Economic Development with Economies of Agglomeration: FDI versus Import Substitution

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Abstract

We contrast FDI liberalization and import substitution as alternative development strategies in the presence of agglomeration economies. We first develop a two-country model where firm-level increasing returns and inter-firm linkages, stemming from the use of intermediates, generate external economies in manufacturing. With positive transport costs, such external economies are partly country-specific. Hence, industry agglomerates in one country (the North), while the other (the LDC) enjoys lower wages and welfare, as in Krugman & Venables (*QJE* 1995).

We then remove policy restrictions on inward FDI. Firms have an incentive to become multinationals (MNC) to reap gains from proximity to foreign customers. We show that MNC may be able to operate profitably in the LDC, even if indigenous firms cannot: the MNC's cost advantage, stemming from firm-level scale economies, helps them overcome the disadvantages of a small local industrial base. In turn, MNC entry expands this industrial base, encouraging further entry. Hence, MNC promote convergence in industrial structure and income. This may hurt the North, since its manufacturing output may contract, but always benefits the LDC.

In contrast, LDC tariffs increase both the domestic demand facing local manufacturers, *and* the cost of imported intermediates used in local production for both domestic *and* foreign markets. If potential export markets are relatively large, if tariffs mainly affect intermediates, or if production relies heavily on intermediates, the cost effect dominates and LDC tariffs reinforce the incentive for industry to cluster in the North. Intuitively, tariffs on intermediates reduce LDC firms' ability to exploit external economies generated abroad. Hence, conventional measures of the gains from trade can substantially underestimate the benefits of LDC trade liberalization.

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1. Introduction[2]

Over the last three decades, the growth performance of several less-developed countries (LDC), particularly in Sub-Saharan Africa, has been disastrous.[3] Recent theoretical work and some empirical evidence suggest that two factors in particular hamper industrialization and development.[4] First, the absence of even a minimal industrial base, and of the network of specialized inputs and business services which accompany it, may deter private investment. That is, failure breeds further failure.[5] Second, in an open-economy setting, while the existence of foreign markets and the availability of foreign inputs provide a spur to production, domestic entrepreneurs may be unable to compete with foreign firms. This is particularly likely if such firms are located in countries where specialized inputs are cheaper and more plentiful, and general business conditions are more favorable. In other words, industrial activity may tend to agglomerate in already developed countries.[6] Such points gain particular relevance in a world of increasingly mobile resources, where patterns of production can be driven by absolute as much as comparative advantage. Put differently, 'globalization' of the world economy is probably raising the payoff to successful economic strategies, but also increasing the costs of failure.

In such a context, what constitutes an appropriate economic policy? Since WW II, two broad strategies have been followed. 'Import-substitution' relied on domestic resources and markets to support industrialization. In contrast, 'outward-orientation' focused on participation in the world economy as a springboard towards development. It has frequently involved reliance not just on trade, but also on foreign direct investment (FDI); the examples of Singapore, Taiwan, and more recently the Mauritius are emblematic.[7]

Lately, the LDC policy consensus has shifted precipitously towards outward-orientation, and in particular towards openness to multinational corporations (MNC).[8] Recent empirical studies suggest this policy shift will yield major benefits.[9] However, there have been no comparable theoretical

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[3] World Bank (1998). For example, average African real per capita GDP remained constant over 1965–1990.

[4] In this paper, we treat industrialization, development, and LDC growth as synonymous. Sachs & Warner (1995b) provide empirical support for such a usage. We do analyze welfare explicitly.

[5] Rosenstein-Rodan (1943) and Hirschman (1958) provide early discussions of underdevelopment traps, Murphy *et al*. (1989) formalize the concept, and Matsuyama (1995) surveys other recent developments. Most relevant to this paper, Faini (1984), Okuno-Fujiwara (1988), Rodrik (1995), and Rodríguez-Clare (1996a) emphasize the role of firm-level increasing returns and of *nontradable* intermediates.

[6] Krugman & Venables (1995a, 1995b) and Venables (1996b) show that firm-level increasing returns and *transport costs* on intermediates can by themselves generate such an outcome. See Ciccone & Hall (1996), Hansen (1993), and Porter (1992) for evidence on the existence of localized (pecuniary) externalities in production.

[7] See Krueger (1994) for an overview of post-war development strategies, World Bank (1993) for East Asian policies and experiences, Romer (1992) for an analysis of the Mauritius and Taiwan.

[8] For instance, UNCTAD (1998,1999) reports that, during 1991–1998, 94 percent of the 895 changes in national FDI regimes were in a liberalizing direction; the liberalization process was particularly marked in developing and transition economies. As a result, FDI inflows into the non-OECD area rose from $34 billion in 1990 (17 % of global inflows) to $173 billion in 1997 (37 % of global inflows); in 1998 they only declined moderately, in spite of the Asian financial crisis and recession, to $173 billion (28 % of global inflows). See also World Bank (1998) and WTO (1996).

[9] Blomström & Kokko (1996) survey the evidence on the impact of MNC. Edwards (1998) and Sachs & Warner

developments. In particular, there are exceedingly few formal analyses of whether and how LDC liberalization of trade and / or inward FDI can break any 'underdevelopment trap', that is, trigger a sudden, discontinuous take-off into industrialization, or of the associated welfare implications. There are no analyses of how such policies operate when industrial activity tends to agglomerate—a serious failing, given that simultaneous liberalization throughout the developing world might well have a major impact on pre-existing global patterns of agglomeration. Our contribution lies in filling this surprising lacuna, thereby placing the policy consensus on a firmer footing.

We draw on the Krugman & Venables (1995a) two-country, general equilibrium model of trade. Firm-level increasing returns imply that industrial operations must reach some minimum size threshold to be profitable. The presence of 'intermediates', interpreted broadly to include capital goods, then creates 'vertical linkages' among industrial firms: whether one firm can reach the size threshold partly depends on whether other firms begin operations. Specifically, each firm can raise other firms' profitability both by providing productivity-enhancing inputs (a cost or 'forward' linkage), and by generating demand for such inputs (a demand or 'backward' linkage). Put differently, there are external economies in manufacturing.

With positive 'transport costs' on intermediates, interpreted broadly to include any gains from proximity to other firms, such external economies are partly country-specific. Industry then agglomerates in one country, the 'North', as long as transport costs (on final goods) are not too high, so that production is not tied to final markets, but transport costs (on intermediates) are not too low, so that proximity to other firms yields significant benefits. Industrial activity is especially likely to cluster in the larger country. In the other country, the LDC, the absence of a local industrial base, together with competition from established firms abroad, hampers industrialization and, crucially, reduces wages and welfare. In other words, we consider a setting where industrial agglomeration both occurs *and*, contrary to perfectly competitive trade models, has real welfare consequences.

Within this context, our contribution is threefold. First, we analyze how LDC trade policy influences agglomeration, industrial development, and welfare.[10] Second, we overlay a model of MNC and FDI.[11] As in Brainard (1993a), we let firms choose between exports and cross-border expansion as alternative modes of foreign market penetration. Firms have an incentive to become multinational so as to reap

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(1995a) assess the benefits of trade liberalization.

[10] Our analysis differs in four respects from Venables (1996a). First, our focus is on the recent, simultaneous liberalization of trade in most LDC, which as a group *can* affect industrial prices and output in the developed world. Hence, we model the possibility of global industrial agglomeration, and analyze how trade policy affects its likelihood. Second, and related, we examine how the impact of tariffs on the developed world feeds back onto the LDC. Third, we allow the protected manufacturing sector to export as well as import, show that this renders import substitution more likely to discourage industrialization, and that this effect is particularly pronounced when domestic markets are relatively small. Finally, we explicitly analyze the welfare implications.

[11] Hymer (1976) and Dunning (1993) provide classic discussions of MNC. Markusen (1995) and WTO (1996) survey more recent developments and summarize the main statistics. There are two dominant theories of MNC. Helpman (1984), Markusen (1991), Helpman & Krugman (1985), Grossman & Helpman (1991), Konan (1996), and Zhang (1996) see MNC as devices whereby firms which carry out activities with different factor requirements can take advantage of cross-country factor-price differentials. That is, they focus on *vertical* FDI, characterized by the geographical dispersion of different stages of production, e.g., American semiconductor FDI in South-East Asia.

In contrast, Markusen (1984), Horstmann & Markusen (1992), Brainard (1993a, 1993c), and Markusen & Venables (1995, 1996a, 1996b, 1999) view MNC expansion as driven by the benefits of closer proximity to customers. Such models focus on *horizontal* FDI, that is, the foreign production of goods similar to those the firm produces for its home market, e.g., Japanese car FDI in the U.S., U.S. and European car and chemical FDI in Latin America, and food and soft-drinks FDI throughout the world. Markusen & Venables (1996c) attempt to integrate these two approaches.

gains from proximity to their foreign customers, provided that establishing additional production plants abroad is not too costly.[12] Further, the presence of economies of multi-plant production, that is, firm-level economies of scale, can give MNC a cost advantage relative to other firms. We examine how FDI interacts with agglomeration, and how restrictions on multinational activity affect agglomeration, industrial development, and welfare.[13] Third, we analyze the interaction between trade policy and multinational investment.

Our key findings are as follows. MNC may be able to start profitable operations in the LDC, *even if* indigenous firms cannot. The reason is that the MNC's cost advantage helps them overcome the disadvantages of a small local industrial base. In turn, entry by MNC expands this industrial base, encouraging further entry. Contrary to a common prejudice, MNC therefore promote convergence in, and in extreme cases complete equalization of, industrial structure and income. This may hurt the North, which without MNC would capture a larger share of world industry, but always benefits the LDC. Hence, removing restrictions on MNC is an effective development strategy.

The mere finding that inward FDI promotes development is not *per se* astonishing. The mechanism we postulate, however, is different from the one commonly highlighted. In particular, in our model FDI has *nothing* to do with capital flows. Rather, MNC seek to attain greater proximity to their customers, and in the process promote the dispersion of industrial activity. Crucially, this can occur *even* when agglomeration forces make indigenous LDC production unprofitable. Put differently, the model provides microfoundations for the notion that MNC may emerge in equilibrium as a vehicle for transferring production technology to the LDC, helping them close the productivity gap with the North.

In contrast, LDC tariffs may *reinforce* the tendency for industry to agglomerate in the North. The reason is that tariffs affect firms in both their product and input markets. First, tariffs increase the *local demand* facing local manufacturers, and reduce that facing foreign firms. Second, tariffs increase the *cost* of imported intermediates used in local production for both the domestic *and* the foreign market. If potential export markets are large relative to the domestic market, if tariffs mainly affect intermediates, or if productions relies heavily on intermediates, then the impact on the total costs of local (relative to foreign) manufacturers dominates the impact on total demand. Here, LDC trade barriers reinforce existing agglomeration patterns and retard industrialization. With a strong cost effect, tariffs may even

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[12] That is, we focus on *horizontal* FDI. This accounts for almost all of world FDI [Markusen (1995)], and probably also for a majority of North-South FDI. For instance, UNCTAD (1996b) argues that Latin America has tended to attract FDI that was oriented towards the local market, and World Bank (1995a) finds that the ratio of exports to total sales of Japanese affiliates in the manufacturing sector in Latin America is only 23 %. Likewise, Dasgupta, Mody, & Sarbajit (1996) argue that Japanese MNC investing in Asia attach a higher priority to a large domestic market, the availability of skilled workers, and minimal restrictions on businesses, than they do to low wages. Again, *The Economist* argues that "American companies invest abroad mainly to serve foreign markets, rather than to produce finished or partly finished goods to ship back home. In 1992, about two-thirds of the sales of American companies' foreign subsidiaries took place in the regions in which they were based… American companies affiliates' in Asia increasingly serve that region's markets. Asia accounted for 62 % of those affiliates' sales in 1992, up from 41 % in 1982." Note that, in most studies, FDI is measured on a balance-of-payments basis using the IMF guidelines; Graham & Krugman (1995) discuss this measure and its main flaws.

[13] Our analysis differs in three main respects from Rodríguez-Clare (1996b) and Markusen & Venables (1999). First, we do not focus on a single country, but rather examine a fully specified multi-country model. In particular, we model the possibility of global industrial agglomeration, and analyze how FDI affects its likelihood. Second, we do not assume that MNC enjoy preferential access to intermediates produced abroad (put differently, we assume that indigenous firms and MNC subsidiaries have the same propensity to source inputs locally). Rather, the MNC's cost advantage stems from their ability to reap firm-level scale economies. Third, and related, we focus on horizontal rather than vertical FDI. The former is less likely to involve the establishment of unskilled-labor–intensive 'screwdriver' operations, and is therefore more likely to promote industrialization.

discourage multinational activity. Conversely, liberalization can destroy the tendency for industry to cluster in the North, inducing a discontinuous increase in LDC output and welfare.

Put differently, agglomeration arises because, if intermediates are subject to transport costs, external economies in manufacturing are partly country-specific. Tariffs on intermediates further 'localize' these external economies, that is, reduce the ability of LDC firms to exploit external economies generated elsewhere. This is particularly devastating for small countries, which cannot themselves generate significant external economies, and where any tariff-induced changes in domestic demand are relatively less important. Conversely, liberalization of intermediate trade partially 'globalizes' external economies, that is, increases their effective geographical reach, which reduces the cost disadvantage of LDC firms.

In this context, it is worthwhile noting that India, Brazil, and Argentina, three of the most important and influential LDC, together with countless others, have long protected their intermediate- and capital-goods industry,[14] on the explicit grounds that such goods generate substantial forward linkages.[15] Ironically, we show this is *precisely* why such protection can hamper industrialization!

Again, the mere finding that tariffs can retard industrialization by increasing the cost of imported intermediates is not *per se* surprising. It was emphasized, for instance, by the 'effective protect literature [Corden (1971)]. The mechanism we highlight, however, is new: LDC tariffs strengthen the tendency for industry to agglomerate elsewhere, that is, they encourage a cumulative, self-reinforcing process of differentiation in production. Further, the impact is particularly pronounced in *small* countries—a prediction conspicuously absent from perfectly competitive models. The point is that, once we allow for imperfect competition, the import-competing sector can also export in equilibrium. Tariffs on intermediates increase the cost of production for export, with no offsetting impact on export (as opposed to domestic) demand. This particularly discourages production in small countries, where potential export markets are large relative to domestic markets.

All this yields two related corollaries. First, agglomeration effects, stemming from the use of intermediates, greatly weaken the case for 'import protection as export promotion' in the LDC. Second, conventional measures of the gains from trade, based on perfectly competitive models with no potential for agglomeration, can substantially underestimate the benefits of LDC trade liberalization.

The rest of this paper is organized as follows. Section 2 presents the formal model. Section 3 derives the equilibrium conditions. Section 4 sets the stage for the analysis by describing the equilibrium in the absence of MNC and of LDC tariffs. Section 5 examines the impact of LDC tariffs. Section 6 analyzes the effect of removing restrictions on MNC, and elaborates on the relationship between globalization, transport costs, and multinational activity. Section 7 discusses how the presence of MNC affects the impact of trade policy. Section 8 concludes. The Appendices demonstrate all the stated Propositions and other results.

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[14] DeLong & Summers (1993) document the resulting impact on the relative price of investment goods and equipment. They also demonstrate this had a significant effect on total equipment investment and on growth.

