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ABSTRACT

The literature on multinationals and developing countries has examined the causality running from direct investment to changes in country characteristics (wages, productivity, skills, etc.) and also the opposite direction of causality, from existing country characteristics to inward direct investment. This paper contributes to the second line of research, inquiring into the question of what country characteristics, particularly market size and labor-force composition, attract inward investment. This approach is motivated by the empirical observation that the poorest countries attract a far smaller share of world direct investment than their share of income. Small markets receive less investment per capita than larger ones. We develop a model that generates both stylized facts in equilibrium, suggesting the existence of a development trap for small, skilled-labor-scarce countries.

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1. Introduction

International trade theory has now been extended to endogenize multinational firms in models with imperfect competition and scale economies in production. The models can be roughly divided into those with "horizontal" multinationals, which build plants in multiple countries to produce the same good or service, and "vertical" multinationals which geographically fragment the production process into a headquarters and a final production activity. An example of the former is Markusen (1984) and one of the latter is Helpman (1984).

The basic idea behind vertical multinationals is that they are able to exploit factor-price differences in the world economy, locating skilled-labor-intensive phases of operation in a skilled-labor-abundant country and unskilled-labor-intensive or resource-intensive phases in suitable locations. The usual example is a multinational firm that produces knowledge-intensive services and perhaps skilled-labor-intensive intermediate inputs at home. The firm supplies services of the knowledge assets and ships the intermediates to a low wage country for assembly, repatriating a large portion of the final output. The production structure of the U.S. semiconductors industry is a good example of vertical MNEs. Blueprints and key components such as chips are designed and produced in the parent plants in the U.S.. Then the chips are shipped to the testing and assembly facilities of subsidiaries in Southeast Asia, where the finished products are assembled by cheap unskilled-labor. Finally the finished products are shipped back to sales destinations in the U.S. and elsewhere (Yoffie, 1993).

It is thus not surprising that the existing literature on the vertical MNEs is founded

on the benefits of labor division, through relocating the unskilled-labor intensive stage (or plants) to foreign countries where wages of the unskilled-labor are relatively low (Helpman and Krugman, 1985). This literature can be seen as a refinement of the conventional framework of comparative advantages, according to which the vertical MNEs are the consequence of the across-country differences of factor endowments. The tendency for vertical MNEs to exploit foreign cheap labor, implied by this framework, leads to a positive link between vertical MNEs and across-country differences of factor proportions. According to such a comparative-advantage perspective, we should see larger FDI flows into the countries with greater relative labor abundance. However, the most labor-abundant countries actually have been receiving very little investment. Table 1 shows inward FDI flows of the least developed countries (LDCs) during the period 1983-1994. Though LDC's shares of domestic production and population in all developing countries were above 4% and 11% respectively, their share of FDI in all developing countries averaged less than 2% in the period, and the share even declined to 1% in 1994.

Another drawback in the existing literature is that role of the country size in terms of GDP of host countries have been overlooked. Table 2 shows FDI flows into developing countries and their links with GDP per capita and country size in terms of GDP of host economies. The size of host economies is positively linked to FDI. As shown in the last column of the table, within the same income levels, larger countries in terms of GDP receive greater amounts of FDI.[1] However, a systematically causal relationship between

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[1] In the group of countries with GDP per capita less than $300, larger countries in terms of GDP attracted less FDI than small countries. This is caused by the fact that some populous but low income countries such as Bangladesh, Myanmar, and Zaire received little FDI, while some small

Table 1 Foreign Direct Investment Flows into the Least Developed Countries, 1983-1994 (FDI and GDP in US$ Millions, and population in millions)

