$ and $c_A = c_B = c_1 = c$, that

$$L_A^D = mcx_u n = c \frac{1}{u} \cdot S \cdot \frac{n-1}{n} \frac{u}{w_A c + w_C \mu}$$

$$L_A^S = N \frac{w_A}{m} \prod_{i=1}^n \left(\frac{u_i}{p_i} \right)^{1/m} = N \frac{w_A}{m} \frac{n-1}{n} \frac{u}{w_A c + w_C \mu}.$$

Equating supply and demand, we obtain

$$\frac{S}{w_A} = \frac{N u}{m c} \tag{37}$$

Combining (36) and (37) we obtain

$$u^{\beta-1} = \frac{1}{a} \cdot \frac{N}{m} \cdot \frac{\varphi}{n^2} \cdot \frac{1}{c} \text{ where } \varphi = \frac{2(n-1)^2}{\beta n} \tag{38}$$

which defines the equilibrium level of quality in the pre globalisation state; here n , as noted, is the largest integer satisfying $2(n + \frac{1}{n} - 2) \leq \beta$.

Similarly, for country B , we have

$$v^{\beta-1} = \frac{1}{b} \frac{N}{m} \frac{\varphi}{n^2} \frac{1}{c}.$$

Following the transfer of capabilities in Phase II, we have, in each industry, n firms with quality u in country A and n firms with some quality v' , $v \leq v' \leq u$, in country B . We now model the re-adjustment of firms in the wake of the (unanticipated) shock of globalisation by reference to a two-stage game, in the first stage of which each firm decides on a non-negative level of incremental investment, while the second stage involves Cournot competition as before. Firms in A can now raise their quality to some new level $\tilde{u} \geq u$, and pay an incremental sunk cost $w_A a(\tilde{u}^\beta - u^\beta)$. Firms in B , who now have access to international know-how, can raise their quality from v' to some level $\tilde{v} \geq v$, at incremental cost $w_B b(\tilde{v}^\beta - (v')^\beta)$.

It is clear that the marginal returns from investing in quality improvement have risen for all firms, and so remaining at the old levels of quality is not an equilibrium. The central question of interest is: Will the process of re-investment lead to a ‘shakeout’ of firms? and if so, which firms survive? A full analysis is beyond the scope of the present paper; here we focus on the ‘best case’ scenario from the point of country B , i.e. that in which catch-up is complete, so that we begin from a symmetric situation in which, in each industry, n firms in A and n firms in B all offer quality u , and both countries have a new common wage rate $w'_A = w'_B = w'$.

The outcome of the re-investment game in the symmetric setting depends upon the value of the parameter β (Recall that a low value of β corresponds to having fewer firms in the industry in the initial equilibrium). The equilibrium is not, in general, unique. An equilibrium outcome may take one of two forms: in each type of equilibrium, some sub-set of the firms re-invest, while the remaining firms make no additional investment. The first form of outcome involves the remaining firms becoming inactive ('shakeout'), while in the second form of outcome, these non-investing firms continue to earn positive sales revenue in equilibrium ('no shakeout'). When β is low (i.e. the industry has few firms), then the outcome involves shakeout, but when β is high, the jump in quality by re-investing firms is relatively small, and the remaining firms remain active (no 'shakeout').

Proposition 2 (Long run adjustment.) *When $k = 1$, then*

- (a) *For $1 < \beta \leq 2$ (whence²⁷ $n = 2$), there exists a symmetric equilibrium in which exactly one firm survives in A and one in B , while the remaining firms make no additional investment and are inactive at equilibrium.*
- (b) *For $\beta > 5$, there is no (symmetric²⁸) equilibrium outcome that involves shakeout.*

Proof: Appendix.

What this suggest, then, is that in all but the most globally concentrated industries, the legacy of the pre-globalisation phase is to leave in place more firms than would

otherwise be in operation; but that in these most highly concentrated markets, a process of shakeout will eliminate this effect. The welfare gain enjoyed by countries in phase III derives from the rise in equilibrium quality, and it is when β is low (i.e. the global market is highly concentrated), that the responsiveness of equilibrium quality to the rise in the size of the market accessible to producers is greatest (as follows from inspection of equation (38)). Thus it is in those industries, where the high pre-globalisation level of concentration is maintained via shakeout (Proposition 2(a)) that the greater welfare gains arise in phase III.