[15] For instance, Nehru, quoted in Srinivasan (1994), argued 'No modern nation can exist without certain essential articles which can be produced only by big industry… Big industry must be encouraged and developed as rapidly as possible… It should be heavy and basic industry, which is the foundation of a nation's economic strength and on which other industries can gradually be built up.'

2. The Model

2.1. Outline

The two countries, N (North) and S (South), are identical in preferences and technology. There is only one primary factor, labor. Hence, we may abstract from comparative advantage. Workers and consumers are immobile across countries. There are two sectors, agriculture and manufacturing. Agricultural goods are homogeneous and are produced under constant returns. In contrast, manufactures are differentiated and subject to increasing returns. The manufacturing sector produces both final goods, which are sold to consumers, and intermediates, which are used as inputs in the production of other manufactures.

There are two types of manufacturing firms: national enterprises (NE) and multinational corporations (MNC). NE produce in a single country, but sell in both. MNC produce and sell in both countries. There are increasing returns at the firm level, owing to some input, such as R&D, advertising, or corporate planning, that can be spread among any number of production facilities with undiminished value. There are also scale economies at the plant level, so that concentrating production lowers unit costs.

NE incur transport costs on foreign sales. The transport costs represent any disadvantage of locating far from customers and suppliers, such as slow responsiveness to changing market conditions, shipping and warehousing expenses, the risk of damage to fragile or perishable products, and linguistic or cultural differences. MNC do not export and hence avoid transport costs. However, they must establish additional production plants abroad, and therefore incur greater plant-level fixed costs. Also, MNC incur greater coordination and communication costs (as emphasized by Hymer (1976)).

2.2. Consumption

The representative consumer in both countries has identical, homothetic preferences between the two types of goods. We adopt the Cobb-Douglas specification

$$U = C_A^{1-g} C_M^{g}, \tag{1}$$

where U is utility, C_A is consumption of agricultural goods, C_M is consumption of manufactures, and g is the share of manufactures in total expenditure.

Agricultural goods are homogeneous. Manufactures are a composite of a large number of symmetric product varieties, with a constant elasticity of substitution $s > 1$ between any two varieties:

$$C_M = \left[\sum_{i=1}^{N} c_i^{(s-1)/s} \right]^{s/(s-1)}, \tag{2}$$

where c_i is the quantity consumed of variety i, and N is the total number of unique varieties available worldwide.

These preferences can be described using the expenditure function

$$E = P_A^{1-g} P_M^{g} U, \tag{3}$$

where E is total consumption expenditure, P_A is the consumer price of agricultural goods, P_M is the true or 'ideal' consumer price index for manufactures, and U is utility. Agricultural goods are traded costlessly, and are the numéraire: $P_A \equiv 1$. In what follows, for any given country j, let $j\_$ denote the other country:

$$j\_ = N, \text{ if } j = S,$$
$$= S, \text{ if } j = N. \quad \textbf{(4)}$$

Manufactured varieties can potentially be supplied by two types of firms, national enterprises (NE) and multinational corporations (MNC). NE produce in a single country, but sell in both. Each country j is home to n_j NE. In equilibrium, these all set the same f.o.b. price p_j. Foreign sales incur 'iceberg' transport costs at rate T, i.e., a proportion $1/T$ of the good arrives, so that the c.i.f. price is $(p_j\, T)$. Also, foreign sales bear *ad valorem* tariffs at rate $t_{j\_}$, so that the price to foreign consumers is $(p_j\, T\, t_{j\_})$.

There are m MNC, which produce and sell in both countries. MNC do not incur trade costs, but may face different marginal production costs in each location. In equilibrium, their price in each market equals that set by domestic NE, p_j. Hence, the ideal price index for the composite manufacture is

$$P_{Mj} = [(n_j + m)\, p_j^{1-s} + n_{j\_}\, (p_{j\_}\, T\, t_j)^{1-s}]^{1/(1-s)},\ j = N, S. \quad \textbf{(5)}$$

2.3. Production

Each country is endowed with L_j units of labor, earning a wage w_j. Agriculture is perfectly competitive, and uses only labor with constant returns to scale. We choose units so that one unit of labor produces one unit of agricultural output Q_A, yielding the constraint

$$w_j \geq 1,\ Q_{Aj} \geq 0,\ \text{complementary slack (c.s.)},\ j = N, S. \quad \textbf{(6)}$$

Manufacturing firms produce output by combining labor and a composite manufactured intermediate, using a Cobb-Douglas technology with intermediate share m. Let the composite intermediate be the same as the composite manufactured consumption good. Then, the price index for the intermediate is P_M, as defined in (5). Production involves firm-level fixed 'R&D' costs, F; plant-level fixed costs, G for NE and 2 $(G + H)$ for MNC, where H reflects the extra coordination costs of MNC; and constant marginal costs, V. All costs are measured in units of the aggregate input bundle.

When MNC exist, they meet their fixed input requirements by drawing on the factor markets of all the countries in which they operate, in proportion to the cross-country division of output.[16] All other inputs are drawn from the local factor markets. Let q_D and q_X denote, respectively, domestic sales and exports. Let TC_j^N, TC_j^M, and TC^M denote, respectively, total costs for country j NE, total costs incurred by MNC in country j, and total costs for MNC. Then,

$$TC_j^N = w_j^{1-m}\, P_{M,j}^m \left[F + G + V\left(q_{D,j} + q_{X,j}\right)\right],\ j = N, S, \quad \textbf{(7)}$$

$$TC_j^M = w_j^{1-m}\, P_{M,j}^m \left\{\left[F + 2\left(G + H\right)\right]\left(\frac{q_{D,j}}{q_{D,j} + q_{D,j\_}}\right) + V\, q_{D,j}\right\},\ j = N, S, \quad \textbf{(8)}$$

$$TC^M = \sum_j TC_j^M. \quad \textbf{(9)}$$

3. Equilibrium

Let E_M denote total expenditure on manufactures. Domestic and foreign demand for each variety take the form

$$q_{Dj} = p_j^{-s}\, P_{Mj}^{s-1}\, E_{Mj},\ j = N, S, \quad \textbf{(10)}$$

[16] Since we do not distinguish MNC according to their country of origin, this is the natural assumption to make. It also accords well with the empirical evidence that most MNC, and in particular those based outside Japan, are increasingly decentralizing corporate activities such as R&D and recruitment.

$$q_{Xj} = p_j^{-s}\, T^{1-s}\, t_{j\_}^{-s}\, P_{Mj\_}^{s-1}\, E_{Mj\_},\ j = N, S. \quad \textbf{(11)}$$

In each market, NE mark up f.o.b. prices over marginal cost by a factor $s / (s - 1)$. MNC do the same, provided that fixed costs are allocated before output levels are chosen. Hence,

$$p_j = [s / (s - 1)]\, w_j^{1-m}\, P_{Mj}^{m}\, V,\ j = N, S. \quad \textbf{(12)}$$

With free entry and exit, there is a zero-profit condition. Given the constant elasticity of demand, this establishes a unique size for each firm type:

$$q_{Dj} + q_{Xj} \le (s - 1)(F + G) / V \equiv q_n,\ n_j \ge 0,\ \text{c.s.},\ j = N, S, \quad \textbf{(13)}$$
$$\textstyle\sum_j q_{Dj} \le (s - 1)[F + 2(G + H)] / V \equiv q_m,\ m \ge 0,\ \text{c.s.} \quad \textbf{(14)}$$

We rewrite (13) and (14), using (10) and (11), as

$$p_j^{-s}\,(P_{Mj}^{s-1} E_{Mj} + T^{1-s}\, t_{j\_}^{-s}\, P_{Mj\_}^{s-1} E_{Mj\_}) \le q_n,\ n_j \ge 0,\ \text{c.s.},\ j = N, S, \quad \textbf{(15)}$$
$$\textstyle\sum_j (p_j^{-s}\, P_{Mj}^{s-1} E_{Mj}) \le q_m,\ m \ge 0,\ \text{c.s.} \quad \textbf{(16)}$$

MNC incur higher fixed costs than NE. In any zero-profit equilibrium, MNC therefore need to operate at a larger scale: $q_m \equiv q_n + (s - 1)(G + 2H) / V > q_n$. But since MNC avoid transport costs and tariffs, they may be able to achieve this greater scale.

We assume that all tariff revenues are dissipated in a waste of real resources, as in rent-seeking models.[17] Since there are no profits, the representative consumer's total income then equals his labor income. Hence, the budget constraint is

$$E_j = w_j L_j,\ j = N, S. \quad \textbf{(17)}$$

Total expenditure on manufactures is

$$E_{Mj} = g E_j + m (n_j TC_j^{N} + m TC_j^{M}),\ j = N, S. \quad \textbf{(18)}$$

The first term on the R.H.S. is consumers' expenditure on manufactures. The second term is intermediate demand; intermediates account for a fraction m of total costs. With no profits, NE's total costs equal their total revenues. Using (17),

$$E_{Mj} = g w_j L_j + m (n_j p_j q_n + m TC_j^{M}),\ j = N, S. \quad \textbf{(19)}$$

Let L_M denote manufacturing employment. The manufacturing wage bill accounts for a fraction $(1 - m)$ of firms' costs:

$$\begin{aligned} w_j L_{Mj} &= (1 - m)(n_j TC_j^{N} + m TC_j^{M}),\ j = N, S, \\ &= (1 - m)(n_j p_j q_n + m TC_j^{M}),\ j = N, S,\ \text{by (13)}. \end{aligned} \quad \textbf{(20)}$$

By (8), using (14),

$$TC_j^{M} = w_j^{1-m}\, P_{Mj}^{m}\, [(F / q_m + V)\, q_{Dj} + (G + H)],\ j = N, S. \quad \textbf{(21)}$$

Finally, factor-market clearing and (6) imply

$$w_j \ge 1,\ L_j \ge L_{Mj},\ \text{c.s.},\ j = N, S. \quad \textbf{(22)}$$

Equilibrium is characterized by (5), (10), (12), (15), (16), (19), (20), (21) and (22). These 17 equations yield the equilibrium values of P_{Mj}, q_{Dj}, p_j, n_j, m, E_{Mj}, L_{Mj}, TC_j^{M} and w_j.

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[17] Appendix IV allows tariff revenues to be redistributed to the representative consumer in a lump-sum fashion.

4. Equilibrium with Neither Multinationals Nor LDC Tariffs

For now, we assume there are prohibitive restrictions on multinational activity: $m \equiv 0$. We also normalize the equilibrium output of active NE to unity: $q_n \equiv 1$. (5), (15), (19), and (20) reduce to

$$P_{Mj} = [n_j p_j^{1-s} + n_{j\_} (p_{j\_} T t_j)^{1-s}]^{1/(1-s)}, \; j = N, S, \tag{23}$$

$$p_j^{-s} (P_{Mj}^{s-1} E_{Mj} + T^{1-s} t_{j\_}^{-s} P_{Mj\_}^{s-1} E_{Mj\_}) \leq 1, \; n_j \geq 0, \text{ c.s., } j = N, S, \tag{24}$$

$$E_{Mj} = g w_j L_j + m p_j n_j, \; j = N, S, \tag{25}$$

$$w_j L_{Mj} = (1 - m) p_j n_j, \; j = N, S. \tag{26}$$

Equilibrium is characterized by (12), (22), (23), (24), (25) and (26). These 12 equations yield the equilibrium values of p_j, w_j, P_{Mj}, n_j, E_{Mj}, and L_{Mj}. Krugman & Venables (1995a) corresponds to the special case of (symmetric) transport costs but no tariffs, and equal labor endowments: $L_j \equiv L \equiv 1$. For readers unfamiliar with their model, in section 4.1 we recapitulate their findings concerning the possibility of agglomeration, and in section 4.2 we extend their findings on the impact of developed-country tariffs. Then, in section 5, we analyze LDC tariffs. Surprisingly, their effects are very different from those of developed-country tariffs.

Note first that an increase in n_j, the number of manufacturing firms in any given country, affects the profitability of other manufacturing firms in that country through four different channels. First, an increase in n_j intensifies *product-market competition*: it reduces the price indices P_M, by (23), which shifts down each firm's demand curve, by (10) and (11), and reduces firms' profitability, by (24). Second, an increase in n_j strengthens *factor-market competition*: it raises manufacturing labor demand, by (26), which in general acts to increase the manufacturing wage. However, assuming that agricultural labor demand is perfectly elastic, this effect only operates if the economy is fully specialized in manufacturing.

The third and fourth channels only operate if m is positive, i.e., manufacturing uses manufactures as an input. The *cost* or *forward linkage* arises because a greater variety of available intermediates lowers the cost of production of final goods. That is, an increase in n_j reduces P_{Mj}; this reduces total and marginal costs, by (7) and (12), and raises firms' profits. The *demand* or *backward linkage* arises because a larger final-goods sector increases the size of the market for intermediates. That is, an increase in n_j raises demand for manufactured intermediates and total expenditure on manufactures E_{Mj}, by (25). This raises each firm's demand curve, by (10), and increases firms' profitability, by (24). These two linkages gives rise to external economies in manufacturing and create the potential for a self-reinforcing process of agglomeration.

4.1. Equilibrium without Tariffs

Without tariffs, the model is characterized by two different types of equilibria. At high trade costs, the external economies are dominated by the need to be near final consumer demand. There is a unique, stable, *non-specialized equilibrium*. Each country produces both agricultural goods and manufactures, has a wage equal to unity, and allocates a fraction g of its workforce to manufacturing, where g is the manufacturing share in final consumption. There is no inter-industry trade, but only two-way trade in manufactures.

At medium trade costs, the linkages are strong enough to create a second, stable, *specialized equilibrium*. If $g \leq 1/2$, all manufacturing agglomerates in a single country, which also produces agricultural goods, and wages in both countries again equal unity. Here, world manufacturing demand is small enough to be met from a single location. But if the manufacturing sector is large enough, i.e., $g > 1/2$, one country completely specializes in manufacturing and, through the self-reinforcing

advantages of backward and forward linkages, enjoys higher wages. Any further demand for manufacturing is met by the other country; international wage differentials offset the locational disadvantage suffered by its firms, distant from their markets and suppliers.

At even lower trade costs, and specifically once T falls below the critical value

$$T^* \equiv \left\{\left(\frac{1+m}{1-m}\right)\left[\frac{s\,(1+m)-1}{s\,(1-m)-1}\right]\right\}^{1/(s-1)}, \qquad \textbf{(27)}$$

the external economies are powerful enough to make the non-specialized equilibrium unstable.[18] Only the specialized equilibrium, characterized by manufacturing agglomeration, is stable. Hence, the world economy spontaneously organizes itself into an industrialized core and a deindustrialized periphery.

Figure 1 illustrates the stable equilibria for a range of transport costs. For each country, we graph welfare, i.e., wages divided by the ideal consumer price index; wages; manufacturing output; and manufacturing employment. Throughout, we drop the subscript identifying the North. The abbreviation 'SPZD' denotes the specialized equilibrium; all other curves refer to the non-specialized equilibrium. In the specialized equilibrium, we assume the North is the 'developed' country, (completely) specialized in manufacturing, whereas the South is the LDC, specialized in agriculture.

With high transport costs, the North and South are symmetric. Both have an active agricultural sector, and the same wages and welfare. Reducing transport costs creates an interval in which there are multiple equilibria. Eventually, the world economy develops an asymmetric structure. Here, welfare rises in the North while falling in the South. Specifically, Southern wages stay at unity. However, the South imports a higher proportion of manufactures, incurring greater transport costs. This raises the consumer price index and reduces welfare. In contrast, Northern wages rise because of the increase in manufacturing labor demand. In addition, a smaller proportion of manufactures is imported, reducing trade costs and further increasing welfare.