Year	FDI, GDP, Population	Least Developed Countries (LDCs)	All Developing Countries (DCs)	Share of LDCs in All DCs (%)
1983-1988 (Average)	FDI	337	19757	**1.71**
	GDP	142891	3269034	4.37
	Population	411	3764	10.92
1989	FDI	1201	28622	**4.20**
	GDP	170114	3662204	4.65
	Population	496	4045	12.26
1990	FDI	423	34698	**1.22**
	GDP	174220	3776691	4.61
	Population	510	4122	12.37
1991	FDI	1063	40889	**2.60**
	GDP	176300	3917428	4.50
	Population	525	4200	12.50
1992	FDI	740	54750	**1.35**
	GDP	178260	4063903	4.39
	Population	540	4280	12.62
1993	FDI	786	73350	**1.07**
	GDP	180431	4216314	4.28
	Population	556	4362	12.74
1994	FDI	853	84241	**1.01**
	GDP	182468	4373388	4.17
	Population	572	4444.5	12.87

Note: FDI and GDP are in millions of US dollars. Population is also measured as millions. The Least Developed Countries (LDCs), following the definition of the United Nations, include countries (48 in number) as follows: Afghanistan, Angola, Bangladesh, Benin, Bhutan, Burkina Faso, Burundi, Cambodia, Cape Verde, Central African Republic, Chad, Comoros, Djibouti, Equatorial Guinea, Eritrea, Ethiopia, Gambia, Guinea, Guinea-Bissau, Haiti, Kiribati, Lao People's Democratic Republic, Lesotho, Liberia, Madagascar, Malawi, Maldives, Mali, Mauritania, Mozambique, Myanmar, Nepal, Niger, Rwanda, Samoa, Sao Tome and Principe, Sierra Leone, Solomon Islands, Somalia, Sudan, Togo, Tuvalu, Uganda, United Republic of Tanzania, Vanuatu, Yemen, Zaire, and Zambia.

Source: Complied from The Least Developed Countries 1996 Report (UNCTAD, 1996)

Table 2 Inward FDI Flows and Their Links with GDP Per Capita and National Income of Developing Countries in 1993

Country Groups by GDP Per Capita (US$)	Average FDI Per Capita (US$)	Country Groups by Country Size in GDP (US$, millions)	Average FDI Per Capita (US$)
> 5000	226.89	> 55000[1]	242.20
		< 49000[2]	53.83
2500 - 5000	45.30	> 31000[3]	45.73
		<17000[4]	32.30
1200 - 2500	33.02	> 10000[5]	33.43
		<9600[6]	30.60
600 - 1200	10.06	> 10000[7]	10.86
		< 9300[8]	2.59
300 - 600	6.56	> 4800[9]	6.91
		< 3700[10]	3.68
< 300	0.63	> 2000[11]	0.34
		< 1500[12]	2.47

Note: [1] Including Korea, Argentina, Taiwan, Saudi Arabia, Hong Kong, Israel, and Singapore. [2] Including Libya, Slovenia, Oman, Cyprus, Bahrain, Bahamas, Malta, Netherlands Antilles, Barbados, Antigua & Barbuda, and Seychelles. [3] Including Brazil, Mexico, Turkey, Malaysia, Venezuela, Chile, Hungary, and Czech Republic. [4] Including Croatia, Uruguay, Panama, Gabon, and Botswana. [5] Including Thailand, Poland, Columbia, Peru, Tunisia, Ecuador, and Slavak Republic. [6] Including Dominica Republic, EI Salvador, Costa Rica, Paraguay, Papua New Guinea, Latvia, and Jamaica. [7] Including Indonesia, Philippines, Egypt, Morocco, Romania, Guatemala, Cameroon, and Bulgaria. [8] Including Cote d'Ivoire, Senegal, Bolivia, Jordan, Lithuania, Congo, and Armenia. [9] Including Pakistan, Nigeria, Sri Lanka, Afghanistan, Sudan, Ghana, Zimbabwe, And Angola. [10] Including Zambia, Honduras, Guinea, Benin, Nicaragua, Togo, Central African republic, Mauritania, and Mongolia. [11] Including Bangladesh, Myanmar, Zaire, Kenya, Ethiopia, Madagascar, Nepal, Uganda, Burkina Faso, Mali, Tanzania, Cambodia, Nigeria, and Malawi. [12] Including Rwanda, Haiti, Mozambique, Laos, Chad, Somalia. Albania, Burundi, Sierra Leone, and Guinea-Bissau. China, with $490 of GDP per capita and $23 of FDI per capita, is not included because its huge economy size. India (GDP per capita is $270 and zero FDI) is excluded because its very restrictive policy towards FDI. For political reasons or wars, South African, Iran, and Yugoslavia with zero FDI are also excluded. Those very small island countries with population less than one million are not included.

