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ABSTRACT

Location of Vertically Linked Industries: Agglomeration *versus* Comparative Advantage*

This Paper analyses the effects of reducing trade costs on the location of manufacturing firms that are vertically linked and differ in factor intensities. I extend the new economic geography literature by embedding a model with vertical linkages within a Heckscher-Ohlin framework. Firms can choose to locate either in a labour-abundant country or a capital-abundant country. I show that lower trade costs on intermediate inputs and final goods can lead to an agglomeration of all upstream and downstream firms in one country, even when they differ in factor intensities. Hence, for some ranges of trade costs, industries may locate in countries where standard trade models would suggest they would not locate. For example, labour-intensive industries may locate in capital-abundant countries. This also has implications for whether trade liberalization leads in the direction of factor price equalization. If the share of manufacturing is high, trade liberalization (from high to medium) leads to an increase in the return to both factors in the country where manufacturing agglomerates.

JEL Classification: F10, F12, F15
Keywords: downstream firms, trade costs, trade liberalization, upstream firms, vertical links

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NON-TECHNICAL SUMMARY

This Paper shows that labour-intensive industries will not always locate in labour-abundant countries, as predicted by standard trade models. I develop a model to show that lower trade costs can lead to the agglomeration of upstream and downstream firms in one country even when they differ in factor intensities.

The model has two factors of production and two countries, with three industries. Two of these industries have increasing returns to scale technologies and are vertically linked through an input–output structure, and the other industry is a constant returns to scale 'agricultural' industry. I embed a new economic geography model with vertically linked firms within a Heckscher-Ohlin model. To date, the new economic geography models have been developed solely in the context of one-factor models (Krugman and Venables, 1995; Venables, 1996), where countries are identical *ex ante* in size and have access to the same technologies. I extend the new economic geography literature by including two factors of production and allowing the production stages to have different factor intensities.

Firms can choose to locate in a labour-abundant country or a capital-abundant country. With different factor intensities, if, for example, upstream intermediate input suppliers (upstream firms) are capital intensive and manufactures of final goods (downstream firms) are labour-intensive, there will be opposing forces driving the location decisions. Factor cost considerations encourage location based on comparative advantage as in a standard trade model and in the fragmentation literature (see Jones and Kierkowski, 1990, 1999, 2001; Deardorff, 1998a, 1998b), with the labour-intensive production stages locating in the labour-abundant country and the capital-intensive production stages locating in the capital-abundant country. The vertical linkages between upstream and downstream firms, however, give rise to 'demand' and 'cost' linkages, promoting the agglomeration of upstream and downstream firms in one country as in the new economic geography literature. The balance between these forces depends on the level of trade costs.

I show that lower trade costs on intermediate inputs and final goods can lead to an agglomeration of all upstream and downstream firms in one country, despite the differences in factor intensities. Hence, for some ranges of trade costs, firms may locate in countries where standard trade models would suggest they would not locate. For example, the labour-intensive downstream firms may locate in the capital-abundant country in order to be close to the intermediate input suppliers. This also has implications for whether trade liberalization leads in the direction of factor price equalization. If the share of manufacturing is high, trade liberalization (from high to medium) leads to an increase in the return to both factors in the country where manufacturing agglomerates.

LOCATION OF VERTICALLY LINKED INDUSTRIES: AGGLOMERATION VERSUS COMPARATIVE ADVANTAGE

I. INTRODUCTION

One of the dominant features of globalisation has been the international fragmentation[1] of production based on factor cost. This phenomenon has received a lot of attention with highly publicised cases such as the textile industries relocating unskilled labour intensive production processes from capital abundant developed countries to unskilled labour abundant developing countries.[2] It has also been widely studied within a trade theoretic framework by Jones and Kierkowski (1990, 1999, 2001), Deardorff (1998a, 1998b) and others[3]. These papers show that when fragmentation is possible a country will produce the range of intermediate inputs in which it has comparative advantage arising from differences in technology (as in Ricardo) or from differences in relative factor endowments (as in Hecksher-Ohlin). They emphasise that new innovations in the service industries, particularly in the transport and communications industries, have promoted international fragmentation. This suggests that as trade costs continue to decline that industrial structures will be primarily determined by factor cost differences (or technology differences).

Contrary to this, another widely observed phenomenon, which has received very little attention within the trade literature, is the emergence of agglomerations of vertically related industries within one country.[4] Such agglomerations often comprise firms with widely differing factor intensities.[5] Consider the example of rubber based components for motor vehicles and aerospace. Though they are often intensive in the use of natural rubber and labour, such components manufacturers are not always based in countries like Malaysia, Indonesia or Thailand that are abundant in unskilled labour and rubber. Instead, they are often located in

[1] The term 'fragmentation', first used by Jones and Kierkowski, is defined as the splitting up of a production process into two or more stages that can be undertaken in different locations. Other terms used to describe the same phenomenon include intra-firm specialisation and outsourcing.
[2] See Hummels, Ishii and Yi (2001) for empirical evidence on vertical specialization.
[3] See also Sanyal and Jones (1982), Arndt (1996) and Feenstra and Hanson (1996).
[4] See Porter (1990) for examples of agglomerations, which he refers to as 'clusters'.
[5] Evidence provided in Markusen and Melvin (1984) suggests that factor intensities differ between upstream and downstream firms. They found that intermediate manufactured goods are on average significantly more capital intensive than final manufactured goods.

developed European countries and US in close proximity to final assembly producers (Barlow, Jayasuriya and Tan (1994)). Furthermore, there is evidence to suggest that some of these agglomerations of vertically related industries have been growing forcefully over the last few decades, for example the aircraft and associated parts industries in southern California (Scott and Mattingly (1989)). In these cases, the advantages of close proximity of buyers and sellers seem to outweigh factor cost considerations. It is this phenomenon which is the focus of this paper.

I develop a model to analyse why falls in trade costs can sometimes lead to the agglomeration of vertically linked industries that differ in factor intensities. There are opposing forces driving the location decisions of these firms. Factor cost considerations encourage location based on comparative advantage as in a standard trade model and in the fragmentation literature, with the labour intensive production stages locating in the labour abundant country and the capital intensive production stages locating in the capital abundant country. However, the vertical linkages between upstream and downstream firms give rise to 'demand' and 'cost' linkages, promoting the agglomeration of upstream and downstream firms in one country, as in Krugman and Venables (1995) and Venables (1996) in the new economic geography literature[6]. The balance between these forces depends on the level of trade costs[7].

To date, these new economic geography models have been developed solely in the context of one-factor models, where countries are identical ex-ante in size and have access to the same technologies, hence they are unable to address the questions raised here. I extend the new economic geography literature, by embedding a model with vertically linked firms in a two-factor Heckscher-Ohlin model. I show that industries may locate in the 'wrong' country from a comparative advantage viewpoint. For example labour intensive industries may locate in capital abundant countries.

[6] The benefits of vertically linked industries locating in close proximity were identified by Alfred Marshall in 1920.

[7] Ricci (1999) and Forslid and Wooton (1999) also consider tensions between agglomeration and comparative advantage, however the forces in their models are quite distinct from those analysed here. In their models, the comparative advantage arises from exogenous technology differences between the two countries (as in Ricardo) and the agglomeration forces arise from migration of workers.