As transport costs fall further, the importance of being close to markets and suppliers, and hence the strength of backward and forward linkages, decline. Meanwhile, the South offers potential producers the advantage of a lower wage. Eventually, this lower wage more than offsets the disadvantage of being remote from markets and suppliers. Then, firms gradually relocate to the South and Northern wages decline. Both effects reduce the consumer price index and raise welfare in the South. They also act to reduce Northern welfare. However, the reduction in trade costs directly reduces the Northern consumer price index. Hence, Northern welfare may rise or fall. In Figure 1, it falls as trade costs are brought down to very low levels.

In Figure 2, the share of manufactures in final demand is raised. This increases the amount of manufacturing in the South, reducing welfare differences. In Figure 3, the share of intermediates in manufacturing is raised. Agglomeration forces are now stronger; indeed, there is a range of transport costs over which all manufacturing is concentrated in the North. Hence, the welfare differential increases.

These numerical results are based on particular parameter values. However, the model generically predicts an initial separation into core and periphery, followed by a return to factor price equalization. Specifically, let

$$m \in (0, (s-1)/s) \;\Leftrightarrow\; m > 0,\;\; s\,(1-m) > 1. \qquad \textbf{(A1)}$$

[18] Throughout this paper, we discuss 'stability' in its static sense, i.e., with reference to 'naive Marshallian' dynamics.

m measures the share of intermediates in costs, and thus the importance of backward and forward linkages. In equilibrium, s is an inverse index of the degree of economies of scale. Hence, (A1) states that linkages are positive, but places limits on combining strong linkages with large economies of scale.

Given this upper bound on the strength of linkages, for all sufficiently large (but finite) values of T, only the symmetric, equal-welfare equilibrium exists, and it is stable. But given positive linkages, $m > 0$, there always exists a critical value of T below which the symmetric equilibrium is unstable. Finally, as $T \to 1$, the welfare differential across countries always disappears. Hence, the U-shaped response of relative welfare to transport costs is robust to parameter changes.

Put differently, a reduction in transport costs exerts two competing effects. Lower trade costs on final goods reduce the need to be near final demand and *encourage* clustering. In contrast, lower trade costs on intermediates reduce the benefits of proximity to other firms and *discourage* clustering. The interaction between these two forces generates a nonlinear response. To the extent that transport costs are falling faster for final goods, clustering occurs earlier and persists for longer. If instead transport costs are falling faster for intermediates, clustering occurs later or not at all.

4.2. Developed-Country Tariffs

Assume first that the world is initially in a symmetric, non-specialized equilibrium, and let the North impose tariffs on manufactured imports. The tariffs both weaken Southern firms' access to Northern markets, *and* increase the price Northern firms have to pay for Southern intermediates. However, the initial symmetry implies that, overall, the relative profitability of producing in the North increases, as shown in Appendix I:

Proposition 1. Consider the neighborhood of any (stable) symmetric equilibrium of the world economy, and let a country raise its tariffs. Then, (i) Its manufacturing industry expands relative to other country's. Further, at least for sufficiently low tariffs, (ii) Its manufacturing industry expands in absolute terms. (iii) The other country's manufacturing industry contracts in absolute terms. (iv) The lower the initial level of trade barriers, the greater the absolute magnitude of the expansions and contractions.

Intuitively, let Northern firms initially import a fraction x of their intermediates, now subject to tariffs. By symmetry, Southern firms must initially have exported at least a fraction x of their sales (more with strictly positive transport costs), now also subject to tariffs. Since the value of final sales exceeds the value of purchased intermediates, Southern firms are hit harder by the tariffs. Hence, manufacturing shifts from the South to the North. In addition, tariffs may induce substitution away from manufactures, and hence a contraction in manufacturing for the world as a whole. However, at least if tariffs are initially low, this effect is dominated by the impact of production-shifting. Hence, in this case, import protection can indeed act as export promotion.

Our conclusions are strengthened if an increase in tariffs raises total domestic tariff revenues, and if the greater revenues feed through into greater domestic income and manufacturing expenditure. To see this, note from (24) that, starting from any symmetric equilibrium with strictly positive trade barriers, an increase in domestic manufacturing expenditure benefits domestic firms relative to foreign firms—the 'home market' effect.

As a corollary, let $T^*(t)$ denote the critical value of T at which the non-specialized equilibrium becomes unstable in the presence of tariffs. At least for low tariffs,

$$T^*(t) > T^*. \qquad \textbf{(28)}$$

Assume instead that the world is initially in a specialized equilibrium, and let the North be the 'developed country', (completely) specialized in manufacturing. Northern tariffs now discourage Southern production even more, for two reasons. First, Southern firms now produce relatively fewer intermediates. Hence, the fact that Northern firms pay tariffs on intermediate imports translates into a smaller cost disadvantage. Second, Northern wages and manufacturing output are now larger relative to their Southern equivalents. This implies that both final and intermediate relative Northern demand for manufactures, and therefore the relative total size of the Northern market, are now larger. Hence, the fact that Southern firms enjoy worse access to this market implies an even larger demand disadvantage.

Figure 4 illustrates these results. We contrast the no-tariff equilibria with the equilibria under Northern tariffs, using the same underlying parameters as Figure 1. The abbreviation 'SPZD' denotes the specialized equilibrium, and the abbreviation 't_N' denotes the equilibria under Northern tariffs. In any equilibrium, Northern tariffs reduce Southern manufacturing output and employment. In the non-specialized equilibrium, tariffs also increase Northern manufacturing output and employment. In the specialized equilibrium, by definition, Northern manufacturing employment cannot rise; increased demand for Northern manufactures translates instead into an increase in Northern wages and (for these parameters) welfare.

5. The Impact of LDC Tariffs

Again, assume that the world is initially in a specialized equilibrium, and let the South be the 'less developed country', (relatively) specialized in agriculture. As discussed, Northern tariffs encourage Northern production. However, Southern tariffs need not encourage Southern production, for two reasons. First, Northern firms produce relatively more intermediates. Hence, the fact that Southern firms pay tariffs on intermediate imports translates into a larger cost disadvantage. Second, Southern wages and manufacturing output, hence final and intermediate demand, and therefore total market size are smaller. Hence, the fact that Northern firms enjoy worse access to this market implies a smaller demand disadvantage.

More formally, let the South initially produce no manufactures at all (necessary and sufficient conditions for this are derived below). The impact of tariffs can then be decomposed into four effects. The first two arise even in a small-economy context, whereas the latter two reflect the impact of tariffs on the Northern economy and the consequent feedback upon the South. We first treat the North as parametric, and then derive the full equilibrium for the global economy. Appendix II proves all the stated results.

5.1. The 'Small Economy' Case

Let the South be 'small', in that it can affect neither foreign aggregate manufacturing prices, $P_{M,N}$, nor total foreign manufacturing expenditure, $E_{M,N}$. That is, we assume the South is small in the world market for its imports, although it still faces a well-defined, downward-sloping demand curve for its manufactured exports. Let

$$f \equiv (T\,t_S)^{-s\mu}\left[(T\,t_S)^{s-1}\,g\,L_S + T^{1-s}\,t_N^{-s}\,E_{M,N}\right] - \left[V\,s/(s-1)\right]^{s}\,P_{M,N}^{-[s(1-\mu)-1]}. \qquad \textbf{(29)}$$

Proposition 2. (i) If and only if $f \leq 0$, then there exists an equilibrium without Southern manufacturing: $n_S = 0$, and $w_S = 1$. (ii) If $f < 0$, then this equilibrium is locally stable. (iii) If $P_{M,N}$ is sufficiently small, then $f < 0$.

Intuitively, if Northern manufacturing prices are too low, then Southern firms cannot profitably enter. This equilibrium, however, need not be unique, or indeed optimal. Manufacturing linkages

represent a pecuniary externality. Given imperfect competition, such externalities can have real welfare consequences. In particular, strong enough linkages generate an underdevelopment trap, i.e., multiple Pareto-rankable equilibria. Let

$$\mu^* \equiv \left(\frac{\sigma - 1}{\sigma}\right)\left[\frac{\left(T t_S\right)^{\sigma-1} \gamma L_S}{\left(T t_S\right)^{\sigma-1} \gamma L_S + T^{1-\sigma} t_N^{-\sigma} E_{M,N}}\right] \in \left(0, \frac{\sigma - 1}{\sigma}\right). \tag{30}$$

Proposition 3. There exist $\underline{\mu}(\phi)$ and $\underline{\phi}(\mu)$, where $\underline{\mu}(0) \in (0, \mu^*)$, $\underline{\mu}'(\phi) < 0$, $\underline{\phi}(\mu^*) \in (-\infty, 0)$, and $\underline{\phi}'(\mu) < 0$, such that, if and only if $\mu \geq \underline{\mu}(\phi)$ and $0 \geq \phi \geq \underline{\phi}(\mu)$, then (i) The South is characterized by two equilibria. In one, there is no manufacturing: $n_S = 0$, and $w_S = 1$. In the other, the economy is fully specialized in manufacturing: $n_S > 0$, $L_{M,S} = L_S$, and $w_S \geq 1$. (ii) Welfare is strictly higher in the equilibrium with manufacturing.

Corollary. There exist $\underline{\mu} < \mu^*$ and $\underline{\phi} < 0$ such that, if $\mu \geq \underline{\mu}$ and $0 \geq \phi \geq \underline{\phi}$, then (i) and (ii) above hold.

Intuitively, the equilibrium without manufacturing represents a coordination failure. No single agent wants to *start* producing manufactures, because the absence of local intermediates increases production costs, while the absence of domestic production, and hence of domestic demand for intermediates, reduces total demand. Given increasing returns, it is impossible to establish manufacturing operations at a profitable scale.

But when domestic manufacturing already exists, linkages imply that production costs are lower and total demand is higher. Hence, agents finds it profitable to continue producing manufactures. Further, everyone is better off in this equilibrium: precisely because of linkages, aggregate manufacturing prices are actually *lower*, while wages are (weakly) higher.

Assume now there is no Southern manufacturing. LDC tariffs affect Southern firms in both their product *and* input markets. First, tariffs increase the *domestic demand* facing LDC firms. Second, tariffs increase the *cost* of imported intermediates used by Southern firms to produce goods for both the domestic *and* the foreign market.

Proposition 4. (i) If the South initially produces no manufactures, then Southern tariffs further discourage Southern manufacturing if and only if $\mu > \mu^*$, that is, the relative size of Northern markets is sufficiently large, linkages are sufficiently strong, and trade barriers are not too high. (ii) Under the same conditions, Southern tariffs expand the set of parameters such that there exists an equilibrium without Southern manufacturing.

Intuitively, the relative importance of the cost effect increases with the relative size of the foreign market, and with the strength of linkages, μ. In addition, greater trade barriers increase the relative importance to Southern entrants of the domestic market, where, by (A1), the demand effect of tariffs outweighs their impact on costs. Hence, as trade barriers becomes arbitrarily large, tariffs eventually encourage LDC manufacturing. We should not, however, stress this conclusion. It stems from the assumption that manufactures are essential to consumers, whereas imported inputs are not essential to producers, so that domestic manufacturing output must be strictly positive under autarky. This would not hold if demand for manufactures were sufficiently elastic, at least at high prices, or if some foreign input were particularly hard to replace. In any case, and particularly for small countries, autarky is hardly likely to increase welfare, whatever its impact on manufacturing output (optimal policy is discussed below).

So far, we have assumed that tariffs are levied at the same rate on both intermediates and final

goods.[19] However, the structure of trade policy also matters:

Proposition 5. (i) If the South initially produces no manufactures, then Southern tariffs on intermediates further discourage Southern manufacturing, whereas tariffs on final goods encourage it. (ii) Southern tariffs on intermediates expand, whereas tariffs on final goods contract, the set of parameters such that there exists an equilibrium without Southern manufacturing.

Intuitively, tariffs on final goods only exert a demand effect. In contrast, tariffs on intermediates also exert a cost effect. Indeed, with no pre-existing final-goods output and hence demand for intermediates, tariffs on intermediates *only* exert a cost effect. Put differently, intermediates exert not just backward, but also forward linkages. Indeed, with no pre-existing intermediate output, intermediates *only* exert forward linkages. Hence, an increase in their price discourages the final-goods sector, which in turn discourages the intermediate sector too.

These result are, of course, reminiscent of the 'effective protection' literature of the 1960s and 1970s. The key difference is that this literature assumed perfect competition and constant returns to scale. Hence, it could not formalize the concept of an underdevelopment trap, nor discuss how policy might affect it. Related to this, the welfare implications of our model are much more complex.

To the extent that policy is concerned with welfare, rather than industrialization *per se*, the key potential justification for government intervention is the presence of multiple Pareto-rankable equilibria.[20] Specifically, by Proposition 3 and Proposition 4, if the strength of linkages m lies in some non-empty interval $[\underline{m}, m^*)$, and if competition from Northern firms is not too stiff, then linkages are both sufficiently strong to generate multiple equilibria, *and* not so strong that tariffs actually discourage industrialization. The fundamental reason for the existence of this interval is the presence of *backward* linkages. These act to generate multiple equilibria, but (unlike forward linkages) do not create a tendency for tariffs to discourage industrialization. Also, by Proposition 5, tariffs on final goods always encourage industrialization, no matter how strong the (forward) linkages.

All this might seem to imply that tariffs, particularly if temporary and selectively aimed at final goods, may increase welfare by helping the private sector to coordinate on the equilibrium with high manufacturing output. Such an interpretation is, however, dubious. First, if trade policy has to be broadly based, and if linkages are strong, then tariffs actually aggravate the coordination problem, as shown by Proposition 4. Conversely, trade *liberalization* may be sufficient to trigger a process of cumulative expansion towards the equilibrium with high manufacturing output.

In addition, even if trade policy can be selective, the highly simplified and symmetric nature of our model hides an unpleasant reality. First, tariffs should only be aimed at industries where backward linkages are strong relative to forward linkages. Such industries can in principle be identified by examining an input-output table. Second, and more important, the linkages must have welfare significance. In our model, the linked industries are always characterized by increasing returns to scale. In practice, governments would have to determine, for *each* linked industry, whether this is indeed the case, and whether the proposed intervention is likely to push this industry over (or under) the threshold

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[19] In the model, there is no formal distinction between intermediates and final goods. However, tariffs can still depend on whether, and to what extent, the manufactured import is used as an intermediate in production rather than as a final good in consumption.

[20] There are two other distortions. First, monopolistic competition in manufacturing, and the associated mark-up of price over marginal cost, implies that manufacturing output and consumption are too low. Second, the South possesses some power in its export markets. Neither issue is germane to our key concern, industrialization and development.

of profitability. Such stringent informational requirements are unlikely to be met.

There is a slightly stronger *prima facie* case for providing explicit subsidies to producers. First, such subsidies always encourage manufacturing, no matter how strong the linkages. Indeed, the stronger the (backward *or* forward linkages), the greater the impact. Second, unlike selective tariffs, subsidies do not require a comparison of the relative strength of backward and forward linkages in any particular industry. Third, infra-marginal subsidies, unlike tariffs, do not distort consumption and trade.[21] Fourth, marginal subsidies can also be used to tackle the monopolistic competition distortion.