Sources: Data of FDI are from International Monetary Fund (1995), Balance of Payments Statistics Yearbook 1995. Data of GDP and Population are from International Monetary Fund (1995), International Financial Statistics Yearbook 1995.

FDI flows and host country per capita income and country size has not been generated from a theoretical perspective yet.

The purpose of this paper is to extend some recent work (particularly Markusen and Venables, 1996,1997) in order to explain the low level of direct investment into small, and skilled-labor scarce countries. Our basic believe is that there are various added costs to investing abroad, and much of this falls on fixed costs and directly or indirectly on skilled labor in the host country. In terms of direct requirements, the multinational needs local engineers, technicians, managers, accountants, etc. In terms of indirect requirements, there is a need for minimal social infrastructure including reliable electrical and water supplies, telecommunications, transport links, and legal institutions. Poor countries are often lacking in both these categories, and it is our guess that if they become sufficiently scarce, multinationals will not invest even if host-country unskilled labor becomes essentially free.

In this paper, we focus on the direct skilled-labor requirements of the multinational firms in the host country as a possible constraint on investment, hoping to treat infrastructure in a later paper. We also find an important role for country size in two senses: fixed costs make market size important and secondly, the smaller the local market the larger the proportion of final output that must be shipped back to the multinational's home country, adding to the total transport cost bill.

The model involves two countries. Country h is a high-income, skilled-labor abundant country and country f is unskilled-labor abundant. There is a composite competitive sector Y, which produces a homogeneous good. The advanced sector produces a skilled-labor-

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countries like Laos and Albania attracted relatively more FDI due to the liberalization of their FDI policies.

intensive intermediate good, Z, which we exogenously assume can be produced only in country h. Then this intermediate is used along with unskilled labor to assemble a final product X. Assembly can take place in either country, but there are plant-level fixed costs which include minimal levels of skilled labor that must be drawn from the country in which the plant is located. There are in addition firm-level fixed costs in R&D, etc. but since these must be drawn from country h, they do not play a strong role in the model.

There are two firm "types" in the model. Type-d firms are integrated firms that do headquarters activities, produce Z, and produce X in country h. Type-m firms are multinationals that fragment production geographically, producing Z in country h and exporting Z to country f where it is assembled into X. For these type-m firms, a portion of X remains in country f to be sold in the local market and a portion is shipped back to country h.

Several results fit the stylized facts noted above. First, there is an inverted U-shaped relationship between the amount of investment country f receives and its endowment ratio. As it becomes very similar to country h, there is no factor-cost reason to fragment production of Z and X, and doing so incurs the added shipping costs of first sending Z to country f and then sending X back to country h. As the countries become extremely different, country f is so skilled-labor scarce that the costs due to local skilled-labor requirements become prohibitive. Inward investment in X assembly plants is thus maximized when country f is unskilled-labor abundant relative to country h, but not extremely so.

Second, country size plays the roles just noted, meaning that direct investment

relative to total country f income falls as country f becomes extremely small. As country f becomes small, a larger and larger proportion of the output of an assembly plant must be shipped back to country h for final sale. Aggregate transport costs thus increase for type-m firms and conversely, aggregate transport costs fall for domestically-integrated type-d firms, as they ship a smaller and smaller proportion of their output to country f for final sale.