The rest of the paper is organised as follows: section II sets out the formal model; section III solves for equilibrium; section IV presents the results; and section V concludes. The proofs are contained in the Appendix.

II. THE MODEL

The model builds on the new economic geography literature in two significant ways. First, we include two factors of production, labelled labour and capital; and second we allow the industries to differ in factor intensities. The two factors of production are immobile between two countries called Home and Foreign. For concreteness, I assume that the upstream firms are capital intensive and downstream firms are labour intensive[8]; and that the Home country is labour abundant and the Foreign country is capital abundant. Both countries have access to the same technology; and consumers in each country have identical homothetic preferences. There are two imperfectly competitive manufacturing industries, upstream and downstream industries, that are vertically linked through an input-output structure; and a perfectly competitive 'agricultural' industry.

Upstream firms produce intermediate inputs, using labour and capital, which they sell to firms in the downstream industry.[9] Downstream firms combine intermediate inputs with labour and capital to produce final manufacturing goods, which they sell to consumers. The two manufacturing industries are labelled by subscripts k=*u*,*d*, where *u* denotes the upstream industry and *d* denotes the downstream industry. The market structure in each of the vertically linked industries is assumed to be Chamberlinian monopolistic competition: there are many firms in both industries, each employing increasing returns to scale technology and producing differentiated goods. Each firm can choose to locate in either country and it draws on the labour and capital available in the country in which it locates.

The agricultural industry is assumed to be perfectly competitive, with constant returns to scale technology, employing labour and capital.

[8] Note that the opposite case can easily be considered.

[9] For simplicity, we assume that upstream firms only sell to downstream firms. Allowing upstream firms to also sell to consumers would weaken the agglomeration forces but would not change the qualitative results.

We specify the equations of the model for the home country and note that the same equations hold for the foreign country, where a superscript * denotes a foreign variable.

Utility

The aggregate utility function, *U*, for the representative consumer is Cobb-Douglas, with exponents *s* and 1-*s*,

$$U = C_d^s C_a^{1-s} \qquad \textbf{(1)}$$

where C_d is aggregate consumption of final manufactured goods and C_a is consumption of agricultural goods. Aggregate demand for final manufactured goods can be represented by a quantity index or sub utility function, C_d, defined as

$$C_d = \left[\sum_i^{n_d} c_{di}^{\frac{\sigma-1}{\sigma}} + \sum_j^{n_d^*} (m_{dj}/\tau_d)^{\frac{\sigma-1}{\sigma}} \right]^{\frac{\sigma}{\sigma-1}} \qquad \textbf{(2)}$$

We assume that consumers have Dixit-Stiglitz preferences so there is a taste for variety; preferences are separable and homothetic. The elasticity of substitution between any pair of differentiated goods σ is assumed to be greater than 1. A consumer's utility is increasing in the number of varieties produced in the Home country, n_d, and the foreign country, n_d^*. Home consumers' demand for each variety produced in the Home country is given by c_{di}, and demand for imported varieties by m_{dj}. Imported goods incur a trade cost[10], which is modelled as Samuelsonian iceberg costs, with $\tau_d \geq 1$. This means that a proportion of imported goods, 1-$1/\tau_d$, melts in transit. Hence, to deliver one unit of any good from one country to another τ_d units must be shipped as only a fraction $1/\tau_d$ arrives. Thus m_{dj}/τ_d is the amount of good *j* that arrives in the Home country from the foreign country. If $\tau_d = 1$ there is free trade in final goods and if $\tau_d = \infty$ there is no trade in final goods. This form of trade costs takes account of the real resource costs used in importing and exporting goods without having to model a separate trade services industry.

Dual to the quantity index for final manufactured goods, the price index, P_d, is

[10] These trade costs are intended to reflect transport costs, communication costs and any other costs involved in international exchange that uses real resources. Alternatively, they could be reinterpreted as tariffs with the appropriate modifications to take account of income effects.

$$P_d = \left[\sum_i^{n_d} p_{di}^{1-\sigma} + \sum_j^{n_d^*} (p_{dj}^* \tau_d)^{1-\sigma} \right]^{\frac{1}{1-\sigma}} \quad \textbf{(3)}$$

where p_{di} is the producer price of good i and p_{di}^* is the free on board price of imported goods.

Manufacturing

Now consider the production technology in the manufacturing sector. We assume that there is a small fixed cost of setting up a plant, f, to produce any variety i. This gives rise to increasing returns technology; and the small size of f ensures that the number of varieties produced is large enough to make oligopolistic interactions negligible.

In the downstream industry, d, the production function for each variety of final manufactured good i is

$$L_{di}^{\delta} K_{di}^{1-\delta-\mu} C_u^{\mu} = f + \beta x_{di} \quad \textbf{(4)}$$

where L_{di} and K_{di} are the labour and capital amounts employed by downstream firm i to produce output, x_{di}. C_u is a quantity index aggregated across varieties of intermediate inputs, defined analogously to equation (2), with the subscript d replaced with u. Hence, industry u's output of intermediate inputs enters the production function of each downstream firm through a CES aggregator as in Ethier (1982) and Venables (1996). The share of intermediate inputs in production, μ, turns out to be a key parameter in this model, representing the vertical linkages between the two industries.

Similarly, in the upstream industry, u, the production function for each intermediate input variety i involves a fixed cost and a constant marginal cost, giving rise to economies of scale[11]:

$$L_{ui}^{\alpha} K_{ui}^{1-\alpha} = f + \beta x_{ui} \quad \textbf{(5)}$$

where L_{ui} and K_{ui} are the labour and capital amounts employed by upstream firm i to produce output x_{ui}.

Profits of each firm are given by total revenue less total costs. Profit for each downstream firm i, π_{di}, is given by

$$\pi_{di} = p_{di} x_{di} - w^{\delta} r^{1-\delta-\mu} P_u^{\mu} \left(f + \beta x_{di} \right) \quad \textbf{(6)}$$

where P_u is the price index of intermediate inputs, defined as in equation (3) with the subscript *d* replaced with *u*.

Profit for each upstream firm *i*, π_{ui}, is given by

$$\pi_{ui} = p_{ui}x_{ui} - w^{\alpha}r^{1-\alpha}\left(f + \beta x_{ui}\right) \quad \textbf{(7)}$$

We assume there is free entry and exit in both upstream and downstream industries, leading to zero profits.

Agriculture

The production function for the perfectly competitive agricultural industry is

$$X_a = L_a^{\gamma}K_a^{1-\gamma} \quad \textbf{(8)}$$

where γ is the share of labour in producing agriculture. Agricultural goods are assumed to be freely traded, with the price set equal to 1, P_a=1. Then the profit function can be written as:

$$\pi_a = X_a - w^{\gamma}r^{1-\gamma}X_a \quad \textbf{(9)}$$

Factors markets are assumed to be perfectly competitive and factors are fully employed.

III. EQUILIBRIUM OF THE MODEL

We solve for equilibrium in four steps. First, we solve the representative consumer's utility maximisation problem to derive the demand for final goods. Second, we solve the i^{th} firm's profit maximisation problem in each industry *k* to derive producer prices, and downstream firms' demand for intermediate inputs. Using the free entry and exit condition, we derive the number of units each manufacturing firm must produce to cover fixed cost. Third, we determine product market clearing conditions and fourth, solve the factor market clearing conditions.