Nevertheless, even subsidies should only be aimed at industries which generate substantial linkages. And such linkages must have welfare significance, e.g., there must be increasing returns in the linked industries, so that subsidies push them over the threshold of profitability. Again, these are demanding informational requirements. Hence, our results do not overturn the presumption in favor of free trade and against industrial policy.

5.2. The 'Large Economy' Case

Next, it is crucial to recognize that trade liberalization has recently been simultaneously undertaken in most LDC. Since developing countries as a whole are rapidly becoming an important component of the world economy, their reforms are likely to affect the developed North.[22] In particular, they may affect the likelihood of global industrial agglomeration. In addition, and related, the impact on the North may feed back into the prospects for LDC industrialization. In terms of the model, we now endogenize n_N, p_N, and $E_{M,N}$.

We find that essentially the same conditions which ensure that tariffs hamper industrialization in a small economy, also ensure that tariffs *reinforce* any tendency towards global agglomeration. Further, the impact of trade liberalization on Northern manufacturing employment, output and productivity, and the subsequent feedback, may dampen, but is unlikely to eliminate, any positive impact of liberalization on LDC manufacturing.

Proposition 6. There exist $\{\underline{L},\ \bar{g}\} \in (0, 1)$, $\underline{m} \in (0, (\sigma - 1) / \sigma)$, and $\{\bar{t}_S,\ \underline{T},\ \overline{T} : \underline{T} < \overline{T}\} \in (1, \infty)$, such that, if $(L_N / L_S) \geq \underline{L}$, $g \leq \bar{g}$, $m \geq \underline{m}$, $t_S \leq \bar{t}_S$, and $T \in [\underline{T},\ \overline{T}]$, then there exists an equilibrium without Southern manufacturing: $n_S = 0$, and $w_S = 1$.

As previously discussed, linkages and transport costs create country-specific external economies. If these are strong enough, and if transport costs are not prohibitive, then manufacturing completely agglomerates in one country. Any reduction in final demand for manufactures further reduces the incentive to start production in the LDC. In addition, with any asymmetries in country size, manufacturing is more likely to concentrate in the larger country: so long as trade barriers are positive, an expansion in the size of the domestic market benefits domestic firms relative to foreign firms—the 'home market' effect.

Assume now that there is no Southern manufacturing. Compared to the 'small' economy case,

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[21] Of course, some level of tariff protection may be justified on public-finance grounds. In addition, tariffs may implicitly act as an optimal export tax. We have nothing new to add here.

[22] World Bank (1995b) estimates that the Low and Middle Income Countries (LMIC) will account for 50 % of world GDP by the year 2020, as opposed to today's 25 %; their share in world trade will follow a similar pattern. Spatafora (1995) provides a detailed analysis of how trade liberalization and rapid growth in the South is likely to affect growth and welfare in the industrialized North.

Southern tariffs exert two new effects. First, they can affect Northern aggregate manufacturing prices, i.e., the terms of trade, through their impact on both the number of Northern varieties, and the price of individual varieties. Given imperfect competition, the sign of the terms-of-trade effect is ambiguous. Tariffs reduce demand for Northern manufactures, and hence Northern manufacturing labor demand. On the one hand, this acts to reduce Northern wages and hence prices. On the other hand, it acts to reduce Northern manufacturing employment and the number of Northern varieties. In turn, this reduces manufacturing productivity and hence increases the price of individual varieties. Both the reduction in variety, and the increase in the price of individual varieties, then increase Northern aggregate manufacturing prices. In our model, the wage-reduction effect only applies if the North is completely specialized, and the variety-reduction effect only applies if the North is incompletely specialized.

To the extent that the tariffs increase Northern aggregate prices, this affects Southern firms in both their product and input markets. Specifically, there is an increase both in the *worldwide* demand facing Southern entrants, and in their costs. However, assuming the non-specialized equilibrium is at least potentially stable, (A1), the demand effect outweighs the cost effect, encouraging Southern production. Of course, the deterioration in the Southern terms of trade also has a directly deleterious welfare effect. Conversely, an improvement in the Southern terms of trade, while directly favorable, discourages Southern production.

In addition, the reduction in Southern demand for Northern manufactures induces a reduction in Northern intermediate demand for manufactures. If Northern wages fall, this is accompanied by a decline in final demand. In turn, the reduction in Northern aggregate manufacturing expenditure reduces the Northern demand facing potential Southern firms.

Formally, assume first that the North is incompletely specialized in manufacturing. This occurs if and only if the share of manufactures in consumption, g, or the relative size of Southern markets, L_S/L_N, are sufficiently low, or Southern tariffs, t_S, are already sufficiently high. Then,

Proposition 7. Let the North be incompletely specialized in manufacturing. (i) If the South initially produces no manufactures, then Southern tariffs further discourage Southern manufacturing if and only if linkages are sufficiently strong; if the relative size of Northern markets is sufficiently large; and only if transport costs and Southern tariffs are not too high. (ii) Under the same conditions, Southern tariffs expand the set of parameters such that in equilibrium there is no Southern manufacturing.

Intuitively, there are three effects at work. First, as in a small economy, tariffs exert both a positive demand effect, and a negative cost effect on Southern production.

Second, since the North is incompletely specialized, Southern tariffs reduce Northern manufacturing employment and the number of Northern firms. In turn, this reduces Northern manufacturing productivity, and increases both individual and aggregate Northern manufacturing prices. This encourages Southern entry.

Finally, Southern tariffs induce a reduction in Northern intermediate demand for manufactures. This decreases the Northern demand facing Southern entrants. Nevertheless, taking into account the terms-of-trade effect above, the overall effect on quantities demanded in the North is still positive. Intuitively, the reduction in Northern demand hurts Northern firms even more than Southern ones.

The key point is that, to the extent that LDC trade liberalization induce an increase in Northern manufacturing employment, output, and productivity (in our view, the empirically relevant scenario), it increases the relative cost disadvantage of LDC producers. Hence, the impact on LDC industrialization (though not necessarily welfare) is less favorable. Nevertheless, the qualitative features of the small-economy analysis still hold.

Specifically, the impact of tariffs on the profitability of Southern entry again depends crucially on the strength of linkages, m. Without linkages, the cost effect disappears, and Southern tariffs encourage Southern production. Greater linkages essentially magnify the cost impact both of the increase in tariffs, and of the induced increase in Northern aggregate manufacturing prices. Hence, if linkages are sufficiently strong, tariffs *must* discourage Southern manufacturing.

An increase in the relative size of Northern markets, L_N/L_S, has two consequences. First, the impact of LDC tariffs on the terms of trade diminishes. Second, the beneficial impact of tariffs on domestic demand becomes less important, relative to their harmful impact on the cost of Southern production for export. If Northern markets are sufficiently large, the cost effect again dominates and tariffs discourage Southern manufacturing.

When analyzing the world economy as a whole, the cost effect can be given a subtler interpretation. Agglomeration (partly) arises because transport costs prevent LDC firms from taking full advantage of those intermediates produced in the North. To the extent that tariffs further increase the cost of imported intermediates, they *aggravate* this handicap. Put differently, linkages and transport costs on intermediates generate external economies that are partly country-specific, and which can therefore produce agglomeration. Tariffs on intermediates further 'localize' these external economies, i.e., reduce the ability of LDC firms to exploit external economies generated abroad. This is likely to reinforce agglomeration, and is particularly harmful for small countries, which cannot themselves generate significant external economies, and where the demand effect of tariffs is relatively less important.

Some further comments about tariffs are required. First, as should be clear from the above discussion, tariffs on final goods always discourage agglomeration, whereas tariffs on intermediates reinforce it (at least if the South initially produces no intermediates). However, for the same reasons discussed in section 5.1, this implies *not* that tariffs on final goods are beneficial, but that tariffs on intermediates are *particularly* nefarious.

Second, sufficiently high tariffs guarantee a country at least the autarkic level of domestic manufacturing output. However, since consumers no longer have access to Northern manufactures, welfare is still likely to fall. In particular, this must be the case for relatively small countries. Furthermore, LDC tariffs here, unlike developed-country tariffs, have little to do with import protection as export promotion.

Third, if the asymmetries in country size are sufficiently small, i.e., if there is little to differentiate 'North' from 'South' *ex ante*, then where industry agglomerates is essentially arbitrary. Hence, sufficiently high tariffs, even if temporary, can turn the South into the developed country, and the North into the LDC! Needless to say, this artifact disappears once we recognize there are good reasons for why industry agglomerates in the *North*. In terms of the model, if the North is much larger, then industry never agglomerates in the South. In a two-factor setting, differences in relative factor endowments would strengthen this conclusion.

Now, assume instead that the North is and remains completely specialized in manufacturing. This requires that the increase in Southern tariffs be sufficiently small. Then,

Proposition 8. Assume that the North is and remains completely specialized in manufacturing. (i) If the South initially produces no manufactures, then Southern tariffs further discourage Southern manufacturing. (ii) Southern tariffs expand the set of parameters such that in equilibrium there is no Southern manufacturing.

This result is driven by the positive effect of tariffs on Southern terms-of-trade. Specifically, since the North is completely specialized, Southern tariffs reduce Northern wages and prices. Indeed, the impact is so large that the (tariff-ridden) price of Northern varieties in Southern markets is unaltered.

Hence, neither domestic demand for Southern entrants, nor the latter's costs, change. Since Northern prices and manufacturing expenditure decline, so does the Northern demand facing LDC entrants. Hence, LDC production is necessarily discouraged.

If one accepts underdevelopment as inevitable, this discussion suggests that protection may be justified on 'optimal tariff' grounds. As we saw, such a result does not hold if the North is initially incompletely specialized. More generally, it need not hold if the South initially produces *some* manufactures. Figures 5 illustrates. We contrast the no-tariff equilibria with the equilibria under Southern tariffs, using the same underlying parameters as Figure 3. The abbreviation 'SPZD' denotes the specialized equilibrium, and the abbreviation 't_S' denotes the equilibria under Southern tariffs. In the specialized equilibrium, Southern tariffs further *reduce* LDC manufacturing output and employment. If manufacturing output is initially low, this essentially reflects Proposition 8. More striking, at low transport costs, LDC manufacturing output is initially substantial. However, LDC tariffs destroy local manufacturing and, related, actually *increase* Northern wages (and prices).

Intuitively, at low transport costs, there is significant LDC production for export, so that the cost effect of tariffs is particularly strong. Put differently, with low initial trade barriers, industry is relatively 'footloose', i.e., very responsive to cost differentials. Hence, tariffs induce firms to migrate to the North. However, the North is already fully specialized, so the shift increases Northern wages and prices rather than output. As discussed, this would not hold if the North were incompletely specialized. In addition, the elimination of LDC varieties directly reduces the productivity of Northern manufacturing. This reduces Northern output and *further* increases Northern prices. It also acts to reduce Northern wages, but on net these can still increase.

Summing up, if the LDC initially produce some manufactures, then LDC tariffs can have an even *more* harmful impact, for two robust reasons. First, since tariffs increase the cost disadvantage of LDC relative to Northern firms, they can not just fail to expand LDC manufacturing, but can even destroy whatever manufacturing already exists. This much we knew from Proposition 7, part (ii), and Proposition 8, part (ii). Second, the contraction in LDC manufacturing reduces Northern productivity, driving up Northern costs and prices, i.e., deteriorating LDC terms-of-trade.

6. The Role of Multinationals

We now remove all restrictions on multinationals (MNC). This would involve, for instance, granting MNC full 'rights of establishment' and 'national treatment', and eliminating all 'performance requirements', such as minimum local content or export requirements.[23] In this section, for simplicity, we assume there are no tariffs (equivalently, all barriers to trade are symmetric): $t_N \equiv t_S \equiv 1$. We also assume there are no asymmetries in country size: $L_N \equiv L_S$.

Before proceeding, two aspects of our treatment of MNC deserve emphasis. First, in our model, MNC and FDI have absolutely *nothing* to do with international capital flows: indeed, there is no capital! Rather, MNC are devices for establishing, acquiring, and maintaining control over foreign production facilities.[24]

Second, 'multinationals' and 'control' should be interpreted loosely. For our purposes, it is essentially irrelevant whether firms directly operate foreign production plants, or simply engage in international subcontracting and / or joint ventures. That is, the literature on 'internalization' has no

[23] See UNCTAD (1999) and WTO (1996) for a discussion of the institutional and legal framework relating to FDI.

[24] Graham & Krugman (1995), among many others, provide strong theoretical and empirical support for this view.

bearing on our results.

Next, before examining the impact of MNC, we must analyze why they may emerge in equilibrium. To develop the intuition, we initially assume there are no linkages stemming from the use of intermediates, as in Brainard (1993a) and Spatafora (1996). Barriers to trade should then be interpreted as applying to *final goods*. Also, with no intrinsic asymmetries across countries, the specialized equilibria described above cannot exist. Let

$$\underline{T} = \begin{cases} \left[\dfrac{F+2(G+H)}{F-2H}\right]^{\frac{1}{s-1}} \in (1,\infty), \text{ if } F > 2H \\ \infty, \text{ otherwise} \end{cases} \tag{31}$$

$$\Rightarrow \quad \underline{T}'(F) < 0,\ \underline{T}'(G) > 0,\ \underline{T}'(H) > 0,\ \underline{T}'(s) < 0, \text{ if } F > 2H. \tag{32}$$

As is well-known,[25]

Proposition 9. Let there be no intermediates. In equilibrium, MNC exist if and only if $T \geq \underline{T}$, while national enterprises (NE) exist if and only if $T \leq \underline{T}$.

Corollary. (i) MNC are more likely, and NE less likely to exist, the smaller the plant-level fixed costs, G, the smaller the extra coordination costs which MNC must incur, H, the greater the firm-level fixed cost F, the greater the transport costs T, and the greater the elasticity of substitution, s. (ii) Unless T *exactly* equals $\underline{T}$, in equilibrium there exist either MNC alone (the 'pure MNC' equilibrium), or NE alone (the

The intuition is as follows. Since this is a general equilibrium model, each plant is in effect fighting on two fronts. First, it must compete for market share with other domestic and foreign plants, including any owned by the same parent firm. Second, it must compete for scarce resources with other domestic plants and sectors.

Hence, the extent of MNC activity is determined by two different considerations. First, *locational advantage.* Manufacturing firms can expand through trade or through FDI. Large plant-level scale economies and small trade barriers create an incentive to concentrate production in one location and export to the foreign market.

Second, *ownership advantage.* Each MNC subsidiary faces potential competition from indigenous producers. In this competition, NE have two advantages. First, they incur lower coordination costs, by assumption. Second, their plants can produce for export, whereas MNC subsidiaries are limited to serving the domestic market. The smaller the trade barriers, the greater the size of NE relative to MNC subsidiaries. In turn, this enables NE to reap greater plant-level scale economies. However, MNC have one crucial advantage. While each subsidiary may produce less than indigenous NE, the MNC as a whole produces more. The larger the trade barriers, the greater the MNC's relative size. In turn, this enables MNC to spread any firm-level fixed costs over a larger total volume of output, reaping economies of multi-plant production.

Overall, MNC activity therefore depends positively on the size of firm-level fixed costs and of barriers to trade in final goods, relative to plant-level scale economies and to the extra MNC coordination costs. With positive barriers to trade, NE are also more likely to exist the smaller the elasticity of substitution s. Intuitively, when products are more differentiated, the transport costs associated with

[25] Brainard (1993a) established this proposition for the special case $H \equiv 0$. Spatafora (1996) allows $H \neq 0$.

exports translate into a smaller loss of sales and profits. Again, this encourages potential MNC to expand through trade instead. Also, it enhances the ability of NE, which can export, to compete with the MNC's domestic subsidiaries, which are confined to the local market.