6 Discussion and Related Literature

Over the past few years, a number of authors have explored the role of quality in trade using CES models (for example, see Hallak and Schott (2005)), while others have examined trade in non-CES models of the ‘monopolistic competition’ kind (Melitz and Ottaviano (2005)). The novelty of the present paper lies in going beyond the monopolistic competition setting by using an example drawn from the general class of models defined in Sutton (1991, 1998) that have proved useful in describing observed patterns of market structure. This example was used to analyse the globalisation process in Sutton (2001), on which the present paper builds. A second example drawn from this class, the ‘linear demand model with quality’ introduced in Sutton (1998), has been used recently by Yanes (2005) to explore similar issues²⁹.

One feature of the example used here is that it does not allow consumers' willingness-to-pay for quality improvements to fall as consumers' incomes decline. If this possibility is introduced, the viability of low quality products offered by low income countries is enhanced. Models that incorporate this feature were used in analysing trade issues by Shaked and Sutton (1984), and by Murphy and Schleifer (1997).

The central element in the present paper relates to the role of tradable intermediate inputs. In interpreting the results, it is useful to distinguish two separate ideas, viz. (1) the material input is tradeable (but may or may not be produced domestically), and (b) the material input is imported. Assumption (a) is a very weak restriction, and is sufficient to imply the main result, i.e. that below a certain relative quality level, no sales can be achieved irrespective of domestic wage rates. Assumption (b) is more restrictive. The possibility of a welfare loss in the liberalization phase relies on this assumption, and so depends upon the pre-globalisation pattern of trade restrictions.

Given the central role played by tradeable inputs in this model, it is natural to ask, will firms not have an incentive to reduce the level of material input? We assume, in the model, a 'fixed proportions' technology. If instead it was possible to substitute labour for raw materials, Country *B*'s position might be improved. This channel, in practice, will probably offer limited scope³⁰. Remaining within the fixed proportions setup, however, there are two channels of interest:

- (i) Just as firms can raise u , or $1/c$, by spending more fixed and sunk outlays, so we might suppose firms to carry out R&D aimed at 'materials savings'. This

can be incorporated into the long-run analysis of Section 5, by way of a fixed cost schedule $F(m) = (1/m)^\delta$, where δ measures the elasticity of response of m to F . For any finite size of economy, m will now take a corresponding long-run equilibrium value; and the short-run analysis of Section 3 goes through as before³¹.

- (ii) A more practically important channel of response lies in efforts by firms in A and B to improve productivity in country C . (China's current activities in Africa are a case in point). This offers a potential escape route from possible welfare losses to country A associated with changes in the terms of trade during the catch-up phase.

7 Conclusions

A central message of this paper is that defences of globalisation based primarily 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 in the first stage of the process. 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 the present globalisation, not –or not primarily– 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 transfer³². Understanding the determinants of the speed and effectiveness of these transfers, and

of the effects of different policies on this process is crucial: 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 or that consideration throw light on the industry- and country-specific determinants of the speed and effectiveness of transfer?

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 in the present model (which ignores transitional problems, distributional issues, etc.). There are many issues involved here which go beyond the range of considerations discussed in the paper; but it is nonetheless worth recalling the issue of ‘absorptive’ capacity discussed in Section 4 above. Here, the danger is that in the lowest income countries, 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 one of the most important issues in the field of industrial development.