Consumers

[11] For simplicity, we assume that *f* and β are the same in both upstream and downstream industries. Allowing them to differ changes the scale of production but does not affect the results.

First, we solve the representative consumer's utility maximising problem using two-stage budgeting. In stage 1 the consumer allocates expenditure between manufactured and agricultural goods by maximising the utility function (1) subject to the budget constraint $(Y = wL + rK)$, which gives:

$$C_a = (1-s)Y \quad \textbf{(10)}$$

$$P_d C_d = sY \quad \textbf{(11)}$$

In stage 2 the consumer maximises the sub utility function, C_d (equation 2), subject to the budget constraint, sY in equation (11), to derive demand functions for each variety of manufactured good *i* produced in the Home country and each imported variety *j* produced in the foreign country, respectively:

$$c_{di} = p_{di}^{-\sigma} P_d^{\sigma-1} sY \quad \textbf{(12)}$$

$$m_{dj} = \tau_d^{1-\sigma} p_{dj}^{*-\sigma} P_d^{\sigma-1} sY \quad \textbf{(13)}$$

Manufacturing

Second, let us turn to firms' behaviour in the manufacturing sector. Each firm in both the upstream and downstream industries chooses a variety *i* and its pricing so as to maximise profits, taking as given the variety choice and pricing strategy of the other firms in the industry. Each firm will produce a distinct variety since it can always do better by introducing a new product variety than by sharing in the production of an existing type.

In the downstream industry, each firm maximises profits with respect to quantity to derive producer prices:

$$\frac{\partial \pi_{di}}{\partial x_{di}} = 0 \Rightarrow p_{di} = w^{\delta} r^{1-\delta-\mu} P_u^{\mu} \beta \frac{\sigma}{\sigma - 1} \quad \textbf{(14)}$$

This gives the usual marginal revenue equals marginal cost condition, with price as a constant mark-up over marginal cost. We choose units of measurement so that $\beta\sigma = \sigma - 1$, then $p_{di} = w^{\delta} r^{1-\delta-\mu} P_u^{\mu}$. Given identical technology, all firms in the downstream industry within the same country set the same price so we can drop the *i* subscript. A proportion, δ, of downstream industry's revenue is spent on labour, $1\text{-}\delta\text{-}\mu$ on capital and μ on intermediate inputs. Hence total expenditure on upstream intermediate inputs is given by $e_u = \mu n_d p_d x_d$. The demand

functions for each variety of intermediate input *i* produced in the Home country and variety *j* imported from the foreign country are analogous to consumers' demand functions for final manufactured goods:

$$c_{ui} = p_{ui}^{-\sigma} P_u^{\sigma-1} e_u \quad \textbf{(15)}$$

$$m_{uj} = \tau_u^{1-\sigma} p_{uj}^{*-\sigma} P_u^{\sigma-1} e_u \quad \textbf{(16)}$$

Similarly in the upstream industry, each firm maximises profit with respect to quantity:

$$\frac{\partial \pi_{ui}}{\partial x_{ui}} = 0 \Rightarrow p_{ui} = w^{\alpha} r^{1-\alpha} \quad \textbf{(17)}$$

We can derive the number of varieties produced in each industry by imposing the free entry and exit condition, which leads to zero profits. This condition determines the quantity of output required to cover fixed costs:

$$\pi_{ki} = 0 \quad \Rightarrow \quad x_{ki} = \frac{f(\sigma-1)}{\beta} \quad k = u, d. \quad \textbf{(18)}$$

Firm size is scaled so that profits are equal to zero at size 1, by setting $f = 1/\sigma$. Note that the equilibrium scale of output is independent of price and the number of firms. This is a direct consequence of Dixit-Stiglitz preferences and a constant elasticity of substitution. Then the complementary slack condition implies that at least one of the following equations must hold with equality.

$$x_{ki} \leq 1 \qquad n_k \geq 0 \quad k = u, d. \quad \textbf{(19)}$$

For example, if output in industry *k* is less than one then firms would earn negative profits so the equilibrium number of firms in that industry would equal zero.

Agriculture

In the agricultural industry, profit maximisation implies price equals marginal cost[12]:

$$1 = w^{\gamma} r^{1-\gamma} \quad \textbf{(20)}$$

Equilibrium

Third, product market equilibrium requires that demand equals supply for each good in each industry[13].

[12] The constant term in the marginal cost function is suppressed to simplify notation.

$$x_{ki} = c_{ki} + m_{ki}^{*} \qquad k = u, d. \tag{21}$$

Fourth, factor market clearing conditions require that demand equals supply for each factor:

$$L = \gamma w^{-1} X_a + \alpha w^{-1} p_u n_u + \delta w^{-1} p_d n_d \tag{22}$$

$$K = (1-\gamma) r^{-1} X_a + (1-\alpha) r^{-1} p_u n_u + (1-\delta-\mu) r^{-1} p_d n_d \tag{23}$$

The factor market clearing conditions (equations (22) and (23)) and the product market clearing conditions below (equations (24) and (25)), derived by substituting equations (3), (12), (13), (15), (16), and (18) into (21)), together with the analogous foreign country equations, simultaneously solve for n_u, n_u^*, n_d, n_d^*, w, w^*, r and r^*. These equations will form the basis for analysing the effects of trade liberalisation on firms' location decisions and factor prices.

$$x_u = \frac{\mu\, n_d x_d w^{\delta} r^{1-\delta-\mu}}{p_u^{\sigma}\left[n_u p_u^{1-\sigma} + n_u^{*}(p_u^{*}\tau_u)^{1-\sigma}\right]^{\frac{\sigma-1+\mu}{\sigma-1}}} + \frac{\mu\, n_d^{*} x_d^{*} w^{*\delta} r^{*1-\delta-\mu}}{p_u^{\sigma}\tau_u^{\sigma-1}\left[n_u (p_u\tau_u)^{1-\sigma} + n_u^{*} p_u^{*1-\sigma}\right]^{\frac{\sigma-1+\mu}{\sigma-1}}} \tag{24}$$

$$x_d = \frac{s(wL + rK)}{n_d p_d + n_d^{*} p_d^{*1-\sigma} p_d^{\sigma} \tau_d^{1-\sigma}} + \frac{s(w^{*}L^{*} + r^{*}K^{*})}{n_d p_d + n_d^{*} p_d^{*1-\sigma} p_d^{\sigma} \tau_d^{\sigma-1}} \tag{25}$$

with $x_k \leq 1 \quad n_k \geq 0 \qquad k = u, d.$

IV. RESULTS

The results highlight that manufacturing firms consider two broad factors in deciding where to locate: large markets for their output (market access) and the availability of cheap inputs (production costs). In order to save on fixed costs, each firm prefers to locate in only one country. Other things equal, the preferred country is the one with the largest demand, in order to save on trade costs. Hence, downstream firms want to locate in a country with lots of consumers. Whereas upstream firms prefer to locate in a country with lots of downstream firms since they form the market for intermediate inputs. This gives rise to a demand linkage, drawing upstream firms to the same location as downstream firms. In turn, downstream firms

[13] By Walras Law we do not need to specify the equilibrium condition in the agricultural sector.

benefit from being close to a large number of upstream firms due to the cost linkage: the more upstream firms in a country the lower the cost of intermediate inputs. We can see this from equation (3), with subscript *d* replaced with subscript *u* - the price index, P_u, is decreasing in the number of upstream firms.[14] This cost linkage reinforces the demand linkage, giving rise to forces for an agglomeration of all upstream and downstream firms in one country.