2. Technology and Equilibrium Market Structure

The theories developed to explain vertical MNEs tend to answer following two questions. First, why are the different stages of production operated under the same ownership and control rather than separate firms? An answer to this question is provided by the vertical integration theory which explains the advantages of internalizing the markets.[2] Internalization is associated with the vertical multi-plant scale economies and the coordination of different stages of production. This paper will not discuss internalization in detail, but it will use the conclusions of the internalization by taking vertical integration for granted.

Second, given same ownership, why are the different stages of production located in different countries rather than in one? The answer to this question relies on the advantages of ownership and location. The ownership advantage of a firm can be seen as something that gives the firm market power or cost advantage, while other firms have no access to

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[2] Mark Casson (1984) provided a detailed survey of the theory of vertical integration, in which he examined the various aspects of vertical integration within a unified framework of internalization. Markusen (1995) surveys more recent contributions more specific to international trade theory.

these benefits. These advantages include patents, blueprints, and brand names. Location advantages refers to various features owned by the potential host country that make the country profitable for multinational production. Cheap labor, for example, is the most obvious source of the location advantage. Trade barriers such as tariffs and transport costs are also sources of location advantages if the finished goods of MNEs are sold at foreign markets, but they deter investment if much of the final output is shipped back to the home country.

Our model is as follows:

(1) There are two countries, home and foreign (*h* and *f*), producing two goods *(Y* and *X)* using two factors, unskilled labor (*L*) and skilled labor *(S)*. *L* and *S* are required in both sectors and are mobile between sectors but are internationally immobile. Country *h* is relatively skilled-labor abundant.

(2) *Y* is produced with *L* and *S* under constant return to scale and perfect competition. *Y* will be used as numeraire throughout the paper.

(3) *X* is produced with increasing returns and imperfect competition in two stages. In the first stage, the intermediate product *Z* is produced with *S* alone. In the second stage, *X* is assembled using unskilled labor, *L,* and the intermediate product *Z*. Each unit of *X* requires one unit of intermediate product *Z*.

(4) We assume that for some exogenous reason, Z can be produced only in country h. Assembly can occur either in country h or in country f.

(5) There are two firm "types" which can produce *X*. A type-d firm (for domestic) produces both *Z* and *X* in country h. Some *X* may or may not be exported to country f.

(6) A type-m (for multinational) firm produces *Z* in country h, which is then shipped to an assembly plant in country f. Some *X* may or may not be exported back to country h.

The term "regime" will denote the set of firm types active in equilibrium. Throughout this paper, superscripts *(d,m)* will denote domestic and multinational firms respectively. *(d,m)* as variables will indicate the number of active *d*-firms and *m*-firms. Subscript *i* will

be used to denote the countries *h* and *f*. The cost structure of the *X* industry is as follows.

b - Constant marginal production cost in units of skilled labor, S, to produce Z.

c - Constant marginal production cost in units of unskilled labor, L, to produce X. c is assumed to be the same in both countries.

u - Constant unit cost, in units of L, of shipping the final good X between markets, assumed to be the same in both directions.

t - Constant unit cost, in units of L, of shipping the intermediate good from country h to country f (incurred by type-m firms only).

G - Fixed cost, in units of L, for an X assembly plant. Incurred in country h for type-d firms, and in country f for type-m firms.

F - Fixed cost, in units of skilled labor S, incurred by type-d firms in country h.

F_h - Fixed cost, in units of skilled labor S, incurred by type-m firms in country h.

F_d - Fixed cost, in units of skilled labor S, incurred by type-m firms in country f.

$$F_h < F < F_h + F_f$$

This last assumption indicates that type-m firms must incur some skilled-labor costs in country f, and that the total skilled-labor cost for a type-m firm are somewhat higher due to the costs of doing business abroad. Overall, we are assuming that the type-m firm incurs all unskilled labor costs in country f, except for tZ^m. A type-d firm incurs all unskilled-labor costs in country h. But type-m firms do have minimal skilled-labor requirements in country f (F_f), and this assumption turns out to be crucial to the results.