If $F \leq 2\ H$, then MNC cannot exist, since their ownership advantage, stemming from their ability to reap economies of multi-plant production, can never offset their production cost disadvantage relative to indigenous producers. Likewise, MNC cannot exist if there are no barriers to trade. We henceforth assume

$$F > 2\ H, \qquad \textbf{(A2)}$$

so that there always exists a critical value of T above which MNC become active.

Finally, as transport costs increase, so does the profitability of MNC relative to NE. Hence, except for the knife-edge case where T is such the profitability of the two types of firms is *exactly* equal, MNC cannot coexist with NE. Put differently, since equilibrium is non-specialized, factor prices must be identical across countries. Then, there is insufficient flexibility in the model for both firm types to be active in equilibrium.

Let us now allow for intermediates. Once again, linkages and transport costs generate country-specific external economies. In turn, these might affect the existence and nature of both the specialized and non-specialized equilibria. Consider first the non-specialized equilibrium. T^*, given in (27), denoted the critical value of T at which this equilibrium became unstable when NE alone were allowed to operate. Let $T^{*,M}$ denote the critical value of T at which this equilibrium becomes unstable when MNC are also allowed to operate.

Proposition 10. Allow for intermediates. Consider the non-specialized equilibrium. (i) MNC still exist if and only if $T \geq \underline{T}$, while national enterprises (NE) still exist if and only if $T \leq \underline{T}$. (ii) If $T > \underline{T}$, then the (pure MNC) equilibrium is stable. (iii) If $T \leq \underline{T}$, then the equilibrium is stable if and only if $T > T^*$.

Corollary. $T^{*,M} = \min\{\underline{T}, T^*\}$. Hence, if $\underline{T} < T^*$, then $\forall T \in (\underline{T}, T^*]$ the non-specialized equilibrium is stable when MNC are allowed to operate, but not otherwise.

The intuition is as follows. First, in the symmetric equilibrium, the strength of (forward or backward) linkages in now way affects the relative advantages and weaknesses of NE versus MNC. Specifically, total market size is identical in both countries, so that both NE (from either country) and MNC can take equal advantage of backward linkages. Further, in any pure MNC equilibrium, by definition, each variety is produced in both countries, so that both MNC and potential NE can take equal advantage of forward linkages. Likewise, in any pure NE equilibrium, exactly half of all varieties are produced in each country, so that both NE (of either country) and potential MNC can again take equal advantage of forward linkages.

Second, in any pure MNC equilibrium, each variety is produced in both countries and there are no exports. Hence, one country's manufacturing industry cannot expand at the expense of the other country's. As a result, the pure MNC equilibrium can only possibly be unstable if perturbation induces entry by NE, i.e., if we are at the knife-edge case $T = \underline{T}$. Third, if MNC do not in fact operate, whether they are allowed to do so is irrelevant. Hence, the pure NE equilibrium again becomes unstable at $T = T^*$.

Say that the underlying production technology is favorable to MNC, ie., firm-level economies of scale, F, are sufficiently large relative to plant-level economies of scale, G, and to the extra coordination costs which MNC must incur, H. Then, $\underline{T} < T^*$, and $T^{*,M} = \underline{T} < T^*$. Hence, there is a range of transport costs such that the non-specialized equilibrium is stable when MNC are allowed to operate, but not

otherwise. Stronger (weaker) linkages increase (decrease) T^*, but do not affect $\underline{T}$, and hence expand (contract) this interval.

Next, consider the specialized equilibrium. Now, factor prices *can* differ across countries, and this differential can respond to changes in transport costs. This introduces some flexibility into the model, and implies that both MNC *and* Northern NE can be active in equilibrium, for some set of transport costs with strictly positive measure.[26] In addition, since the number of varieties and total market size are smaller in the South, linkages *do* affect the relative advantages and weaknesses of Northern NE versus MNC (and, even more strongly, Southern NE). Specifically, stronger linkages increase the cost and demand advantage of being located in the more developed North, discouraging MNC and, in particular, raising the critical value of T and F, relative to G and H, at which MNC begin production.

Unfortunately, all this flexibility comes with a heavy analytical price. If the South initially produces no manufactures, and if production technology sufficiently favors MNC, we can show that removing restrictions on MNC activity encourages Northern NE to expand through foreign investment rather than trade, so that Southern manufacturing output *must* increase. Both to explore the more general properties of the model, and to illustrate our previous analytical results, we now turn to numerical simulations.

Figure 6 illustrates the impact of removing all restrictions on MNC, using the same underlying parameters as Figure 1. In particular, we keep constant the total fixed costs of NE, $(F + G)$. We set the ratio of firm-level to plant-level fixed costs, F / G, equal to two, and the ratio of the MNC's extra communication costs to their (other) plant-level fixed costs, H / G, equal to one-quarter. The abbreviation 'SPZD' denotes the specialized equilibrium, and the abbreviation 'OLD' denotes the equilibria prior to FDI liberalization. We add two new panels, depicting the output of each type of NE and the total output of MNC. MNC entry has five main consequences.

First, the non-specialized equilibrium is stable for a wider range of parameters, i.e., $T^{*,M} < T^*$. Second, the specialized equilibrium exists for a narrower range of parameters. That is, for some parameters, agglomeration is viable in the absence of MNC, but MNC entry forces a complete convergence in industrial structure and income. Third, even if agglomeration remains viable, LDC manufacturing output increases so long as MNC are in fact active. The broad intuition is that the MNC's cost advantage, stemming from economies of multi-plant production, helps them overcome the disadvantages of a small LDC industrial base. In turn, MNC entry expands this industrial base, encouraging further entry. If conditions are sufficiently favorable to MNC, i.e., transport costs are not too low, the process culminates in a complete convergence in industrial structure.

Fourth, MNC entry always increases Southern welfare. In contrast, if the world economy was initially in a specialized equilibrium, MNC *reduce* Northern welfare. Intuitively, to the extent that MNC represent a more efficient form of production, they increase welfare in both countries—an 'efficiency' effect. However, MNC also promote convergence in industrial structure and income—an 'equalization' effect. This again increases Southern welfare, but acts to reduce Northern welfare. Overall, if the initial differences across countries are small, the efficiency effect dominates, and both countries gain. If instead the initial asymmetries are large, the equalization effect dominates, and the North is made worse off. For these parameters, starting from any specialized equilibrium, the equalization effect dominates.[27]

In Figure 7, we raise the share of intermediates in manufacturing, as in Figure 3. As expected from

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[26] The flexibility is still insufficient for MNC to coexist with NE from *both* countries, except for a knife-edge case.

[27] Markusen & Venables (1995) also find that the welfare impact of MNC entry hinges on the size of the initial cross-country asymmetries. In their model, however, such asymmetries reflect assumed differences in size, relative factor endowments, or technology. In our model, instead, the asymmetries are the endogenous outcome of a cumulative, self-reinforcing process of agglomeration.

Proposition 10, stronger linkages only act to destabilize the non-specialized equilibrium when MNC are not active. Hence, there is an even wider range of parameters such that the non-specialized equilibrium is stable in the presence of MNC, but not otherwise. In addition, stronger linkages increase the viability of agglomeration whether or not MNC can operate. Nevertheless, there is an even wider absolute range of parameters such that agglomeration is viable in the absence of MNC, but not otherwise.

In Figure 8, we instead raise the share of manufactures in final demand, as in Figure 2. This increases the amount of LDC manufacturing prior to MNC entry. With smaller initial disparities, the relative importance of the MNC's equalization effect diminishes. Hence, the negative impact on Northern welfare in the specialized equilibrium is smaller.

In Figure 9, we also halve the ratio of firm-level to plant-level fixed costs, F / G, while keeping H constant. This reduces the cost advantage of MNC and shrinks the range of parameters such that MNC exist. Hence, the non-specialized equilibrium is stable for a narrower range of parameters, while agglomeration is viable for a wider range of parameters. Within the specialized equilibrium, the critical value of T which triggers MNC entry increases, which acts to reduce LDC manufacturing output and welfare. For these parameters, even starting from a specialized equilibrium, MNC entry increases both Southern *and* Northern welfare, so long as it only promotes *partial* convergence. Here, the equalization effect is weak relative to the efficiency effect.

As a polar case, assume now that MNC can establish production facilities abroad at no extra cost, i.e., set $G = 0 = H$, while keeping $(F + G)$ constant. Then, for all strictly positive transport costs, MNC are the only viable firm type. Hence, only the symmetric, non-specialized, pure MNC equilibrium exists. Since MNC do not export, transport costs have no impact on welfare, i.e., each country's welfare *always* equals the value which formerly prevailed without barriers to trade. Put differently, the productive efficiency of MNC enables agents to avoid transport costs without incurring offsetting costs. Here, both the efficiency and equalization effect of MNC are at their maximum. Then, FDI liberalization hugely benefits the LDC. It *may* however reduce Northern welfare if, in the specialized equilibrium without MNC, some positive level of transport costs benefits the North by suppressing the rise of LDC competition. Figures 1 and 3 (but *not* Figure 2) constitute such a case.

We now elaborate on the relationship between economic integration, MNC expansion, and LDC industrialization. In the model, the fundamental motivation behind FDI is the desire to reap gains from proximity to the final market. To the extent that economic integration and 'globalization' essentially involve a reduction in transportation costs, they reduce the benefits from proximity, and hence discourage MNC expansion. In turn, this can have a catastrophic impact on LDC. An alternative viewpoint, however, is that whereas globalization in the 19th century was driven mainly by falling transport costs, now it is being driven by plunging communication costs. These make much deeper international integration possible; in particular, cheap and efficient communications networks allow companies to locate different parts of their production process in different countries while remaining in close contact. In terms of the model, lower transport costs, T, may be accompanied by a reduction in MNC's extra communication and coordination costs, H. By (32), the latter acts to increase the cost advantage of MNC and the range of parameters such that they exist. Figure 10 illustrates. We use the same underlying parameters as Figure 6, but reduce H to zero. This further encourages MNC expansion. Hence, if reductions in T are accompanied by sufficiently large reductions in H, they *must* promote LDC industrialization.

In general, reductions in either transportation *or* communication costs are likely to reduce the costs of both NE *and* MNC. However, lower communication costs probably have a relatively larger impact on MNC operations, i.e., they reduce the *relative* costs of MNC. Put differently, a 'deep' integration that goes beyond mere free trade is likely to encourage MNC expansion, and will therefore prove particularly beneficial to the LDC. Parenthetically, this distinction between transportation and communication costs

helps reconcile models of FDI based on the gains from proximity with the observation that, both historically and more recently, improvements in transportation and communications technologies have been associated with an expansion in MNC activity.[28]

7. Trade Policy and Multinationals

We now briefly discuss the impact of trade policy on economic activity in the presence of MNC. Consider first the non-specialized equilibrium. Let $T^{*,M}(t)$ denote the critical value of T at which this equilibrium becomes unstable when MNC are allowed to operate, *and* tariffs are present. Numerical simulations suggest

Proposition 11. Allow for MNC. Consider any symmetric equilibrium of the world economy, and let a country raise its tariffs. (i) MNC still exist if and only if $T \geq \underline{T}$, while national enterprises (NE) still exist if and only if $T \leq \underline{T}$. (ii) If $T > \underline{T}$, then the (pure MNC) equilibrium is stable. (iii) If $T \leq \underline{T}$, then the equilibrium is stable if and only if $T > T^*(t)$, where $T^*(t) > T^*$.

Corollary. $T^{*,M}(t) = \min \{\underline{T}, T^*(t)\}$. Hence, if $\underline{T} < T^*$, then tariffs have no impact on the set of stable, non-specialized equilibria.

The intuition is as follows. First, in any pure MNC equilibrium, each variety is produced in both countries and there are no exports. Hence, tariffs affect neither MNC nor potential domestic NE, but simply discourage potential foreign NE. Hence, the pure MNC equilibrium remains viable. Second, in any initially symmetric, pure NE equilibrium, tariffs favor domestic NE relative to both foreign NE and potential MNC. Hence, the pure NE equilibrium continues to exist. However, it may become unstable, just as when MNC were not allowed to operate.

The result that, in any symmetric equilibrium, (unilateral) tariffs have no impact on the extent of MNC activity is not generic. Rather, it reflects the fact that, when factor prices are identical across countries, there is insufficient flexibility in the model for both MNC and NE to be active in equilibrium.

Next, consider the specialized equilibrium. Here, tariffs *can* affect MNC activity. In particular, LDC tariffs again exert both a cost and a demand effect on the profitability of local MNC operations. The crucial point is that, since MNC do not produce for export, the cost effect harms their LDC subsidiaries less than Southern NE. This yields two implications. First, LDC tariffs may, surprisingly, favor MNC relative to Southern NE. This could not occur starting from a symmetric equilibrium. The point is that asymmetries increase the costs of LDC tariffs relative to their benefits, but less so for MNC, which are focused on production for the domestic market.

Second, and related, if the cost effect is strong but not *too* strong, LDC tariffs may encourage LDC manufacturing when MNC are allowed to enter, but discourage it otherwise. However, as in section 5.1, tariffs on *intermediates* exert a particularly strong cost effect. Indeed, if the South initially produces no manufactures, tariffs on intermediates *only* exert a cost effect. They then discourage both LDC manufacturing, *and* MNC expansion into the South.

In addition, LDC tariffs exert a terms-of-trade effect, whose sign is in general ambiguous. As in

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[28] For instance, Vernon (1993) argues that 'Setting the stage for the development of these [early 20th century] multinational networks were the dramatic improvements in the technologies of transportation and communication...'. Likewise, recent technological innovations in transportation and communications have been accompanied by an explosive growth of FDI flows, both in absolute terms and relative to trade, as documented in WTO (1996). See Markusen & Venables (1995, 1996b) and Spatafora (1996) for an alternative interpretation of this puzzle.

section 5.2, if the North is and remains completely specialized in manufacturing, *and* if the LDC initially produces no manufactures, then LDC tariffs exert such a large, negative impact on Northern wages and prices that the (tariff-ridden) price of Northern varieties in LDC markets is unaltered. Then, the reduction in Northern final and intermediate demand necessarily discourages Southern NE. The impact on Northern NE and MNC, however, is fully offset by the reduction in Northern wages.

Figure 11 illustrates both this extreme (and unrealistic) result, and Proposition 11. We contrast the no-tariff equilibria with the equilibria under Southern tariffs, using the same underlying parameters as Figure 9. The abbreviation 'SPZD' denotes the specialized equilibrium, and the abbreviation 't_S' denotes the equilibria under Southern tariffs (we do not depict the equilibria prior to FDI liberalization). As discussed, tariffs have no impact on the set of stable, non-specialized equilibria. In any specialized equilibrium, Southern tariffs further *discourage* Southern NE. At high transport costs, the exit of Southern NE induces some MNC entry (which in turn induces the exit of some Northern NE), but LDC manufacturing output and employment nevertheless contract.

8. Conclusion

We developed a two-country, general equilibrium model of trade and FDI. Firm-level increasing returns interact with inter-firm linkages, stemming from the use of intermediates, to generate external economies in manufacturing. With positive transport costs on intermediates, such external economies are partly country-specific. Industrial activity can then agglomerate in one country, the North, while the other country, the LDC, enjoys lower welfare.