However, there are two forces working against agglomeration. One, the immobility of final demand, given that labour and capital are internationally immobile, encourages the location of downstream firms in both countries. Two, given the differences in factor intensities between upstream and downstream firms, the production cost effect pulls them in opposite directions, with upstream firms drawn to the country that offers a relatively lower rental rate and downstream firms to the country that offers a relatively lower wage rate. These factor prices themselves depend on where firms locate.

Whether upstream and downstream firms agglomerate in one country depends on the relative importance of each force. The strength of these forces depends on the level of trade costs and the size of the vertical linkages. We begin by determining the equilibrium location of firms and factor prices when trade costs are very high, and then analyse the effects of reducing trade costs from these very high levels to low levels.[15]

Proposition 1: *There exists a high value of* $t_{u1}>1$ *and a high value of* $t_{d1} > 1$ *such that if* $\tau_u>t_{u1}$ *and* $\tau_d>t_{d1}$ *then* $n_u >0$, $n_u^*>0$, $n_d>0$ *and* $n_d^*>0$; *and* $w<w^*$ *and* $r>r^*$.

Proof: see Appendix.

At high levels of trade costs, both countries produce intermediate inputs and final manufactured goods. In this case, the wage rate is lower in the labour abundant Home country and the rental rate is lower in the capital abundant Foreign country.

[14] The cost linkage would also be present if the upstream industry was a Cournot oligopoly producing a homogeneous good. See Amiti (2001). In that case the larger the number of upstream firms the lower the price of intermediate inputs due to increased competition.

[15] Note that the free trade equilibrium is indeterminate given the number of freely traded goods (three) would be greater than the number of immobile factors of production (two). See Melvin (1968).

The proof of Proposition 1 is by contradiction. We evaluate the product market equilibrium conditions at $\tau_u \to \infty$, $\tau_d \to \infty$, set n_d=0, and then show that profits of downstream firms in the Home country are higher than in the Foreign country. Positive profits lead to entry of downstream firms in the Home country, hence n_d=0 cannot be an equilibrium. Using the same argument we show that the number of downstream firms in the Foreign country must also be positive; and the number of upstream firms in each country is positive. This result is consistent with a standard trade model. At high levels of trade costs, it is cheaper to be self-sufficient than to import varieties of intermediate inputs and final goods.

Given that both countries have identical tastes and technologies, the relative demands for labour to capital will be the same. Yet the Home country has a higher relative fixed endowment of labour to capital, hence its wage to rental rate must be lower.

Proposition 2: *There exists a unique equilibrium where all upstream and downstream firms agglomerate in the capital abundant Foreign country for some range of trade costs* τ_u, τ_d, *where* $t_{u1} > \tau_u > t_{u2} > 1$ *and* $t_{d1} > \tau_d > t_{d2} > 1$, *for some* $s < ½$ *and* $\mu > 0$, *and* $\alpha < \gamma$.

Proof: see Appendix.

If upstream firms are more capital intensive than the agricultural sector ($\alpha < \gamma$) and they are vertically linked to downstream firms ($\mu > 0$), then all upstream and downstream firms will agglomerate in the Foreign country for some range of trade costs when two conditions are satisfied. One, profits of an upstream firm must be higher in the Foreign country, given any initial distribution of upstream and downstream firms. Two, given all upstream firms are located in the Foreign country, profits of a downstream firm must be higher in the Foreign country, for any initial distribution of downstream firms. We discuss each of these in turn.

One, profits of an upstream firm are higher in the Foreign country than in the Home country, $\pi_u^* > \pi_u$ (see equations (A5) and (A6) in the Appendix), if

$$v_u = \frac{p_u}{p_u^*} = \left(\frac{w}{w^*}\right)^{\alpha} \left(\frac{r}{r^*}\right)^{1-\alpha} \geq \tau_u^{\frac{\sigma-1}{\sigma}} > 1 \qquad \textbf{(26)}$$

All upstream firms will locate in the Foreign country irrespective of where downstream firms are located if the factor cost advantage of locating there outweighs the trade cost of exporting intermediate inputs to the Home country. The condition in equation (26) is actually more stringent than is necessary[16] - profits may be higher in the Foreign country for higher levels of trade costs. The key point to note is that for low levels of trade costs on intermediate inputs, the production cost effect dominates the market access effect. Since upstream firms are assumed to be capital intensive, they place more weight on a lower relative rental rate than low relative wages. Hence, locating in the Foreign country where the rental rate is lower is more important than locating close to the market for intermediate inputs (where downstream firms locate).

We can see that the rental rate will be lower in the Foreign country if upstream firms are more capital intensive than the agricultural sector, $\alpha<\gamma$, and the share of manufactures in total consumption is low, $s<½$. This ensures that agriculture will be produced in both countries and hence factor prices are constrained by equation (20), where

$$w^{\gamma}r^{1-\gamma} = w^{*\gamma}r^{*1-\gamma} = 1 \Rightarrow \left(\frac{r}{r^{*}}\right)^{\frac{1-\gamma}{\gamma}} = \frac{w^{*}}{w} \qquad \textbf{(27)}$$

Equation (27) implies that both the rental and wage rate cannot be higher in any one country. Given that the Foreign country is assumed to be relatively capital abundant, we can ensure that $w^{*}>w$ and $r^{*}<r$. Substituting equation (27) into equation (26) we show that $\nu_u>1$ if $\alpha<\gamma$.

Two, given $n_u=0$ and $n_u^{*}>0$, profits of a downstream firm are higher in the Foreign country than in the Home country, $\pi_d^{*} > \pi_d$ (see equations (A8), (A9) and (A10) in the Appendix)[17], if

$$\nu_d = \frac{p_d}{p_d^{*}} = \left(\frac{w}{w^{*}}\right)^{\delta}\left(\frac{r}{r^{*}}\right)^{1-\delta-\mu}\tau_u^{\mu} \geq \tau_d^{\frac{\sigma-1}{\sigma}} > 1 \qquad \textbf{(28)}$$

Low values of trade costs on final goods also increases the importance of production costs relative to market access for downstream firms. Hence, locating in the country that offers the lowest production costs is more important than locating close to final consumer demand. However, it is not clear in which direction the production costs effect will draw them, since

[16] It is a sufficient but not necessary condition. See equation (A5) in the Appendix.
[17] Note that this is a sufficient but not necessary condition (see equation (A9) and (A10) in the Appendix).

downstream firms' production costs not only depend on relative wages and relative rental rates but also on the price of intermediate inputs (the cost linkage). If the vertical linkages are significant, high μ, then the cost linkage dominates and encourages downstream firms to locate in close proximity to upstream firms. With all upstream firms located in the Foreign country, the higher is τ_u and μ (equation (28)) the stronger the force pulling downstream firms to locate in the Foreign country where intermediate inputs are cheaper due to the saving on trade costs, and hence the more likely that agglomeration will be the equilibrium outcome.