The output of *Y* in country *i* is a Cobb-Douglas function.

$$(1) \qquad Y_i = L_{iy}^{\alpha} S_{iy}^{1-\alpha} \qquad i = h, f$$

Skilled labor requirements for a single type-d and type-m firms are given by:

(2) $S_h^d = F + bZ^d$

(3) $S_h^m = F_h + bZ^m \qquad S_f^m = F_f$

Let X_i^d be sales in country i of a type-d firm, while X_i^m be sales in country i of a type-m firm. The unskilled labor used in one X-assembly plant to produce $X^j = X_h^j + X_f^j$ ($j=d, m$) units of finished good in the two regimes is given by

(4) $L_f^m = G + cX_f^m + (c + u)X_h^m \qquad L_h^m = tZ^m$

(5) $L_h^d = G + cX_h^d + (c + u)X_f^d$

Let w_i and v_i (measured in terms of Y) denote the prices of unskilled and skilled labor in country i, respectively. Then the cost functions of a firm under regimes d and m are given by

(6) d: $w_h L_h^d + v_h S_h^d = w_h[cX_h^d + (c + u)X_f^d + G] + v_h(bZ^d + F)$

(7) m: $w_f L_f^m + v_f S_f^m + w_h L_h^m + v_h S_h^m = w_f[cX_f^m + (c + u)X_h^m + G]$

$$+ v_f F_f + w_h tZ^m + v_h(bZ^m + F_h)$$

where $Z^j = X^j = X_h^j + X_f^j$ ($j=d,m$), because we assume an one to one relationship between X and Z.

Let L_i^* and S_i^* be total factor endowments of country i. The adding-up constraint on labor supply, i.e., the factor-market-clearing condition, is then

(8) $L_h^* = L_{hy} + dL_h^d + mL_h^m \qquad S_h^* = S_{hy} + dS_h^d + mS_h^m$

$$(9) \qquad L_f^* = L_{fy} + mL_f^m \qquad\qquad S_f^* = S_{fy} + mS_f^m$$

In equilibrium, the X-sector makes zero profits; therefore country i's income, denoted by M_i is

$$(10) \qquad M_i = w_i L_i^* + v_i S_i^* \qquad\qquad i = h, f$$

Let X_{ic} and Y_{ic} denote the consumption of X and Y in country i. Note that part of Y produced by f will generally be exported to h (Y_{fh}). The utility of the representative consumer in each country is a Cobb-Douglas function, as follows,

$$(11) \qquad U_i = X_{ic}^{\beta} Y_{ic}^{1-\beta} \qquad X_{ic} \equiv mX_i^m + dX_i^d \qquad\qquad i = h, f$$

Maximizing utility, subject to the income constraint, the first order conditions give demands for X and Y as follows,

$$(12) \qquad X_{ic} = \frac{\beta M_i}{p_i} \qquad\qquad Y_{ic} = (1-\beta) M_i$$

where p_i denotes the price of X in country i. p_i is measured in terms of good Y.

The equilibrium in the X sector is determined by pricing equations and free-entry conditions. Let e be the proportional markups of price over marginal costs, so e_i^m and e_i^d are the markups of type-m and -d firms in market i, respectively. There are four pricing equations in the model, two for type-d firms (one for each country), and two for type-m firms (one for each market). These are written in complementary-slackness form as

follows,

$$(13) \quad p_h(1 - e_h^d) \le w_h\, c + v_h\, b \qquad X_h^d$$

$$(14) \quad p_h(1 - e_h^m) \le w_f\,(c + u) + v_h\, b + w_h\, t \qquad X_h^m$$

$$(15) \quad p_f\,(1 - e_f^d) \le w_h(c + u) + v_h\, b \qquad X_f^d$$

$$(16) \quad p_f\,(1 - e_f^m) \le w_f\, c + v_h\, b + w_h\, t \qquad X_f^m$$

There are two zero-profit conditions corresponding to the numbers of the two types of firms. Given pricing equations, zero-profits can be given as the requirement that markup revenues equal fixed costs.