We found that MNC may be able to start profitable operations in the LDC, even when indigenous firms cannot. The reason is that the MNC's cost advantage, stemming from economies of multi-plant production, helps them overcome the disadvantages of a small local industrial base. In turn, MNC entry expands this industrial base, encouraging further entry. This promotes convergence in, and in extreme cases complete equalization of, industrial structure and income. This may hurt the North, since its manufacturing output may contract, but always benefits the LDC. Hence, removing restrictions on inward FDI is an effective development strategy. Put differently, international agreements to liberalize FDI are especially likely to benefit the LDC.

In contrast, LDC tariffs increase both the domestic demand facing local manufacturers, *and* the cost of imported intermediates used in local production for both the domestic *and* the foreign market. If potential export markets are relatively large, if trade barriers mainly affect intermediates, or if production relies heavily on intermediates, the cost effect dominates. Then, LDC tariffs reinforce the tendency for industry to cluster elsewhere. Put differently, barriers to trade in intermediates reduce the ability of LDC firms to exploit any external economies in manufacturing generated abroad, with a particularly devastating effect on small countries. Conversely, liberalization reduces the cost disadvantage of LDC firms. It may therefore destroy the pre-existing agglomeration patterns, and induce a discontinuous increase in LDC output and welfare.

Our results, while suggestive, are far from definitive. Two issues in particular stand out. First, in our treatment of MNC, we focused on what is, in our view, their key aspect: namely, that they are very large and efficient firms. In particular, their size enables them to reap firm-level economies of scale, and therefore to enter markets which other firms find unprofitable. Economies of scope would strengthen this argument. However, some commentators have emphasized rather different, and altogether more ominous characteristics of MNC: specifically, their alleged predatory behavior in product markets, rapacious behavior in labor markets, and nefarious influence in political markets.

Ongoing research tackles explicitly the argument that MNC may systematically extract rents from the host country. Specifically, we assume that entry into the manufacturing sector is restricted. In this

setting, excess profits can arise even in equilibrium. To the extent that MNC displace Southern firms, and that MNC profits are repatriated to the North, MNC entry may reduce Southern welfare through a 'profit-shifting' effect analogous to those highlighted by the strategic trade policy literature. However, the smaller the level of Southern manufacturing in the absence of MNC, the weaker this argument. In particular, 'profit-shifting' cannot (by definition) arise, if the South in fact produces no manufactures prior to entry by MNC.

Finally, this paper dealt with comparative statics. Yet, industrialization and development are inherently dynamic processes. At a minimum, one should therefore allow for some reproducible factor of production. This has a potentially important implication. In our model, the North and the South are to some extent fighting a constant-sum game: if the South can break the existing pattern of industrial agglomeration, it gains while the North is likely to lose. But if Southern growth rates were to increase sharply, and if the total size of world markets were ultimately to expand, the presence of increasing returns suggests the North might gain too, whether through increased product variety and quality, or through greater competition in manufacturing.

Ongoing research explores this issue by building a model where both firm location *and* growth are endogenous. Specifically, we introduce R&D as a source of long-run growth. We also assume that there are localized externalities from industrial production to R&D, that is, being close to production processes makes it easier to invent new goods or processes. In this context, there are two potential links between industrial location and growth rates. First, assume that, because of the localized spillovers, R&D always clusters in the more developed country. Then, since multinationals promote industrial dispersion, they reduce total spillovers to the R&D sector, and hence reduce growth rates.[29]

Alternatively, assume that R&D also requires some specific input, whose supply in each country is fixed ('human capital'). Here, the local availability of human capital may sharply constrain R&D. Further, industrial dispersion may be accompanied by the dispersion of R&D. In turn, this may help overcome any R&D bottlenecks, sharply increasing growth rates. Then, even though the static impact of the relocation of industry and R&D hurts the North, the dynamic gains may imply that multinational activity increases both countries' welfare.

[29] Martin & Ottaviano (1996a, 1996b) emphasize a similar mechanism, albeit in the context of trade liberalization rather than multinational expansion.

9. Appendix I: Developed-Country Tariffs

Proposition 1. Consider the neighborhood of any (stable) symmetric equilibrium of the world economy, and let a country raise its tariffs. Then, (i) Its manufacturing industry expands relative to other country's. Further, at least for sufficiently low tariffs, (ii) Its manufacturing industry expands in absolute terms. (iii) The other country's manufacturing industry contracts in absolute terms. (iv) The lower the initial level of trade barriers, the greater the absolute magnitude of the expansions and contractions.

Proof. Let underlining denote the ratios of Northern to Southern values of endogenous variables:

$$\underline{P}_M \equiv P_{M,N} / P_{M,S},\ \underline{p} \equiv p_N / p_S,\ \underline{E}_M \equiv E_{M,N} / E_{M,S},\ \underline{w} \equiv w_N / w_S. \quad \textbf{(33)}$$

Let $TT \equiv T^{1-s}$. **(34)**

By (12), (23), (24) and (25), and using (26),

$$\underline{p} = \underline{w}^{1-m}\, \underline{P}_M^{\,m}, \quad \textbf{(35)}$$

$$\underline{P}_M^{\,1-s} = (L_{M,N}\, \underline{w}\, \underline{p}^{-s} + TT\, t_N^{\,1-s}\, L_{M,S}) / (TT\, t_S^{\,1-s}\, L_{M,N}\, \underline{w}\, \underline{p}^{-s} + L_{M,S}), \quad \textbf{(36)}$$

$$\underline{p}^{s} = (\underline{P}_M^{\,s-1}\, \underline{E}_M + TT\, t_S^{-s}) / (TT\, t_N^{-s}\, \underline{P}_M^{\,s-1}\, \underline{E}_M + 1), \quad \textbf{(37)}$$

$$\underline{E}_M = \underline{w}\, [g\,(1 - m)\, L_N + m\, L_{M,N}] / [g\,(1 - m)\, L_S + m\, L_{M,S}]. \quad \textbf{(38)}$$

Eliminating $\underline{P}_M$ and $\underline{E}_M$ yields

$$\underline{p}^{-(s-1)/m}\, \underline{w}^{(s-1)(1-m)/m} = (L_{M,N}\, \underline{w}\, \underline{p}^{-s} + TT\, t_N^{\,1-s}\, L_{M,S}) / (TT\, t_S^{\,1-s}\, L_{M,N}\, \underline{w}\, \underline{p}^{-s} + L_{M,S}), \quad \textbf{(39)}$$

$$\underline{p}^{(s-1)/m}\, \underline{w}^{[1-s(1-m)]/m}\, [g\,(1 - m)\, L_N + m\, L_{M,N}] / [g\,(1 - m)\, L_S + m\, L_{M,S}] = (TT\, t_S^{-s} - \underline{p}^{s}) / (TT\, t_N^{-s}\, \underline{p}^{s} - 1). \quad \textbf{(40)}$$

These two equations define a relationship between the endogenous variables $\{\underline{w}, \underline{p}, L_{M,N}, L_{M,S}\}$ and the exogenous parameters $\{L_N, L_S, t_N, t_S\}$. By inspection, if $L_N = L_S = L$ and $t_N = t_S = t$, there exists a symmetric equilibrium with $\underline{w} = \underline{p} = 1$ and $L_{M,N} = L_{M,S} \equiv L_M$. Let

$$k \equiv s\,(1 - m) - 1 > 0, \text{ by (A1)}, \quad \textbf{(41)}$$

and $$k_2 \equiv s\,(1 + m) - 1 \equiv k + 2s\,m. \quad \textbf{(42)}$$

Linearizing (39) and (40) in the neighborhood of this symmetric equilibrium yields

$$\{[TT\, t^{1-s}\,(k + 2m) + k]\, d\underline{w} - (TT\, t^{1-s}\, k_2 + k)\, d\underline{p}\} / m - [(1 - TT\, t^{1-s}) / L_M]\, d(L_{M,N} - L_{M,S}) = -(s - 1)\, TT\, t^{-s}\, d(t_N - t_S), \quad \textbf{(43)}$$

$$s\, TT\, t^{-s-1}\, d(t_N - t_S) = [(1 - TT\, t^{-s})\, k\, d\underline{w} + (TT\, t^{-s}\, k_2 - k)\, d\underline{p}] / m - \{(1 - TT\, t^{-s})\, m / [g\, L\,(1 - m) + m\, L_M]\}\, d(L_{M,N} - L_{M,S}). \quad \textbf{(44)}$$

Holding $L_{M,N} = L_{M,S}$ yields

$$d\underline{w} = d\underline{p} = d(t_N - t_S) / 2t. \quad \textbf{(45)}$$

We can interpret $\underline{w}$ as the ratio of the Northern to the Southern maximum manufacturing wage compatible with zero profits, given the constraint of equal manufacturing employments. Hence, the change in $\underline{w}$ indicates the shift in the relative Northern manufacturing labor demand. This establishes (i).

Next, let m denote the import share in total manufacturing demand. In any non-specialized equilibrium, where both country's wages equal unity,

$$(1 - m_j)\, E_{Mj} + m_{j\_}\, E_{Mj\_} / t_{j\_} = L_{M,j} / (1 - m),\ j = N, S \quad \textbf{(46)}$$

$$\Rightarrow \quad x_N\, E_{M,N} + x_S\, E_{M,S} = (L_{M,N} + L_{M,S}) / (1 - m), \quad \textbf{(47)}$$

$$\text{where } x_j \equiv 1 - m_j\,(1 - 1/t_j) \le 1,\ j = N, S, \quad \textbf{(48)}$$

$$E_{Mj} = g\, L_j + m\, L_{M,j} / (1 - m),\ j = N, S. \quad \textbf{(49)}$$

(47) and (48) state that, for the world as a whole, total manufacturing expenditure, net of tariff revenues, equals the value of output, which is the wage bill divided by the labor share. (49) gives manufacturing expenditure in each location. Substituting for E_{Mj},

$$g\,(1 - m)\,(L_N\,x_N + L_S\,x_S) \;=\; L_{M,N}\,(1 - m\,x_N) + L_{M,S}\,(1 - m\,x_S). \qquad \textbf{(50)}$$

In any symmetric equilibrium, where $m_N = m_S \equiv m$ and $x_N = x_S \equiv x$,

$$L_M \;=\; g\,L\,(x - x\,m) / (1 - x\,m). \qquad \textbf{(51)}$$

Note that (41)–(44) and (51) imply

$$d(L_{M,N} - L_{M,S}) / d(t_N - t_S) \;=\; -\,1 / [2\,t\,d\underline{w} / d(L_{M,N} - L_{M,S})] \qquad \textbf{(52)}$$

$$\Rightarrow \quad d(L_{M,N} - L_{M,S}) / d(t_N - t_S) \;>\; 0 \;\text{ iff }\; d\underline{w} / d(L_{M,N} - L_{M,S}) \;<\; 0, \qquad \textbf{(53)}$$

which is simply the definition of stability of the symmetric equilibrium. This provides an alternative way to establish (i). Also, linearizing (50) in the neighborhood of the symmetric equilibrium yields

$$\begin{aligned} d(L_{M,N} + L_{M,S}) \;&=\; [g\,L\,(1 - m) / (1 - x\,m)^2]\; d(x_N + x_S) \\ &=\; -\,[g\,L\,(1 - m) / (1 - x\,m)^2]\; [(m / t^2)\; d(t_N + t_S) + (1 - t^{-1})\; d(m_N + m_S)]. \end{aligned} \qquad \textbf{(54)}$$

Let $\quad t \equiv 1 \;\Rightarrow\; x \equiv 1.$ **(A3)**

Then $\quad d(L_{M,N} + L_{M,S}) / d(t_N + t_S) \;=\; -\,g\,L\,m / (1 - m) \;<\; 0.$ **(55)**

Given (i), this establishes (iii).

Further, (41)–(44), (51), and (A3) imply

$$d\underline{w} \;/\; d(L_{M,N} - L_{M,S}) \;<\; 0 \;\text{ iff }\; T \;>\; T^*, \qquad \textbf{(56)}$$

where $\quad T^* \;\equiv\; \{[(1 + m) / (1 - m)]\,[s\,(1 + m) - 1] / [s\,(1 - m) - 1]\}^{1/(s-1)} \;>\; 1,$ **(57)**

and $\quad d(L_{M,N} - L_{M,S}) / d(t_N - t_S) \;=\; g\,L\,TT\,[TT\,k_2 + k\,(2s - 1)] / z,$ **(58)**

where $\quad z \;\equiv\; k\,(1 - m) - TT\,\{2s\,m\,(1 - TT)\,(1 + m) + k\,[2 - TT\,(1 + m)]\}.$ **(59)**

Consistent with (53) and (56), $z = 0$ at $T = T^*$, and $z > 0\;\forall T > T^*$. Further, at $T = T^*$, $dz / dTT = -\,2\,m\,(2\,s - 1) < 0$, and $d^2z / dTT^2 = 2\,k_2\,(1 + m) > 0$ everywhere. Hence, z increases monotonically as $TT \downarrow 0$. Also, under (A3),

$$m = TT / (1 + TT). \qquad \textbf{(60)}$$

(55), (59), and (60) imply

$$dL_{M,N} / dt_N \;=\; (g\,L\,TT / 2)\;\{[TT\,k_2 + k\,(2s - 1)] / z \;-\; 1 / [(1 + TT)\,(1 - m)]\}. \qquad \textbf{(61)}$$

The expression in braces decreases monotonically as $TT \downarrow 0$, and asymptotes to $2\,(s - 1) / (1 - m) > 0$. Hence, $(dL_{M,N} / dt_N)$ decreases monotonically with T, but is strictly positive $\forall T \in (T^*, \infty)$. This establishes (ii).

Finally, using (55) and (60), $[d(L_{M,N} + L_{M,S}) / d(t_N + t_S)]$ is negative and decreasing in TT. As discussed, $(dL_{M,N} / dt_N)$ is positive and increasing in TT. Hence, $(dL_{M,S} / dt_N)$ is negative and decreasing in TT. This establishes (iv). **QED**.

10. Appendix II: The Impact of LDC Tariffs

We now examine the existence and nature of equilibria with no Southern manufacturing. By (24), using (12),

$$[w_S^{1-m} P_{M,S}^{\ m} V s / (s - 1)]^{-s} (P_{M,S}^{\ s-1} E_{M,S} + TT\, t_N^{-s} P_{M,N}^{\ s-1} E_{M,N}) \leq 1,\ n_S \geq 0,\ \text{c.s.} \quad \textbf{(62)}$$

where $TT \equiv T^{1-s}$. **(63)**

Assume there is no Southern manufacturing:

$$n_S = 0,\ w_S = 1. \quad \textbf{(A4)}$$

By (23), using (A4),

$$P_{M,S} = T\, t_S\, P_{M,N}, \quad \textbf{(64)}$$

and $$P_{M,N} = n_N^{1/(1-s)} p_N. \quad \textbf{(65)}$$

By (25), using (A4),

$$E_{M,S} = g\, L_S. \quad \textbf{(66)}$$

By (62), using (A4), (64), and **(66)**, Southern manufacturing is indeed unprofitable if and only if

$$[(T\, t_S\, P_{M,N})^m V s / (s - 1)]^{-s} [(T\, t_S\, P_{M,N})^{s-1} g\, L_S + TT\, t_N^{-s} P_{M,N}^{\ s-1} E_{M,N}] \leq 1 \quad \textbf{(67)}$$

$$\Leftrightarrow \quad P_{M,N}^{\ k} (T\, t_S)^{-sm} [V s / (s - 1)]^{-s} [(T\, t_S)^{s-1} g\, L_S + TT\, t_N^{-s} E_{M,N}] \leq 1, \quad \textbf{(68)}$$

where $k \equiv s(1 - m) - 1 > 0$, by (A1). **(69)**

10.1. The 'Small Economy' Case

We first treat both $P_{M,N}$ and $E_{M,N}$ as parametric.