However, the labour intensity of downstream firms can act as a force against agglomeration in the Foreign country.[18] The relative significance of wages in producing final goods depends on δ. The size and significance of the wage cost advantage offered by the Home country depends on the labour intensity of downstream firms relative to the agricultural sector. If downstream firms are less labour intensive than the agricultural sector, $\frac{\gamma}{1-\gamma} > \frac{\delta}{1-\delta-\mu}$, then the inequality in (28) will hold for some range of low values of τ_d, since $\left(\frac{w}{w^*}\right)^{\delta}\left(\frac{r}{r^*}\right)^{1-\delta-\mu} > 1$. That is, when the rental rate is significant in the downstream firms' production costs, they too will be drawn to the Foreign country where the relative rental rate is cheaper (and intermediate inputs are cheaper). However, this is not necessary for agglomeration. Even if downstream firms are more labour intensive than the agricultural sector, $\frac{\gamma}{1-\gamma} < \frac{\delta}{1-\delta-\mu}$, which implies $\left(\frac{w}{w^*}\right)^{\delta}\left(\frac{r}{r^*}\right)^{1-\delta-\mu} < 1$, the inequality in equation (28) will still hold provided the cost linkage outweighs the wage cost advantage in the Home country, leading to the agglomeration of upstream and downstream firms in the Foreign country.

With an agglomeration in the Foreign country, the number of upstream firms and downstream firms are given by setting $x_u^*=1$ and $x_d^*=1$ (and $n_u=n_d=0$) in equations (24) and (25):

[18] Note that if there were no vertical linkages, $\mu=0$, then for low values of τ_d the location of downstream firms would be entirely determined by factor costs, for example if $\delta>\gamma$ all downstream firms would locate in the Home country.

$$n_u^* = \left[\mu n_d^* \left(\frac{w^*}{r^*} \right)^{\delta - \alpha(1-\mu)} \right]^{\frac{\sigma-1}{\sigma-1+\mu}} \qquad n_d^* = \frac{s(Y+Y^*) n_u^{*\frac{\mu}{\sigma-1}}}{w^{*\delta+\alpha\mu} r^{*(1-\delta-\mu)+(1-\alpha)\mu}} \qquad \textbf{(29)}$$

From equation (29) we can see that the number of upstream firms is increasing in the number of downstream firms, and vice versa. This arises due to the demand and cost linkages between upstream and downstream firms. The results are illustrated in Figure 1, which shows the number of manufacturing firms in each country as a function of trade costs. [19] In this example, upstream and downstream firms agglomerate in the Foreign country when trade costs fall to 2.01.

Where will the agglomeration locate?

We have seen that upstream firms take account of two factors in deciding where to locate: the production cost effect, which is dominated by a low rental rate; and market access which is determined by the location of downstream firms (demand linkage). Whereas downstream firms effectively have to take account of three factors: the production cost effect that depends on low wage rates, and low priced intermediate inputs, determined by the location of upstream firms (the cost linkage); and market access, determined by the income of each country.

For low levels of trade costs on intermediate inputs and final goods, the production cost effect dominates the location decisions of both upstream and downstream firms. This production cost effect unambiguously draws upstream firms to the Foreign country. However, the production cost effect could draw downstream firms either to the Home country where wages are lower or to the Foreign country where intermediate inputs are cheaper, due to the cost linkage. If vertical linkages are strong, it is the cost linkage that will dominate. Note that if downstream firms are more labour intensive than the agricultural sector and trade costs are very low, the location of upstream and downstream firms will be based on comparative advantage as in the fragmentation literature. See *Proposition* 3 and the proof in the Appendix.

[19] The parameter values in the simulations generating Figures 1 and 2 are as follows: L=200, L^*=150, K=150, K^*=200, s=0.45, μ=0.6, α=0.1, δ=0.3, γ=0.5, σ=4, with $\tau_u=\tau_d=\tau$.

Higher values of τ_u could also promote agglomeration of upstream and downstream firms, but the location of the agglomeration will not necessarily be the Foreign country. The effect of increasing τ_u is to raise the importance of market access relative to the production cost effect for upstream firms, strengthening the demand linkage. In this case, the production cost effect drawing upstream firms to the Foreign country is weakened. Instead the market access effect drawing them close to downstream firms is strengthened. Hence where upstream firms locate depends on where downstream firms locate. A higher τ_u also strengthens the cost linkage, making it more important for downstream firms to be close to upstream firms. This implies that the agglomeration can occur in either the Home or the Foreign country, and will depend on the initial distribution of upstream and downstream firms, except in the following two cases.

One, if downstream firms have a very high labour intensity, then the wage rate becomes the most important factor determining location, drawing downstream firms to the Home country.[20] With a high level of τ_u, upstream firms would have to locate close to downstream firms, in which case the agglomeration of upstream and downstream firms would locate in the Home country.

Two, if the Home country is significantly larger than the Foreign country then the market access effect for downstream firms dominates, drawing all downstream firms to the Home country. Again, a high level of τ_u ensures that upstream firms locate in close proximity to downstream firms.

The implication of this result is that a large country like China or India is likely to also produce capital intensive intermediate inputs. Of course, the relative 'country sizes' not only depend on the exogenous factor endowments of labour and capital but also on the endogenous factor prices, which themselves depend on the location of firms.

Figure 2 gives the factor prices corresponding to the production patterns depicted in Figure 1. It illustrates the case where trade liberalisation leads to a tendency towards factor price equalisation. This is true if the agricultural sector's labour share is higher than the average of the upstream and downstream firms labour share, $\gamma > \alpha\mu + \delta$ (see Appendix) and agriculture is

[20] A high δ reduces the value of ν_d and can reverse the inequality in equation (A8) in the Appendix.

produced in both countries, which ensures that factor prices are constrained by equation (20), with $\left(\frac{r}{r^*}\right)^{\frac{1-\gamma}{\gamma}} = \frac{w^*}{w}$. Hence, if the wage to rental ratio in the Home country rises, the wage to rental ratio in the Home country must fall.