8 Appendix: Proofs

8.1 *The Zone 2 Equilibrium*

We confine attention to the case $r = 0$ in this Appendix. Following the same arguments as before we have:

$$\frac{L_S^A}{L_S^B} = \frac{w_A}{w_B} = \frac{L_D^A}{L_D^B} = \frac{c_A n x_u}{c_B n x_v}$$

Substituting for x_u and x_v from (16), (17) and setting $r = 0$, the value of x_u/x_v reduces to

$$\frac{x_u}{x_v} = \left\{ 1 - \frac{2n-1}{n} \frac{w_A c_A + w_C \mu}{u \left[\frac{w_A c_A + w_C \mu}{u} + \frac{w_B c_B + w_C \mu}{v} \right]} \right\} \div \left\{ 1 - \frac{2n-1}{n} \frac{w_B c_B + w_C \mu}{v \left[\frac{w_A c_A + w_C \mu}{u} + \frac{w_B c_B + w_C \mu}{v} \right]} \right\} \quad (39)$$

We focus here on the role of quality differences, by setting $c_A = c_B = 1$ and examining how the wage ratio w_B/w_A and the utility indicator U_A vary as v falls from $v = u$ to its critical (threshold) value.

Following the same arguments as before, we have in this zone that

$$w_C = \frac{\mu}{c_A} w_A + \frac{\mu}{c_B} w_B = \mu(w_A + w_B).$$

Substituting for w_C in (39), and writing w_B/w_A as ω , we have on re-arranging,

$$\frac{1}{\omega} = \frac{[\mu^2 + (1 + \mu^2)\omega]u - \frac{n-1}{n}[(1 + \mu^2) + \mu^2\omega]v}{[(1 + \mu^2) + \mu^2\omega]v - \frac{n-1}{n}[\mu^2 + (1 + \mu^2)\omega]u}$$

which reduces to the quadratic,

$$[(1 + \mu^2)u - \frac{n-1}{n}\mu^2v]\omega^2 + [\mu^2 + \frac{n-1}{n}(1 + \mu^2)](u - v)\omega - [(1 + \mu^2)v - \frac{n-1}{n}\mu^2u] = 0.$$

It can be seen from inspection of the third coefficient that for

$$u \geq v > v_C = \frac{n-1}{n} \cdot \frac{1}{1 + 1/\mu^2} \cdot u$$

that the coefficients are positive, positive and negative respectively; ω is defined by the single positive root, and as $v \rightarrow v_C$, so that the constant coefficient falls to zero, $\omega \rightarrow 0$.

The ‘cost differences’ case can be examined in the same way; by fixing the values of u and v , and examining the behaviour of w_B/w_A as c_B rises, holding c_A constant. Here, the wage ratio remains positive for all c_B , falling asymptotically to zero as $c_B \rightarrow \infty$.

8.2 Welfare in Zone 2

We next examine the welfare indicator U_A as a function of v in zone 2. The welfare indicator (7) is

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

Setting $r = 0$, applying the price equation (14) for p_u/u and p_v/v , setting $c_A = c_B = \mu = u = 1$, and writing $w_C = \mu(w_A + w_B)$ and $\omega = w_B/w_A$ as before, we obtain

$$U_A = \frac{1}{2m^2} \left(\frac{2n-1}{n} \right)^2 \frac{u^2}{\left[((1+\mu^2) + \mu^2\omega) + (\mu^2 + (1+\mu^2)\omega) \frac{u}{v} \right]^2}. \quad (40)$$

Combining the solution for ω with (40), the behaviour of U_A as a function of v over the range $v_C \leq v \leq u$ can be checked. The behaviour of the function depends on μ and n .

Here we summarize the relevant properties:

- (i) When $\mu = 0$, U_A rises with v (while profits fall) for all n . In the limit $n \rightarrow \infty$, the schedule becomes flat, i.e. U_A is independent of v .
- (ii) For each n , there is a critical value of μ above which the relationship is non-monotonic. Above this value, v increases from v_C , U_A rises up to a certain value of v , and thereafter falls (Figure 3).

Insert Figure 3 about here

Figure 3: The behaviour of the welfare indicator U_A as a function of v . The case $n = 2$ is illustrated. Here, when $\mu = 1$, U_A takes the same value at $v = v_C$ and at $v = u$.