$$(17) \quad p_h e_h^d X_h^d + p_f e_f^d X_f^d \le v_h F + w_h G \qquad (d)$$

$$(18) \quad p_h e_h^m X_h^m + p_f e_f^m X_f^m \le v_h F_h + w_f G + v_f F_f \qquad (m)$$

In a Cournot model with homogeneous products, the optimal markup formula is given by the firm's market share divided by the Marshallian price elasticity of demand in that market. In our model, the price elasticity is one, since we have a Cobb-Douglas utility function homogeneous of degree one. Unit elasticity reduces the firm's markup to its market share. Using demand equations, we have

$$(19) \quad e_i^d = \frac{X_i^d}{X_{ic}} = \frac{p_i\, X_i^d}{\beta M_i}$$

$$(20) \quad e_i^m = \frac{X_i^m}{X_{ic}^m} = \frac{p_i\, X_i^m}{\beta M_i}$$

Substituting the markup equations into the pricing equations gives expressions for demand or output in terms of price (recall $X^j = X_h^j + X_f^j$, $j=d, m$).

$$(21) \quad X_h^d \geq \beta M_h \frac{p_h - w_h c - v_h b}{p_h^2}$$

$$(22) \quad X_h^m \geq \beta M_h \frac{p_h - w_f (c + u) - v_h b - w_h t}{p_h^2}$$

$$(23) \quad X_f^d \geq \beta M_f \frac{p_f - w_h(c + u) - v_h b}{p_f^2}$$

$$(24) \quad X_f^m \geq \beta M_f \frac{p_f - w_f c - v_h b - w_h t}{p_f^2}$$

Each of these inequalities holds with equality if the right hand side is positive, otherwise output is zero. If the terms are positive, then the free entry condition (17) - (18) can be rewritten as:

$$(25) \quad \beta M_h \left[\frac{p_h - w_h c - v_h b}{p_h}\right]^2 + \beta M_f \left[\frac{p_f - w_h (c + u) - v_h b}{p_f}\right]^2 \leq v_h F + w_h G \qquad (type\text{-}d\ firms)$$

$$(26) \quad \beta M_h \left[\frac{p_h - w_f (c + u) - w_h t - v_h b}{p_h}\right]^2 + \beta M_f \left[\frac{p_f - w_f c - w_h t - v_h b}{p_f}\right]^2 \leq v_h F_h + w_f G + v_f F_f \qquad (type\text{-}m\ firms)$$

Now we have a completed general-equilibrium model. The four inequalities (21) - (24) are associated with two output levels (one for each regime), and the two inequalities (25) and (26) are associated with the number of firms in each regime. Moreover, goods

prices are given by equation (12), factors prices can be derived from factor-market-clearing condition equations (8) and (9), and income levels from (10).

3. Intuition from Partial Equilibrium Analysis

The inequalities in (25) and (26) contain a large number of simultaneously-determined, endogenous variables. In this section, we will therefore make some partial-equilibrium assumptions in order to try to develop some intuition about how the model works and the general-equilibrium results to follow. Let us therefore *assume* that we have an equilibrium in which there are no type-m firms, meaning that country f is specialized in good Y. Then we will inquire as to whether in fact this is an equilibrium. If country f's factor endowment is entirely allocated to Y, then the factor-price ratio is given by the slope of the Y isoquant through the endowment point.

$$(27) \qquad Y = F(L_f^*, S_f^*), \qquad \frac{F_L(L_f^*, S_f^*)}{F_S(L_f^*, S_f^*)} = \frac{w_f}{v_f}$$