Proposition 2. (i) If and only if $f \leq 0$, then there exists an equilibrium without Southern manufacturing: $n_S = 0$, and $w_S = 1$. (ii) If $f < 0$, then this equilibrium is locally stable. (iii) If $P_{M,N}$ is sufficiently small, then $f < 0$.

Proof. Rewrite (68) as

$$0 \geq f \equiv (T\, t_S)^{-sm} [(T\, t_S)^{s-1} g\, L_S + TT\, t_N^{-s} E_{M,N}] - [V s / (s - 1)]^s P_{M,N}^{-k}. \quad \textbf{(70)}$$

This establishes (i). Then, smoothness of f establishes (ii), and direct inspection of f establishes (iii). **QED**.

Proposition 3. There exist $\underline{\mu}(f)$ and $\underline{f}(m)$, where $\underline{\mu}(0) \in (0, m^*)$, $\underline{\mu}'(f) < 0$, $\underline{f}(m^*) \in (-\infty, 0)$, and $\underline{f}'(m) < 0$, such that, if and only if $m \geq \underline{\mu}(f)$ and $0 \geq f \geq \underline{f}(m)$, then (i) The South is characterized by two equilibria. In one, there is no manufacturing: $n_S = 0$, and $w_S = 1$. In the other, the economy is fully specialized in manufacturing: $n_S > 0$, $L_{M,S} = L_S$, and $w_S \geq 1$. (ii) Welfare is strictly higher in the equilibrium with manufacturing.

Proof. By (23), using (12),

$$P_{M,S}^{\ 1-s} = n_S [w_S^{1-m} P_{M,S}^{\ m} V s / (s - 1)]^{1-s} + n_N (p_N\, T\, t_S)^{1-s}. \quad \textbf{(71)}$$

Assume that the South is not fully specialized in manufacturing:

$$w_S = 1. \quad \textbf{(A5)}$$

By (71), using (A5),

$$P_{M,S}^{-(s-1)(1-m)} = n_S [V s / (s - 1)]^{1-s} + P_{M,S}^{(s-1)m} n_N (p_N T t_S)^{1-s}. \quad \textbf{(72)}$$

$$\Rightarrow \quad dP_{M,S} / dn_S < 0. \quad \textbf{(73)}$$

Hence, an increase in n_S reduces $P_{M,S}$; these are the forward linkages. By (62), using (A5),

$$0 \geq f_2 \equiv P_{M,S}^{-sm} (P_{M,S}^{s-1} E_{M,S} + TT t_N^{-s} P_{M,N}^{s-1} E_{M,N}) - [V s / (s - 1)]^s, \; n_S \geq 0, \text{ c.s.} \quad \textbf{(74)}$$

Let $f_2 = 0$. **(A6)**

Then, by Proposition 2, there exists an equilibrium with $n_S = 0$. A necessary and sufficient condition for multiple equilibria to exist is that an (exogenous) increase in n_S raise f_2, triggering a further increase in n_S. Such a cumulative process of expansion would only stop once the economy became fully specialized in manufacturing, and wages began to rise. By (25),

$$E_{M,S} = g L_S + g_1(n_S), \quad \textbf{(75)}$$

where $g_1(n_S) \equiv m n_S p_S$ **(76)**

$$\equiv m n_S P_{M,S}^m [V s / (s - 1)], \text{ by (12) and (A5)} \quad \textbf{(77)}$$

$$\equiv m [V s / (s - 1)]^s [P_{M,S}^{-k} - P_{M,S}^{sm} n_N (p_N T t_S)^{1-s}], \text{ by (72)} \quad \textbf{(78)}$$

$$\Rightarrow \quad g_1(0) = 0, \quad \textbf{(79)}$$

$$g_1'(n_S) = - m [V s / (s - 1)]^s [k P_{M,S}^{-k-1} + s m P_{M,S}^{sm-1} n_N (p_N T t_S)^{1-s}] (dP_{M,S} / dn_S) \quad \textbf{(80)}$$

$$> 0, \text{ by (73).} \quad \textbf{(81)}$$

For now, let us set

$$g_1(.) \equiv g_1(0) = 0, \quad \textbf{(A7)}$$

i.e., ignore backward linkages. Then, (74) reduces to

$$0 \geq f_3 \equiv P_{M,S}^{-sm} (P_{M,S}^{s-1} g L_S + TT t_N^{-s} P_{M,N}^{s-1} E_{M,N}) - [V s / (s - 1)]^s, \; n_S \geq 0, \text{ c.s.} \quad \textbf{(82)}$$

$$\Rightarrow \quad df_3 / dP_{M,S} = - s m P_{M,S}^{-sm-1} (P_{M,S}^{s-1} g L_S + TT t_N^{-s} P_{M,N}^{s-1} E_{M,N}) + (s - 1) P_{M,S}^{-sm} (P_{M,S}^{s-2} g L_S) \quad \textbf{(83)}$$

$$= P_{M,S}^{k-1} \{- s m [g L_S + TT t_N^{-s} (P_{M,N} / P_{M,S})^{s-1} E_{M,N}] + (s - 1) g L_S\}. \quad \textbf{(84)}$$

Let $(P_{M,N} / P_{M,S})^{1-s} \equiv g_2(n_S)$. **(85)**

Then, $g_2(0) = (T t_S)^{s-1}$ **(86)**

and, for given $P_{M,N}$,

$$g_2'(n_S) = (s - 1) P_{M,N}^{1-s} P_{M,S}^{s-2} (dP_{M,S} / dn_S) \quad \textbf{(87)}$$

$$< 0, \text{ by (73).} \quad \textbf{(88)}$$

For now, let us set

$$g_2(.) \equiv g_2(0) = (T t_S)^{s-1}. \quad \textbf{(A8)}$$

Then, using (73), (84) reduces to

$$df_3 / dn_S > / = / < 0, \text{ according as } m > / = / < m^*, \quad \textbf{(89)}$$

where m^* is given in (30). Next, let us allow for backward linkages, i.e., use (78)–(81) to determine $g_1(n_S)$, rather than assume (A7). Then, (74) reduces to

$$0 \geq f_4 \equiv f_3 + P_{M,S}^k g_1(n_S), \; n_S \geq 0, \text{ c.s.} \quad \textbf{(90)}$$

$$\Rightarrow \quad df_4 / dn_S = df_3 / dn_S + h_1(n_S) \quad \textbf{(91)}$$

where $h_1(n_S) \equiv k P_{M,S}^{k-1} g_1(n_S) (dP_{M,S} / dn_S) + P_{M,S}^k g_1'(n_S)$ **(92)**

$$= - m [V s / (s - 1)]^s (s - 1) P_{M,S}^{s-2} n_N (p_N T t_S)^{1-s} (dP_{M,S} / dn_S), \text{ by (78) and (80)} \quad \textbf{(93)}$$

$$> 0, \text{ by (73)} \quad \textbf{(94)}$$

$$\Rightarrow \quad df_4 / dn_S > / = / < 0, \text{ according as } m > / = / < \mu_2^*(n_S), \quad \textbf{(95)}$$

where $\mu_2^*(n_S) < m^*, \ \forall n_S.$ **(96)**

This critical value of m is likewise reduced when we use (85)–(88) to determine $g_2(n_S)$, rather than assume (A8):

$$df_2 / dn_S > / = / < 0, \text{ according as } m > / = / < \mu_3^*(n_S), \quad \textbf{(97)}$$

where $\mu_3^*(n_S) < \mu_2^*(n_S) < m^*, \ \forall n_S.$ **(98)**

This analysis was predicated on (A6). Smoothness of f_2 then establishes (i). Finally, (3) establishes (ii).[CLEAN UP] **QED**.

Proposition 4. (i) If the South initially produces no manufactures, then Southern tariffs further discourage Southern manufacturing if and only if $m > m^*$, that is, the relative size of Northern markets is sufficiently large, linkages are sufficiently strong, and trade barriers are not too high. (ii) Under the same conditions, Southern tariffs expand the set of parameters such that there exists an equilibrium without Southern manufacturing.

Proof. Consider (70).

$$df / dt_S = - s m T^{-sm} t_S^{-sm-1} [(T t_S)^{s-1} g L_S + TT t_N^{-s} E_{M,N}] + (s - 1) (T t_S)^{-sm} (T^{s-1} g L_S t_S^{s-2}) \quad \textbf{(99)}$$

$$= T^{-sm} t_S^{-sm-1} \{- s m [(T t_S)^{s-1} g L_S + TT t_N^{-s} E_{M,N}] + (s - 1) (T t_S)^{s-1} g L_S\} \quad \textbf{(100)}$$

$$< / = / > 0, \text{ according as } m > / = / < m^*, \quad \textbf{(101)}$$

where m^* is given in (30). Let

$$z \equiv [(T t_S)^{s-1} g L_S + TT t_N^{-s} E_{M,N}]^2 > 0. \quad \textbf{(102)}$$

Then $\lim [(L_S / E_{M,N}) \to 0] \ m^* = 0,$ **(103)**

$$dm^* / dL_S = [(s - 1) / s] (t_S^{s-1} g t_N^{-s} E_{M,N}) / z > 0, \quad \textbf{(104)}$$

$$dm^* / dE_{M,N} = - [(s - 1) / s] (t_S^{s-1} g L_S t_N^{-s}) / z < 0, \quad \textbf{(105)}$$

$$\lim [(L_S / E_{M,N}) \to \infty] \ m^* = (s - 1) / s, \quad \textbf{(106)}$$

$$\lim \{\{T, t_S, t_N\} \to 1\} \ m^* = [(s - 1) / s] [g L_S / (g L_S + E_{M,N})], \quad \textbf{(107)}$$

$$dm^* / dt_S = [(s - 1)^2 / s] (t_S^{s-2} g L_S t_N^{-s} E_{M,N}) / z > 0, \quad \textbf{(108)}$$

$$dm^* / dt_N = (s - 1) (t_S^{s-1} g L_S t_N^{-s-1} E_{M,N}) / z > 0, \quad \textbf{(109)}$$

$$dm^* / dT = 2 [(s - 1)^2 / s] (t_S^{s-1} g L_S t_N^{-s} E_{M,N} / T) / z > 0, \quad \textbf{(110)}$$

$$\lim (T \to \infty) \ m^* = \lim (t_S \to \infty) \ m^* = \lim (t_N \to \infty) \ m^* = (s - 1) / s, \quad \textbf{(111)}$$

and $\lim (T \to \infty) \ df / dt_S = \lim (t_S \to \infty) \ df / dt_S = \infty$, by (A1). **(112)**

This establishes (i). Then, smoothness of f establishes (ii). **QED**.

Proposition 5. (i) If the South initially produces no manufactures, then Southern tariffs on intermediates further discourage Southern manufacturing, whereas tariffs on final goods encourage it. (ii) Southern tariffs on intermediates expand, whereas tariffs on final goods contract, the set of parameters such that there exists an equilibrium without Southern manufacturing.

Proof. Let $t_{S,I}$ and $t_{S,F}$ denote, respectively, tariffs on intermediates and on final goods. Rewrite (70) as

$$0 \geq f \equiv (T t_{S,I})^{-sm} [(T t_{S,F})^{s-1} g L_S + TT t_N^{-s} E_{M,N}] - [s V / (s - 1)]^s P_{M,N}^{-k}. \quad \textbf{(113)}$$

Then $df / dt_{S,I} = - s m T^{-sm} t_S^{-sm-1} [(T t_S)^{s-1} g L_S + TT t_N^{-s} E_{M,N}] < 0,$ **(114)**

and $df / dt_{S,F} = (s - 1) T^k t_S^{k-1} g L_S > 0.$ **(115)**

This establishes (i). Then, smoothness of f establishes (ii). **QED**.

10.2. The 'Large Economy' Case

We now allow for the endogenous determination of $E_{M,N}$, n_N, p_N, and $P_{M,N}$. By (A4),

$$E_{M,N} + (E_{M,S} / t_S) = (w_N L_{M,N}) / (1 - m), \quad \textbf{(116)}$$
$$E_{M,S} = g L_S, \quad \textbf{(117)}$$
$$E_{M,N} = g w_N L_N + m (w_N L_{M,N}) / (1 - m). \quad \textbf{(118)}$$

(116) states that, for the world as a whole, total manufacturing expenditure, net of tariff revenues, equals the value of output, which is the wage bill divided by the labor share. (117) and (118) give manufacturing expenditure in each location; Northern expenditure includes intermediate demand.

We first analyze whether the North is completely specialized in manufacturing. If so,

$$L_{M,N} = L_N, \quad \textbf{(119)}$$
$$\Rightarrow \quad w_N = g L_S / [t_S (1 - g) L_N], \quad \textbf{(120)}$$
$$E_{M,N} = g L_S [g + m / (1 - m)] / [t_S (1 - g)], \text{ by (116)–(118).} \quad \textbf{(121)}$$

Given that Northern workers can always move into agriculture, if (120) yields $w_N < 1$, then the North must in fact be incompletely specialized. Then

$$w_N = 1, \quad \textbf{(122)}$$
$$\Rightarrow \quad L_{M,N} = g (L_N + L_S / t_S), \quad \textbf{(123)}$$
$$E_{M,N} = g (L_N + m L_S / t_S) / (1 - m), \text{ by (116)–(118).} \quad \textbf{(124)}$$

Next, we check that it is unprofitable to produce in the South. We can write (68) as an upper bound on Northern aggregate manufacturing prices:

$$P_{M,N}^{\,k} \le (T t_S)^{s\,m} [s V / (s - 1)]^s / [(T t_S)^{s-1} g L_S + TT\, t_N^{-s} E_{M,N}]. \quad \textbf{(125)}$$

We can also write (68) as an upper bound on Northern wages. By (26),

$$n_N = (w_N L_{M,N}) / [(1 - m) p_N] \quad \textbf{(126)}$$
$$\Rightarrow \quad P_{M,N} = [(w_N L_{M,N}) / (1 - m)]^{1/(1-s)} p_N^{\sigma/(s-1)}, \text{ by (65)} \quad \textbf{(127)}$$
$$= [(w_N L_{M,N}) / (1 - m)]^{1/(1-s)} \{[V s / (s - 1)] w_N^{1-m} P_{M,N}^{\,m}\}^{s/(s-1)}, \text{ by (12)} \quad \textbf{(128)}$$
$$= [(1 - m) / L_{M,N}]^{1/(s-1)} [V s / (s - 1)]^{s/(s-1)} w_N^{\,k/(s-1)} P_{M,N}^{\,m\,s/(s-1)} \quad \textbf{(129)}$$

$$\Leftrightarrow \quad P_{M,N}^{\,k} = [(1 - m) / L_{M,N}] [V s / (s - 1)]^s w_N^{\,k} \quad \textbf{(130)}$$
$$\Leftrightarrow \quad w_N^{\,k} \le [L_{M,N} / (1 - m)] (T t_S)^{\sigma\mu} / [(T t_S)^{s-1} g L_S + TT\, t_N^{-s} E_{M,N}], \text{ by (125).} \quad \textbf{(131)}$$

The South indeed produces no manufactures if, given either (119)–(121) or (122)–(124), Northern aggregate manufacturing prices are low enough that (125) holds, or equivalently Northern wages are low enough that (131) holds.