8.3 Proof of Proposition 2 (a)

Recall that it was shown in the text that, pre-globalisation, $S/w_A = (N/m)/(u/c)$. We begin by deriving the equivalent expression for total global expenditure on final goods post-liberalization, S' , relative to the post-liberalization wage rate, w'_A . We confine attention to symmetric outcomes in which n' firms operate in each industry, $n'/2$ in country A and $n'/2$ in country B . We then have

$$L_A^D = m c x_u(n'/2) = c \frac{1}{u} S' \frac{n' - 1}{n'} \frac{u}{w'_A c + w'_C \mu}$$

$$L_A^S = N \frac{w_A}{m} \prod_i \left(\frac{u_i}{p_i} \right)^{1/m} = N \frac{w'_A}{m} \frac{n' - 1}{n'} \frac{u}{w'_A c + w'_C \mu}.$$

Equating, we have

$$\frac{S'}{w'_A} = 2 \frac{N u}{m c}. \quad (41)$$

When β lies in the range $1 < \beta \leq 2$, it follows from (35) that each country initially supports $n = 2$ firms in each industry. We aim to show that there exists a post-globalisation equilibrium in which $n^* = n = 2$ firms survive, one in each country, in each industry.

It was shown in the text that the pre-globalisation level of quality in country A satisfies

$$u^\beta = \frac{1}{a} \frac{S}{w_A} \frac{\varphi}{n^2}, \text{ whence } u^{\beta-1} = \frac{1}{a} \frac{N}{m} \frac{\varphi}{n^2} \frac{1}{c}, \text{ where } \varphi = \frac{2}{\beta} \frac{(n-1)^2}{n}. \quad (42)$$

Following a similar argument, if shakeout occurs so that in the post-globalisation setup we have $n^* < 2n$ active firms, then the first order condition for choice of quality implies that they have a common quality u^* , where

$$u^{*\beta} = \frac{1}{a} \frac{S'}{w'_A} \frac{\varphi^*}{n^{*2}}, \text{ whence } u^{*\beta-1} = \frac{2}{a} \frac{N}{m} \frac{\varphi^*}{n^{*2}} \frac{1}{c}, \text{ where } \varphi^* = \frac{2}{\beta} \frac{(n^*-1)^2}{n^*}. \quad (43)$$

We are concerned with investigating a candidate equilibrium in which $n^* = n$, whence comparing with (42)

$$\left(\frac{u^*}{u}\right)^{\beta-1} = 2 \quad (44)$$

and since $1 < \beta \leq 2$, it follows that $u^* \geq 2u$.

Now if n^* firms offer quality u^* , the threshold quality for viability is $[(n^*-1)/n^*] \cdot u^* = u^*/2$, whence the non-investing firms that continue to offer the original quality u are inactive. It therefore follows that the gross profit earned by the n^* firms that jump to u^* equals S'/n^{*2} . The cost they incur is $w'_A[F(u^*) - F(u)] = w'_A \cdot a(u^{*\beta} - u^\beta)$. We need to check that, for these firms, jumping to u^* is more profitable than staying at u (which yields payoff zero); i.e. that the locally optimal choice of quality defined by the

first order condition (43) is globally optimal. To see this, note the first order condition defining u^* , and recall that $n^* = 2$, and $1 < \beta \leq 2$, whence $\varphi^* < 1$, and so the gross profit of the firm,

$$\frac{S'}{n^{*2}} > w'_A \cdot au^{*\beta} > w'_A \cdot a(u^{*\beta} - u^\beta) = w'_A [F(u^*) - F(u)]$$

whence the firm earns positive net profit.

It remains to check that a firm who does not invest can not profitably deviate by setting some quality above u . Consider such a deviant and denote the quality level it sets as ku^* , for some $k > 1/2$ (Recall that $u^* \geq 2u$ and a quality below $u^*/2$ is non-viable). From the profit function (3) we have that the deviant's gross profit, when competing against two firms offering u^* , is

$$\left(1 - \frac{2}{1+2k}\right)^2 S' \tag{45}$$

The fixed cost it incurs, $w'_A(F(ku^*) - F(u))$ equals

$$w'_A((ku^*)^\beta - u^\beta) = w'_A \left[k^\beta - \left(\frac{u}{u^*}\right)^\beta \right] u^{*\beta} > w'_A \left[k^\beta - \frac{1}{2} \right] u^{*\beta} \tag{46}$$

where the last inequality follows on noting that $u/u^* < 1/2$, and $\beta > 1$ whence $(u/u^*)^\beta < 1/2$.