However, if the share of manufacturing in consumption is large enough so that agglomeration of upstream and downstream firms involves one of the countries only producing manufactures, for some s>½, it may end up with a higher rental rate and wage rate than the other country. With all (or most) of upstream and downstream firms agglomerated, say, in the Foreign country, $n_d \to 0$ and $n_u \to 0$, and all of the agricultural goods produced by the Home country, $X_a^* \to 0$, factor prices are given by:

$$w = \left(\gamma(1-s)(Y+Y^*)\right)/L\,; \qquad r = \left((1-\gamma)(1-s)(Y+Y^*)\right)/K \tag{31}$$

$$w^* = \left(\alpha\mu s(Y+Y^*) + \delta s(Y+Y^*)\right)/L^*\,;\; r^* = \left((1-\alpha)\mu s(Y+Y^*) + s(1-\delta-\mu)(Y+Y^*)\right)/K^*$$

Both the rental and wage rates are higher in the Foreign country under the following conditions:

$$r^*>r \text{ if } \left[\frac{s}{1-s}\frac{(1-\alpha)\mu+(1-\delta-\mu)}{1-\gamma}\right] > \frac{K^*}{K} \text{ and } w^*>w \text{ if } \frac{L}{L^*} > \left[\frac{(1-s)}{s}\frac{\gamma}{\alpha\mu+\delta}\right] \tag{32}$$

The rental rate is higher in the Foreign country if the demand for capital in Foreign relative to Home (the first bracketed term in equation (32)) exceeds the supply of capital in Foreign relative to Home. The supply of capital is given by the fixed factor endowments; and the demand depends on the factor intensities of the goods produced. Both factor prices are higher in the Foreign country provided that the average labour intensity of the combined upstream and downstream firms is not high relative to the agricultural sector. This case is depicted in Figure 3.[21] In this example, upstream and downstream firms agglomerate in the Foreign country when trade costs fall to 1.96, at which point the returns to both factors in the Foreign country (w^* and r^*) increase whereas in the Home country on wages increase (and the rental rate falls).

[21] The parameter values are the same as for Figures 1 and 2, except the share of manufactures is higher with s=0.55.

The interaction of the factor markets with the product market strengthens the forces for agglomeration. The more upstream firms in a country, the lower the price of intermediate inputs attracting more downstream firms (due to the cost linkage). The more downstream firms in a country the more upstream firms (due to the demand linkage). The more upstream and downstream firms, the higher the demand for labour and capital bidding up factor prices (as in Figure 3). The higher the factor prices, the higher is income and the higher the demand for final products, hence attracting even more downstream firms.

V. CONCLUSIONS

This paper shows that reducing trade costs can create forces that promote the agglomeration of vertically linked industries that differ in factor intensities to locate in one country. The benefits of close proximity between upstream and downstream firms sometimes outweigh the factor cost considerations. Hence, labour intensive firms may locate in capital abundant countries; or capital intensive firms may locate in labour abundant countries. This contrasts with predictions of a standard trade model.

When the share of manufacturing in consumption is low, then trade liberalisation tends towards factor price equalisation. However, this need not always be the case. If the share of manufacturing in consumption is so high that a country only produces manufacturing goods then trade liberalisation may lead to a rise in the return to both factors.

These results have quite important implications. Clearly, trade liberalisation need not always lead to a pattern of industry location based solely on comparative advantage. Indeed, once the country size effect is taken into consideration, vertical linkages among firms are likely to ensure that countries like Brazil, India and China are likely to produce not only labour intensive products but also a range of more capital products, thus ensuring a diversified manufacturing production structure. Further, even some small countries may end up attracting some types of agglomerations with trade liberalisation.

Appendix

It will be useful to define the following ratios:

$$\omega = \frac{w}{w^*},\ \rho = \frac{r}{r^*},\ \nu_u = \frac{p_u}{p_u^*} = \omega^{\alpha}\rho^{1-\alpha},\ \nu_d = \frac{p_d}{p_d^*} = \omega^{\delta}\rho^{1-\delta-\mu}\left[\frac{n_u\nu_u^{1-\sigma} + n_u^*\tau_u^{1-\sigma}}{n_u\nu_u^{1-\sigma}\tau_u^{1-\sigma} + n_u^*}\right]^{\frac{\mu}{1-\sigma}}.$$

Proof of Proposition 1

Number of firms:

Evaluate the product market equilibrium conditions at $\tau_u \to \infty$, $\tau_d \to \infty$.

(i) In the downstream industry at $\tau_d \to \infty$,

$$x_d \to \frac{sY}{n_d p_d} \qquad x_d^* \to \frac{sY^*}{n_d^* p_d^*} \qquad \textbf{(A1)}$$

If n_d=0 then $x_d > x_d^*$, so n_d=0 is not an equilibrium; if n_d^*=0 then $x_d < x_d^*$, so n_d^*=0 is not an equilibrium. Therefore n_d>0, n_d^*>0.

(ii) In the upstream industry at $\tau_u \to \infty$, $\tau_d \to \infty$,

$$x_u \to \frac{\mu\, n_d x_d w^{\delta} r^{1-\delta-\mu}}{p_u n_u^{\frac{\sigma-1+\mu}{\sigma-1}}} \qquad x_u^* \to \frac{\mu\, n_d^* x_d^* w^{*\delta} r^{*1-\delta-\mu}}{p_u^* n_u^{*\frac{\sigma-1+\mu}{\sigma-1}}} \qquad \textbf{(A2)}$$

Evaluated at n_d >0, n_d^*>0 (hence $x_d = x_d^* = 1$) if n_u=0 then $x_u > x_u^*$; if n_u^*=0 then $x_u < x_u^*$. Therefore n_u>0, n_u^*>0. QED

Factor prices:

At $\tau_u \to \infty$, $\tau_d \to \infty$, each industry's revenue only comes from domestic demand, hence $X_a = (1-s)Y;\quad p_d x_d n_d = sY;\quad p_u x_u n_u = \mu sY$. With Cobb-Douglas production functions, a constant share of revenue in each industry goes to labour and capital, hence the factor market conditions can be rewritten as:

$$L = \gamma(1-s)Yw^{-1} + \alpha\mu sYw^{-1} + \delta sYw^{-1}$$

$$K = (1-\gamma)(1-s)Yr^{-1} + (1-\alpha)\mu sYr^{-1} + (1-\delta-\mu)sYr^{-1}$$

Taking the ratio of L to K and rearranging:

$$\frac{L}{K}=\left(\frac{r}{w}\right)\left(\frac{\gamma(1-s)+\alpha\mu s+\delta s}{(1-\gamma)(1-s)+(1-\alpha)\mu s+(1-\delta-\mu)s}\right) \quad \textbf{(A3)}$$

From (A3), clearly $\frac{d(r/w)}{d(L/K)}>0$, hence $\frac{w}{r}<\frac{w^*}{r^*}$

With agriculture produced in both countries, the price equals average cost condition gives:

$$1=w^{\gamma}r^{1-\gamma}=w^{*\gamma}r^{*1-\gamma} \quad \textbf{(A4)}$$

$\Rightarrow w<w^*$ and $r>r^*$. This can be seen from (A4), which ensures that of the factor prices in a country cannot be higher than in the other country; and (A3), which ensures that the reverse inequalities cannot be true. *QED*

Proof of Proposition 2: **Agglomeration in the Foreign country**

For $n_u\to 0$, $n_u^*>0$, $n_d\to 0$, $n_d^*>0$ to be a unique equilibrium, two conditions must be satisfied.