Assume that the North is incompletely specialized in manufacturing, i.e., (120) yields $w_N < 1$ because g or (L_S / L_N) are low, or t_S is high. Using (122)–(124), (131) reduces to

$$0 \ge f_2 \equiv (1 - m) [t_S / (L_S + L_N t_S)] [(T t_S)^{s-1} L_S + TT\, t_N^{-s} (L_N + m L_S / t_S) / (1 - m)] - (T t_S)^{\sigma\mu}. \quad \textbf{(132)}$$

Assume instead that the North is completely specialized in manufacturing and remains so after the policy change, i.e., (120) holds throughout with $w_N \ge 1$. Using (119)–(121), (131) reduces to

$$0 \ge f_3 \equiv \{g L_S / [(1 - g) L_N]\}^k [(1 - m) / L_N] - T^{\sigma\mu} t_S^{\sigma-1} / \{g L_S \{(T t_S)^{s-1} + TT\, t_N^{-s} [g + m / (1 - m)] / [t_S (1 - g)]\}\}. \quad \textbf{(133)}$$

Proposition 6. There exist $\{\underline{L}, \bar{g}\} \in (0, 1)$, $\underline{m} \in (0, (s - 1) / s)$, and $\{\bar{t}_S, \underline{T}, \bar{T} : \underline{T} < \bar{T}\} \in (1, \infty)$,

such that, if $(L_N / L_S) \geq \underline{L}$, $g \leq \bar{g}$, $m \geq \underline{m}$, $t_S \leq \bar{t}_S$, and $T \in [\underline{T}, \bar{T}]$, then there exists an equilibrium without Southern manufacturing: $n_S = 0$, and $w_S = 1$.

Proof. Follows by direct inspection of (122)–(124) and (132), (119)–(121) and (133), smoothness of f, and smoothness of f_2. **QED**.

Krugman & Venables (1995) establish this proposition in the special case of no tariffs, $t_S = t_N = 1$, and equal populations, $L_N = L_S$. We now consider how an increase in Southern tariffs affects the viability of the equilibrium without Southern manufacturing.

Proposition 7. Let the North be incompletely specialized in manufacturing. (i) If the South initially produces no manufactures, then Southern tariffs further discourage Southern manufacturing if and only if linkages are sufficiently strong; if the relative size of Northern markets is sufficiently large; and only if transport costs and Southern tariffs are not too high. (ii) Under the same conditions, Southern tariffs expand the set of parameters such that in equilibrium there is no Southern manufacturing.

Proof. Consider (132), and let

$$S_j \equiv L_j / (L_S + L_N t_S) \in (0,1), \; j = N, S. \tag{134}$$

Then
$$df_2 / dt_S = (1 - m) S_S [(T t_S)^{s-1} S_S + TT t_N^{-s} (S_N + m S_S / t_S) / (1 - m)] - m t_S S_S TT t_N^{-s} / t_S^2 + (1 - m) t_S S_S (s - 1) T^{\sigma-1} t_S^{\sigma-2} - m s T^{\sigma\mu} t_S^{\sigma\mu-1} \tag{135}$$

$$= (1 - m) S_S [(T t_S)^{s-1} (S_S + s - 1) + TT t_N^{-s} S_N] - m s T^{\sigma\mu} t_S^{\sigma\mu-1}; \tag{136}$$

$$\lim (m \to 0) \; df_2 / dt_S = S_S [(T t_S)^{s-1} (S_S + s - 1) + TT t_N^{-s} S_N] > 0; \tag{137}$$

$$d^2 f_2 / (dt_S \, dm) = - S_S [(T t_S)^{s-1} S_S + TT t_N^{-s} (S_N + m S_S / t_S) / (1 - m)] + S_S TT t_N^{-s} (S_N + S_S / t_S) / (1 - m) - t_S S_S TT t_N^{-s} / t_S^2 - t_S S_S (s - 1) T^{\sigma-1} t_S^{\sigma-2} - s T^{\sigma\mu} t_S^{\sigma\mu-1} [1 + m s \ln (T t_S)] \tag{138}$$

$$= - S_S [(T t_S)^{s-1} (S_S + s - 1) + TT t_N^{-s} S_N] - s T^{\sigma\mu} t_S^{\sigma\mu-1} [1 + m s \ln (T t_S)] \tag{139}$$

$$< 0; \tag{140}$$

$$\lim [m \to (s - 1) / s] \; df_2 / dt_S = (S_S / s) [(T t_S)^{s-1} (S_S + s - 1) + TT t_N^{-s} S_N] - (s - 1) T^{s-1} t_S^{s-2} \tag{141}$$

$$< 0, \text{ for } s \text{ large enough}; \tag{142}$$

$$\lim [(L_S / L_N) \to 0] \; df_2 / dt_S = - m s T^{\sigma\mu} t_S^{\sigma\mu-1} < 0; \tag{143}$$

$$d^2 f_2 / [dt_S \, d(L_S / L_N)] = (1 - m) \{[(L_S / L_N) (2 T^{\sigma-1} t_S^{\sigma} - TT t_N^{-s}) + TT t_N^{-s} t_S] / [(L_S / L_N) + t_S] + (s - 1) T^{\sigma-1} t_S^{\sigma}\} / [(L_S / L_N) + t_S]^2 > 0; \tag{144}$$

$$\lim [(L_S / L_N) \to \infty] \; df_2 / dt_S = s [(1 - m) (T t_S)^{s-1} - m T^{\sigma\mu} t_S^{\sigma\mu-1}]; \tag{145}$$

$$\lim \{\{T, t_S\} \to 1\} \; df_2 / dt_S = (1 - m) [L_S / (L_S + L_N)^2] [L_S + t_N^{-s} L_N] + (1 - m) [L_S / (L_S + L_N)] (s - 1) - m s \tag{146}$$

$$\leq s \{(1 - m) [L_S / (L_S + L_N)] - m\} \tag{147}$$

$$< 0, \; \forall m > L_S / (2L_S + L_N) \in (0,1/2); \tag{148}$$

$$\lim (T \to \infty) \; df_2 / dt_S = \lim (t_S \to \infty) \; df / dt_S = \infty, \text{ by (A1)}; \tag{149}$$

$$d^2 f_2 / (dt_S \, dt_N) = - s (1 - m) S_S TT t_N^{-s-1} S_N < 0; \tag{150}$$

and
$$\lim (t_N \to \infty) \; df_2 / dt_S = (1 - m) S_S (T t_S)^{s-1} (S_S + s - 1) - m s T^{\sigma\mu} t_S^{\sigma\mu-1}. \tag{151}$$

Consider (135)–(151). (df_2 / dt_S) is strictly positive for m sufficiently small, decreases monotonically with m, and becomes strictly negative as $m \to [(s - 1) / s]$, for s sufficiently large. Also, (df_2 / dt_S) is strictly negative for (L_S / L_N) sufficiently small, and increases monotonically with (L_S / L_N). Further, for sufficiently small transport costs and Southern tariffs, (df_2 / dt_S) must be strictly negative $\forall m \geq 1/2$. But as such trade barriers become arbitrarily large, so does (df_2 / dt_S). This establishes (i). Smoothness of f_2 then implies (ii). **QED**.

Intuitively, LDC tariffs again reduce demand for Northern manufactures. Since the North is incompletely specialized, this does not affect Northern wages, by (122), but rather reduces Northern manufacturing employment, by (123), and the number of Northern firms, by (126). This reduces Northern manufacturing productivity, and increases both individual and aggregate Northern manufacturing prices, by (130) and (12). Hence, LDC tariffs now have an adverse effect on LDC terms-of-trade. This exerts three effects. First, it increases the Northern demand facing LDC entrants, by (62). In addition, higher Northern aggregate manufacturing prices feed through into higher LDC prices, by (64). This affects potential LDC firms in both their product *and* input markets. Specifically, the domestic demand facing LDC entrants increases, by (62). However, potential LDC firms' supply decreases, i.e., their costs and profit-maximizing price increase, by (12). Given (A1), the overall effects on quantities demanded in, and the profitability of production for, both the Southern and Northern markets are positive, and appear respectively as the first and second terms in (135).

Further, the reduction in LDC demand for Northern manufactures induces a reduction in Northern intermediate demand and hence manufacturing expenditure, by (124). This decreases the Northern demand facing LDC entrants, by (62), and appears as the negative third term in (135). However, taking into account the terms-of-trade effect, the overall effect on quantities demanded in the North, given by the second term in brackets in (136), is positive.

Finally, higher tariffs directly increase LDC aggregate manufacturing prices, by (64). Again, this increases both the LDC demand facing potential LDC firms, and the latter's costs. These two effects appear, respectively, as the positive fourth term and the negative fifth term in (135). The increase in demand only applies to the LDC market, whereas the increase in costs affects production for both markets. Hence, while (A1) still ensures a positive effect on quantities demanded and profitability in the Southern market, the profitability of production for the Northern market decreases. If the Northern market is much larger, the latter effect dominates.

The sign of the overall impact on the profitability of LDC entry depends on the strength of linkages, m. Stronger linkages exert the following effects. First, they magnify the impact of the terms-of-trade deterioration on the costs of LDC entrants, by (12) and (64). This weakens the positive impact of an increase in Northern manufacturing prices on quantities demanded in both LDC and Northern markets, as shown, respectively, by the negative first & second terms in (138).

Second, in equilibrium, stronger linkages are associated with an increase in Northern manufacturing expenditure and in the share of intermediate demand in manufacturing expenditure, by (124). The increase in the size of the total Northern market magnifies the absolute positive impact of an increase in Northern manufacturing prices on the Northern demand facing potential LDC firms, and appears as the positive third term in (138). Conversely, since LDC tariffs do not affect Northern final demand, the increase in the share of intermediate demand magnifies the negative impact of LDC tariffs on Northern manufacturing expenditure, as shown by the negative fourth term in (138). Taking into account the change in the terms-of-trade effect, the total impact on the change in Northern demand, given by the second term in brackets in (139), is negative.

Third, stronger linkages magnify the direct impact of LDC tariffs on the costs of LDC entrants, by (12) and (64). This appears as the negative sixth term in (138). Finally, stronger linkages imply that potential LDC firms are at a greater competitive disadvantage and face smaller domestic sales, by (130). Given iso-elastic demand, this reduces the *marginal* impact of LDC tariffs on the domestic sales of LDC entrants, and appears as the negative fifth term in (138).

Overall, if linkages are sufficiently strong, an increase in LDC tariffs, and the induced increase in Northern manufacturing prices, exerts an adverse impact on LDC production costs which outweighs the positive impact on the demand facing potential LDC firms. If instead linkages are weak, then tariffs encourage entry.

An increase in the relative size of Northern markets, L_N/L_S, has two consequences. First, the impact of LDC tariffs on the terms of trade diminishes: by (123) and (130), the elasticity of aggregate Northern manufacturing prices with respect to LDC tariffs is proportional to $[L_S / (L_S + L_N t_S)]$. Second, the beneficial impact of tariffs on domestic demand becomes less important, relative to their harmful impact on the cost of LDC production for export. As (L_N/L_S) becomes arbitrarily large, the cost effect eventually dominates.

Finally, greater transport costs or LDC tariffs increase the relative importance to LDC firms of the domestic market. Here, by assumption, the demand effect of tariffs outweighs the impact on costs. As such barriers to trade become arbitrarily large, tariffs eventually encourage LDC mfg.

Proposition 8. Assume that the North is and remains completely specialized in manufacturing. (i) If the South initially produces no manufactures, then Southern tariffs further discourage Southern manufacturing. (ii) Southern tariffs expand the set of parameters such that in equilibrium there is no Southern manufacturing.

Proof. Consider (133).

$$df_3 / dt_S < 0. \qquad \textbf{(152)}$$

This establishes (i). Smoothness of f_3 then implies (ii). **QED**.

Intuitively, LDC tariffs reduce demand for Northern manufactures. Since the North is completely specialized, this reduces proportionately Northern wages, by (120), manufacturing expenditure, by (121), and aggregate manufacturing prices, by (130). The fall in Northern expenditure and aggregate prices reduce the *Northern* demand facing LDC entrants, by (62).

In addition, the higher tariffs exactly offset the reduction in import prices, with no change in LDC aggregate manufacturing prices, by (64). This yields two implications. First, there is no change in the *Southern* demand facing potential LDC firms, by (117) and (62). Hence, the *total* demand facing LDC entrants declines. Second, potential LDC firms' supply, i.e., their profit-maximizing price, is unchanged, by (12). Overall, LDC tariffs discourage LDC manufacturing through their negative impact on Northern wages, expenditure, and terms-of-trade.

11. Appendix III: The Role of Multinationals

Proposition 9. Let there be no intermediates. In equilibrium, MNC exist if and only if $T \geq \underline{T}$, while national enterprises (NE) exist if and only if $T \leq \underline{T}$.

Proof. Let

$$g \equiv (1 - T^{1-s}) / (1 + T^{1-s}) - (G + 2H) / (F + G), \quad \textbf{(153)}$$

Brainard (1993a), extended in Spatafora (1996), show that MNC exist if and only if $g \geq 0$, while national enterprises (NE) exist if and only if $g \leq 0$. The rest follows by direct inspection. **QED**.

Proposition 10. Allow for intermediates. Consider the non-specialized equilibrium. (i) MNC still exist if and only if $T \geq \underline{T}$, while national enterprises (NE) still exist if and only if $T \leq \underline{T}$. (ii) If $T > \underline{T}$, then the (pure MNC) equilibrium is stable. (iii) If $T \leq \underline{T}$, then the equilibrium is stable if and only if $T > T^*$.

Proof. (i) is established analogously to Proposition 9. The text establishes (ii) and (iii). **QED**.

12. Appendix IV: Tariff-Revenue Redistribution

If tariff revenues are redistributed in a lump-sum fashion to the representative consumer, the model must be modified as follows. First, for each country j variety sold abroad, the dutiable price is $(p_j T)$, and the dutiable quantity is (q_{Xj} / T). Hence, total tariff revenues TR are

$$TR_j = (t_j - 1) n_{j\_} p_{j\_} q_{Xj\_}, \; j = N, S. \quad \textbf{(154)}$$

Second, the budget constraint, (17), becomes

$$E_j = w_j L_j + TR_j, \; j = N, S. \quad \textbf{(155)}$$

Third, total expenditure on manufactures, (19), becomes, using (11) and (154),

$$E_{Mj} = [\gamma w_j L_j + \mu (n_j p_j q_n + \mu TC_j^M)] \; / \; [1 - \gamma (t_j - 1) n_{j\_} (p_{j\_} T)^{1-s} t_j^{-s} P_{Mj}^{s-1}], \; j = N, S. \quad \textbf{(156)}$$

This model is hard to characterize analytically. Nevertheless, extensive numerical simulations suggest that all our qualitative results continue to hold.

13. References

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Figure 1. Simulation Results.

Figure 2. Simulation Results.

Figure 3. Simulation Results.

Figure 4. Simulation Results.

Figure 5. Simulation Results.

Figure 6. Simulation Results.

Figure 7. Simulation Results.

Figure 8. Simulation Results.

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Figure 10. Simulation Results.

Figure 11. Simulation Results.