We aim to show that the deviants' profit (45) is less than its cost (46), for all

$k > 1/2$. Recall from (??) that $S'/n^{*2} > w'_A u^{*\beta}$ whence it suffices to show that

$$\left(1 - \frac{2}{1+2k}\right)^2 < k^\beta - \frac{1}{2}.$$

It is easily checked that this is true on $k > 1/2$, for $1 < \beta < 2$.

8.4 *Proof of Proposition 2 (b)*

The form of the first order condition implies that all pure strategy equilibria take a form in which n^* firms jump to quality level u^* , while the remaining $2n - n^*$ firms remain at level u , where $1 \leq n^* \leq 2n$. We confine attention to symmetric outcomes in which the former firms are drawn equally from A and B , so $w'_A = w'_B$. We aim to show that for $\beta \geq 5$, no equilibrium of this form exists in which the ‘fringe’ of non-investing firms is inactive. The condition for these latter firms to become inactive is $u^*/u > n^*/(n^* - 1)$.

We begin by noting that $n^* \geq n$. This follows from noting that if shakeout occurs, so that non-investing firms are inactive, the first order condition in a symmetric equilibrium, following equation (34) of the text, is

$$\frac{2}{\beta} \frac{(n^* - 1)^2}{n^*} \frac{S'}{n^{*2}} = w'_A \cdot au^{*\beta}.$$

The (gross) profit of the firm is S'/n^{*2} and the incremental fixed cost incurred is $w'_A \cdot au^{*\beta} - w'_A \cdot au^\beta > w'_A \cdot au^{*\beta}$. It follows that n^* must be at least equal to the largest

integer value satisfying $2(n^* + 1/n^* - 2) \leq \beta$, whence, using equation (35) of the text, $n^* \geq n$.

To see that no shakeout equilibrium exists, suppose n^* firms set a quality $u^* > (n^*/(n^* - 1))u$. The profit of each of these firms, assuming that the remaining firms are inactive, equals S'/n^{*2} , where $S' = 2\frac{N}{m} \frac{u^*}{c} w'_A$, i.e.

$$\pi = 2\frac{N}{m} \frac{u^*}{c} w'_A \frac{1}{n^{*2}}.$$

The fixed outlay of each firm, in moving from u to u^* , equals

$$aw'_a(u^{*\beta} - u^\beta)$$

where, following the same argument leading to (38) of the text, u is defined implicitly by

$$u^{\beta-1} = \frac{1}{a} \frac{\varphi}{n^2} \frac{N}{m} \frac{1}{c} \quad \text{where } \varphi = \frac{2}{\beta} \frac{(n^* - 1)^2}{n^*}$$

(where $\varphi = 1$ if the value of n satisfying $\beta = 2(n + 1/n - 2)$ is an integer), whence the fixed outlay is

$$F = w'_a \left[\left(\frac{u^*}{u} \right)^\beta - 1 \right] \cdot \frac{\varphi}{n^2} \frac{N}{m} \frac{1}{c} u$$

whence the investing firms cannot recover their fixed outlays if $\pi < F$, which reduces to

$$2\frac{u^*}{u} < \left[\left(\frac{u^*}{u} \right)^\beta - 1 \right] \varphi \left(\frac{n^*}{n} \right)^2.$$

Since $n^* \geq n$, it suffices to show that

$$2\frac{u^*}{u} < \left[\left(\frac{u^*}{u} \right)^\beta - 1 \right] \varphi$$

Recall that n is the integer part of the solution to $\beta = 2(n + \frac{1}{n} - 2)$, and that $u^*/u > n^*/(n^* - 1)$, and that φ denotes $\frac{2}{\beta} \frac{(n^*-1)^2}{n^*}$, so that this condition reduces to

$$2\frac{u^*}{u} < \left[\left(\frac{u^*}{u} \right)^\beta - 1 \right] \frac{1}{\beta} 2 \frac{(n^* - 1)^2}{n^*} \text{ when } \frac{u^*}{u} > \frac{n^*}{n^* - 1}.$$

It can be checked directly that the inequality holds when $\beta = 5$, $n^* = 4$; and it follows a fortiori that it is true for $5 < \beta < \beta(5)$, where $\beta(n) = 2(n + 1/n - 2)$. Finally, for all $n^* \geq 5$ and $\beta \in (\beta(n^*), \beta(n^* + 1))$, it holds. This establishes Proposition 2 (b).