(i) $x_u^*>x_u$ $\forall$ possible of n_d, n_d^*, n_u, n_u^*. Rearranging equation (24) and the analogous equation for the Foreign country, we see this is true if

$$f_u=x_u^*-x_u=\frac{n_d^*x_d^*\left[\tau_u^{\sigma-1}\nu_u^{\sigma}-1\right]}{\left[\nu_u^{1-\sigma}\tau_u^{1-\sigma}n_u+n_u^*\right]^{\frac{\sigma-1+\mu}{\sigma-1}}}+\frac{n_dx_d\omega^{\delta}\rho^{1-\delta-\mu}\left[\nu_u^{\sigma}-\tau_u^{\sigma-1}\right]}{\left[n_u\nu_u^{1-\sigma}+n_u^*\tau_u^{1-\sigma}\right]^{\frac{\sigma-1+\mu}{\sigma-1}}}>0 \quad \textbf{(A5)}$$

A sufficient, but not necessary, condition for this inequality to hold is

$$\nu_u=\left(\frac{w}{w^*}\right)^{\alpha}\left(\frac{r}{r^*}\right)^{(1-\alpha)}\geq\tau_u^{\frac{\sigma-1}{\sigma}}>1. \quad \textbf{(A6)}$$

This implies that both terms in (A5) are positive.

- $\nu_u>1$ if $\alpha<\gamma$, provided $w<w^*$ and $r>r^*$. To see this, first note that agriculture is produced in both countries for $s<1/2$, hence $1=w^{\gamma}r^{1-\gamma}=w^{*\gamma}r^{*1-\gamma}\Rightarrow\left(\frac{r}{r^*}\right)^{\frac{1-\gamma}{\gamma}}=\frac{w^*}{w}$ (and for sufficiently different relative factor endowments $w<w^*$ and $r>r^*$). Substituting this into (A6), we see that $\nu_u>1$ if $\alpha<\gamma$.

(ii) $x_d^*>x_d$ for $\forall$ possible n_d, n_d^*; and $n_u=0$. Rearranging equation (25) and the analogous Foreign equation, $x_d^*>x_d$ if

$$f_d = x_d^* - x_d = \frac{1}{n_d^* + n_d v_d^{1-\sigma}\tau_d^{1-\sigma}} + \frac{\overline{Y}}{n_d^* + n_d v_d^{1-\sigma}\tau_d^{\sigma-1}} - \frac{1}{n_d v_d + n_d^* v_d^{\sigma}\tau_d^{\sigma-1}} - \frac{\overline{Y}}{n_d v_d + n_d^* v_d^{\sigma}\tau_d^{1-\sigma}} > 0$$

(A8)

- Evaluating equation (A8) for $n_d \to 0$:

$$f_d(n_d \to 0) = \frac{[v_d^{\sigma} - \tau_d^{1-\sigma}] + \overline{Y}[v_d^{\sigma} - \tau_d^{\sigma-1}]}{n_d^* v_d^{\sigma}} > 0 \ \text{if} \ v_d^{\sigma} \geq \tau_d^{\sigma-1} \qquad \textbf{(A9)}$$

- Evaluating equation (A8) at $n_d^* \to 0$:

$$f_d(n_d^* \to 0) = \left[\frac{(\tau_d^{\sigma-1} v_d^{\sigma} - 1) + \overline{Y}(\tau_d^{1-\sigma} v_d^{\sigma} - 1)}{n_d v_d}\right] > 0 \ \text{if} \ v_d^{\sigma} \geq \tau_d^{\sigma-1} \qquad \textbf{(A10)}$$

- Evaluated at $n_u=0$, $v_d = \omega^{\delta}\rho^{1-\delta-\mu}\tau_u^{\mu}$. **(**Note that a sufficient but not necessary condition for $v_d>1$ is $\omega^{\delta}\rho^{1-\delta-\mu} > 1$, which is true if $\frac{\gamma}{1-\gamma} > \frac{\delta}{1-\delta-\mu}$. Even if $\omega^{\delta}\rho^{1-\delta-\mu} < 1$, ie $\frac{\gamma}{1-\gamma} < \frac{\delta}{1-\delta-\mu}$, there is a τ_u such that $v_d>1$).

- $$Sign\left[\frac{\partial f_d}{\partial(n_d / n_d^*)} \middle| \tau_d \to 1\right] = -Sign\left[\frac{v_d(v_d^{\sigma} - 1)(1+\overline{Y})}{((n_d / n_d^*)v_d + v_d^{\sigma})^2}\right] < 0 \ \text{if} \ v_d^{\sigma} > 1$$

Hence, for $\forall\ n_d, n_d^*$ (and $n_u=0 \Rightarrow v_d>1$) $f_d = x_d^* - x_d > 0 \ \text{if} \ \tau_d \leq v_d^{\frac{\sigma}{\sigma-1}}$. QED

Factor Price Equalisation

We show that if $\frac{w}{r}$ increases, then $\frac{w^*}{r^*}$ decreases.

Relative factor prices in Home

If $n_u=0$ and $n_d=0$, then factor prices in Home are given by:

$$w = \left(\gamma(1-s)(Y+Y^*)\right)/L; \qquad r = \left((1-\gamma)(1-s)(Y+Y^*)\right)/K \qquad \textbf{(A11)}$$

and the wage to rental ratio is given by:

$$\frac{w}{r} = \left(\frac{K}{L}\right)\left(\frac{\gamma}{1-\gamma}\right) \qquad \textbf{(A12)}$$

The wage to rental ratio in Home increases.

Comparing (A12) with the autarky factor price ration in equation (A3), the trade wage to rental ratio is higher if

$$\frac{\gamma}{1-\gamma} > \frac{\gamma(1-s)+\alpha\mu s+\delta s}{(1-\gamma)(1-s)+(1-\alpha)\mu s+(1-\delta-\mu)s} \quad \textbf{(A13)}$$

Rearranging, the inequality in equation (A13) holds if $\gamma > \alpha\mu+\delta$, that is the labour share in agriculture must be higher than that in the upstream and downstream industries.

The wage to rental ratio in the Foreign country decreases

If $\frac{w}{r}$ increases, then $\frac{w^*}{r^*}$ decreases, since $w^\gamma r^{1-\gamma} = 1$, if w increases, r must decrease. Then, from equation (A4), $\left(\frac{r}{r^*}\right)^{\frac{1-\gamma}{\gamma}} = \frac{w^*}{w}$, which implies that w^* decreases and r^* increases.

Agglomeration in the Home country

(i) $x_d > x_d^* \; \forall$ possible of n_d, n_d^*, n_u, n_u^* for some τ_u, τ_d.

$f_d = x_d^* - x_d < 0$ (equation A8) if $\nu_d < 1$, which may be true if δ is high and $\bar{Y}$ is high. In equations (A9) and (A10), we see that with these conditions the first term may still be positive but the second term becomes negative; the higher is $\bar{Y}$ the larger this negative term and hence the more likely that $f_d < 0 \Rightarrow n_d > 0$ and $n_d^* = 0$.

(ii) $x_u > x_u^*$ (ie $f_u < 0$) holds for $\forall$ possible n_u, n_u^*; and $n_d^* = 0$.

$f_u < 0$ at $n_d^* = 0$ if $\nu_u < \tau_u^{\frac{\sigma-1}{\sigma}}$. See equation (A5).

Proposition 3: Fragmentation *If* $\frac{\delta}{1-\delta-\mu} > \frac{\gamma}{1-\gamma} > \frac{\alpha}{1-\alpha}$ *and s<1/2 there exists a unique equilibrium where all upstream firms locate in the capital abundant country and all downstream firms locate in the labour abundant country for some range of trade costs* τ_u, τ_d, *where* $t_{u1} > t_{u3} > \tau_u > 1$ *and* $t_{d1} > t_{d3} > \tau_d > 1$.