The dual of the production isoquant in sector Y is zero-profit curve ($\pi_Y = 0$), which can be derived as follows. Let $C(w,v)$ be the unit cost function for Y.

$$(28) \qquad 1 = C(w_f, v_f), \qquad 0 = C_w dw_f + C_v dv_f, \qquad -\frac{dv_f}{dw_f} = \frac{C_w}{C_v} = \frac{L_f^*}{S_f^*}$$

This isocost curve is shown in the top panel of Figure 1: under the assumption that country f is specialized in Y, the slope of the isocost curve is the endowment ratio.

Fix the commodity prices and incomes in both countries and factor prices in country

h at their values in the "proposed" specialized equilibrium. Note from (13) and (15) that, if only type-d firms are active in equilibrium, then we must have $p_h < p_f$ (the markups are the same in the two countries): prices are higher in country f due to the transport cost from country h. We can then derive zero-profit curve of a potential type-m firm ($\pi_X=0$) from inequality (26) by setting it to be an equality, and taking derivatives of w_f and v_f.

$$(29) \qquad -\frac{dv_f}{dw_f} = \frac{2\beta}{F_f}\left[\frac{M_h(c+u)}{p_h^2}(p_h - w_f c - w_f u - w_h t - v_h b)\right] + \frac{2\beta}{F_f}\left[\frac{M_f c}{p_f^2}(p_f - w_f c - w_h t - v_h b)\right] + G$$

This result is shown in the lower panel of Figure 1. The slope of the potential type-m firm's zero-profit locus is clearly negative. Second, note from (26) that this zero-profit locus must touch the w_f axis, since there is clearly a value of w_f high enough that profits are negative even at v_f equal to zero. Similarly, the zero-profit curve must intersect the v_f axis by a similar argument.

Finally, consider differences in country size, measured by the distribution of total M between M_h and M_f. The proposed equilibrium has $p_h < p_f$, which is a sufficient condition for the left-most bracketed term in (26) to be smaller than the right-most bracketed term. This in turn implies that a shift in income $dM_h = -dM_f > 0$ must reduce the value of the left-hand side of (26). Thus the zero-profit locus for a potential type-m firm is closer to the origin the smaller is country f, or the larger is country h. Intuitively, when country h is larger, a higher proportion of final output must be shipped back to country h, incurring added transport costs. This is reinforced if $p_h < p_f$. Two zero-profit loci are shown in the

lower panel in Figure 1, the inner curve corresponding to a smaller country f.

We can now ask whether or not the proposed equilibrium is indeed an equilibrium. The top panel of Figure 2 puts together the two panels of Figure 1. If country f is sufficiently small as with size ratio $M_f/M_h = \delta$, the iso-cost line for type-m firms lies inside of the zero-profit locus for Y, and thus the proposed equilibrium with only type-d firms active is indeed an equilibrium. For a larger size ratio $M_f/M_h = \gamma$, there are two intersections of the zero-profit curves of the two industries. These two intersections define two endowment ratios of unskilled/skilled labor α and ß, such that between these ratios, production by a type-m firm is profitable in the proposed equilibrium.

At endowment ratios L/S less than ß in Figure 2, country f is essentially too similar to country h. Referring back to inequalities (25) and (26), w_f gets too expensive to justify the costs of shipping the intermediate good to country f and the final good back to country h. The equilibrium will involve country specialization. At endowment ratios L/S greater than α in Figure 2, we are making skilled labor just too expensive in country h to offset the lower costs of unskilled labor. These results are shown schematically in the lower panel of Figure 2. Direct investment activity will be high when the countries are in some intermediate range of endowment differences and when country f is big.