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Notes

¹ The CES models and related models arise as special limiting cases of this general class of models, within which certain results central to the present paper vanish. The CES-type model fails to account for the fact that many industries remain concentrated even in very large (global) markets.

²If quality improvements are associated with a rise in variable costs (labour and raw material inputs), as opposed to a rise in fixed and sunk outlays, then ‘quality competition’ is precisely analogous to competition in product variety of the Hotelling kind (i.e. to ‘horizontal’ product differentiation). This distinction was introduced in Shaked and Sutton (1982), where a precise characterization of the difference between the two cases is developed. The ‘variable cost’ case is captured, for example, in Rosen (1978); for a discussion, see Sutton 1991, chapter 3.

³This 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; and as the number of product varieties becomes arbitrarily large, the market share of each variety, including the highest quality variety, shrinks to zero.

⁴This equilibrium level of concentration is, in general, consistent with the existence of an arbitrarily large number of firms. This can happen, for example, if we have two groups of consumers, one of which is sensitive to quality, while the other is not (Sutton, 1991, chapter 3). In the present 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.

⁵In terms of the classical trade literature, we have a Ricardian model in which two countries share the same technology for producing ‘commodity’ goods, while one country has a comparative and absolute advantage in producing ‘quality’ goods; but under imperfect competition, complete specialization occurs only if the technology gap is sufficiently large. Our focus of attention lies in exploring the determinants of the critical gap that excludes one country from the production of quality goods.

⁶More generally, materials or component inputs that are internationally traded.

⁷It 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 component inputs determines 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, in return for a given quality increment over rival products to pay a corresponding price increment, and that this remains true, even when the number of low quality rival products becomes arbitrarily large.

⁸This can be motivated by supposing the effectiveness of R&D spending in raising capability to be low in these industries (the ‘exogenous sunk cost’ limit; see Sutton (2007))

⁹Some of these firms may be inactive at equilibrium.

¹⁰Since this is a free entry model, where the present value of the flow of gross (‘final stage’) profits coincide with fixed and sunk outlays (i.e. zero net profits), up to ‘integer effects’, this seems a reasonable welfare indicator. However, once we introduce the unanticipated shock of liberalization, the profit flows change, and we need to track both the utility score (5) and the profit flows. See footnote 11 below.

¹¹This representation is motivated by the situation prevailing in Soviet bloc countries prior to the collapse of the Soviet Union.

¹² S represents total expenditure on final goods and can be written as $(m - r)np_u x_u + rn_1 p_1 x_1$.

¹³This equation may be derived as a limit case for the zone 1 equations as follows: set the (bracketed term in the) expression x_{1A} in (18) to zero, to obtain the criterion $(w_A c_1 + w_C \mu)/(w_B c_1 + w_C \mu) = n_1/(n_1 - 1)$. Substitute this into the expression for x_{1B} to obtain (21).

¹⁴See footnote 7 above.

¹⁵The ratio $1/(1 + (c_A/\mu)^2)$ in (31) represents the most favourable unit cost ratio that B can enjoy in producing v , relative to A in producing u . To see this, note that B ’s unit cost cannot fall below $\mu w_C = (\mu^2/c_A)w_A$ while A ’s unit cost is $w_A c_A + w_C \mu = (c_A + \mu^2/c_A)w_A$.

¹⁶We noted above that the flow of (gross) profits also changes. In zone 3, the profit flow to firms in country B falls to zero, while the profit flow to firms in A rises.

¹⁷Opportunities to communicate directly with foreign buyers can of itself 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)).

¹⁸Some 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 (Sutton, 2001).