For low τ_u and τ_d all upstream firms locate in Foreign and all downstream firms in Home.

- From (A5), we see that $x_u^* > x_u$ for low values of τ_u.
- From (A8), we see that for low values of τ_u and τ_d, provided that $\nu_d < 1$. For $\tau_u \to 1$, we see this is true if $\frac{\delta}{1-\delta-\mu} > \frac{\gamma}{1-\gamma}$ ie downstream more labour intensive than agriculture.

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Figure 1: Industrial Location

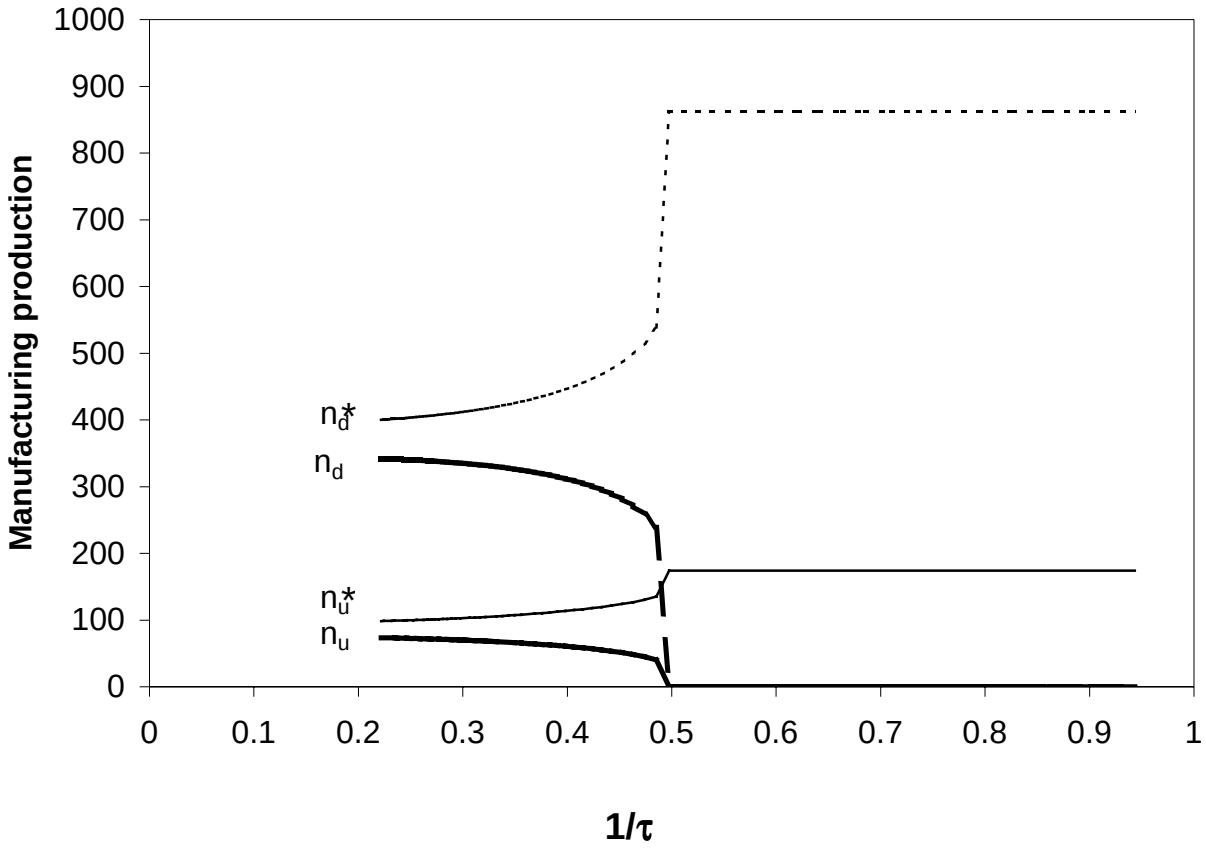

Figure 2: Factor Prices
Small manufacturing share

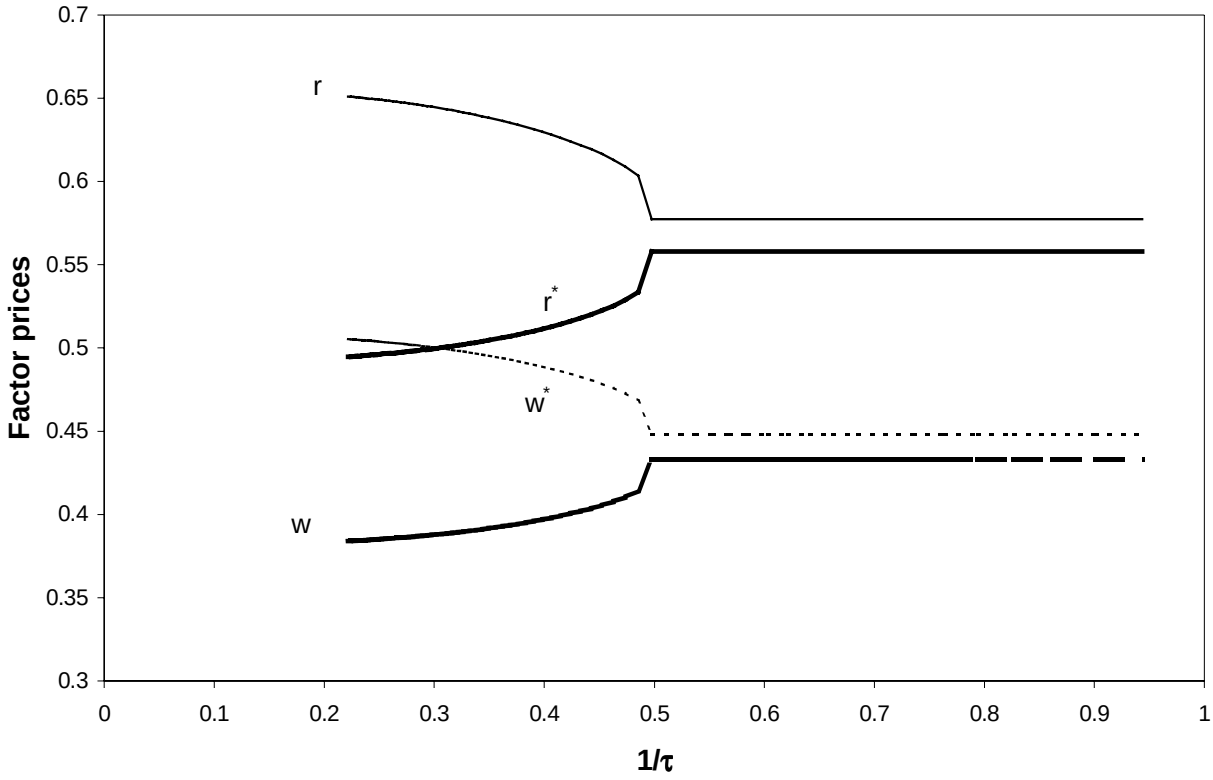

Figure 3: Factor Prices
Large manufacturing share