¹⁹This 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, direct (‘first-tier’) suppliers, both domestic and foreign-owned, had within 7-8 years of the arrival of the main wave of international car makers attained ‘world-class’ standards of quality and productivity by 2003, as measured by conventional defect rates in parts supplied (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 general. This 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-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, the auto-maker advises and incentivises its many suppliers, in a process that involves the back-and-forth movement of engineers and managers between the two firms; and (ii) the auto sector is unusual in the degree to which a common set of business practices and production routines leading to high levels of productivity and quality have become standardized throughout the international industry, thus leading to an institutional structure in which transfers are facilitated. These 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’. In contrast to this, the process of adjustment in the Indian machine tool industry has been extremely slow and difficult (Sutton, 2000, 2001).

²⁰The 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.

²¹An acid test is provided by the question: is it more attractive for an incoming multinational to develop capabilities in a local joint-venture partner, or to begin *ab initio* on a greenfield site? In many instances (such as the production of car seats, say) the greenfield option is usually preferred (Sutton, 2004).

²²Two further factors that are not built into the present model are worth noting:

- (a) If trade liberalization is less than complete, or if transport costs are significant, then the size of country *B* (or more, precisely, the size of the market that may be accessed by locating in country *B*), becomes an important determinant of FDI flows. China's approach to globalisation may be seen as merging phases I and II by attracting FDI over the same period as trade barriers were gradually relaxed; and in relying on the size of its market as a key factor attracting FDI. Ireland, on the other hand, liberalized abruptly as of 1958, and then worked to attract FDI, using the proximity to the wider European market (and from 1972, EEC membership) to offset its small size.
- (b) The country specific characteristics that affect the cost of doing business (the 'investment climate') have a two-fold effect on outcomes. First, a reduction in the 'cost of doing business' is equivalent in the present setting to a rise in capability across all firms in the country concerned. Second, improvements in the 'investment climate' will affect the degree of catch-up, via their influence, *inter alia*, on FDI flows.

²³This effect is analogous to that explored by Stokey (1991) in the context of a dynamic quality competition model. A similar effect arises in the context of a learning-by-doing model in Young (1991).

²⁴In the sense that if we change the quality levels by the firms, for example, this will affect individuals' labour supply decisions.

²⁵The intuition is as follows: as β falls, it is less costly to achieve any given level of u , but this leads to an escalation of spending and raises the cost of entry, so we get a smaller number of firms, each spending more fixed outlays, at equilibrium.

²⁶The reason for separating the ‘entry’ stage from the ‘quality choice’ stage is technical: it ensures that if a number of firms (somewhat) exceeding the equilibrium number enter, the equilibrium choices of quality in the ensuing ‘quality choice’ subgame are still described by the first order conditions set out in the text (i.e. there exists a symmetric pure strategy equilibrium in this subgame; see Sutton (1991), Chapter 3.)

²⁷Condition (35) implies that $n = 2$ for $1 < \beta < 3/8$.

²⁸I.e., one in which surviving products are equally distributed across countries, so that $w_A = w_B$.

²⁹A key feature common to all these models, and to the present analysis lies in their focus on the firm as an institution that can transfer (homogeneous) labour inputs into final goods of different, firm specific, quality levels. Behind such an assumption lies the idea that the individuals comprising the firms have some collective know-how, or working practices, that allow the firm to transform input into outputs in a more or less effective way; and that the firm can invest in developing this know-how, the benefit of which can be applied across the firm’s range of output. This contrasts with a ‘human capital’ approach to these issues, as developed most notably by Nancy Stokey (1991), in which differences in output quality derive from differences in human capital at the level of the individual worker, as opposed to the firm.

³⁰A more interesting channel lies in ‘materials saving’ through the use of more capital-intensive techniques; for a Chinese example, see Sutton (2004).

³¹This functional form pre-supposes that there is no ultimate limit to m ; a more realistic form would be $F(m) = (1/(m - m_0))^\delta$, where m_0 represents the unavoidable cost of the basic chemical elements in the material inputs, excluding all costs of mechanical or chemical transformations.

³²On this interpretation, the worst case scenario is that of the former East Germany, in that the key driver of the transfer process was cut off by the setting of currency parity between East and West.