Before continuing, we would like to offer one caveat. It may appear here that we have done nothing more than to stumble on a model which generates a case of factor-intensity reversal as suggested by Figure 2.[3] But the argument presented there is full of

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[3]Our cost functions seem to imply that the elasticity of substitution in X is less than in Y (i.e., the dual cost function for X is "flatter" than that for Y Figures 1 and 2), although it is much more complicated than such a statement is in a traditional competitive model; for example, firm scale and hence output price and indeed the factor-intensity of production is not independent of relative factor

difficulties when we move to general equilibrium. For example, if the world endowment of all factors is fixed, we cannot vary the endowment ratio in country f without doing so in country h, thereby changes all prices in the proposed equilibrium. Similarly, it is generally not possible to change the distribution of income in the model without changing prices in the proposed equilibrium. Changes in factor prices change firm scale and hence commodity prices in the X industry as well. Figure 2 therefore has the status of a "hypothesis" drawn from partial-equilibrium thought experiments on inequalities (25) and (26).

4. General Equilibrium Simulations

While some insights can be gained analytically in the preceding section, the dimensionality of the model and the fact that it contains many inequalities makes the usual analytical techniques of limited value. We thus simulate the model using Rutherford's (1994) non-linear complementarity software MPS/GE, solving for the parameter values that support different production regimes. The full model involves 37 non-linear inequalities. We will use "production regime" to denote a set of firm types active (producing positive outputs) in equilibrium. For example, type-m firms only active is one regime, while both type-m and type-d active is another regime.

Figure 3 presents a complete characterization of production regimes with medium

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prices. It seems reasonable to assume that minimum levels of skilled labor are more important to industrial production than to traditional agriculture, for example, where skilled and unskilled labor may be good substitutes. But we have also implicitly assumed that skilled labor cannot be used in variable costs in substitution for unskilled labor in X. We believe that the model generalizes to a case where S and L have the identical productivity in activities we have specified as using L only, but not vice versa. Provided that S is more expensive than L in equilibrium, a firm would never choose to use S in activities that we assume can use only L. In such a case, the crucial assumption is that of minimum skilled-labor requirements in X, an assumption which we feel is reasonable.

transport costs. t and u are each set at 5% of the marginal production cost of Z and X respectively (i.e., t and τ are not equal to each other in units of L). The horizontal axis of Figure 3 indexes relative country size, with the two countries identical in all respects in the middle cell (column 10) of the bottom row (row 1). Country h is small and f is large in the left corner, and vice versa in the right corner. The vertical axis of Figure 3 indexes relative factor endowments, with the countries having identical relative endowments in the bottom row (row 1; i.e., we restrict the discussion to cases where country h is relatively skilled-labor abundant). In the top row, country h is very skilled-labor abundant and country f very unskilled-labor abundant.

Results indicate that all production is by type-m firms if country f is both large and the relative endowment differences are large (northwest corner of Figure 3). In such a case, there is both a strong factor-price motive for locating final X production in country f, and aggregate transport costs are not large since most of the final output stays in country f. All production is by type-d firms if country f is small and the relative endowment difference is small (southeast corner). In this case, there is neither a factor-price motive nor a transport-cost motive for locating final production in country f. Running between these two regions from the southwest to the northeast corner is a mixed regime of type-m and type-d firms.[4]

Figure 4 gives the corresponding results for the number of type-m firms active in

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[4]We see "reversals" in the extreme southwest and northeast corners of Figure 3. The reversals in the northeast corner moving down columns 17-19 is precisely what we discussed in connection with Figure 2. In the northeast corner, country f is so scarce in skilled labor and so small that it is not profitable to produce any X in f. In the southwest corner, country h is so small that the skilled labor requirements for producing all the Z for both countries drives the price of S_h sufficiently high that all final production is located in country f (reducing the demand for skilled labor in h from F to F_h per firm).

equilibrium (top panel) and the direction of trade in X (bottom panel). Very clear results emerge in the top panel: the number of type-m firms is largest when country f is large and relative endowment differences are significant but not extreme. Again, the first of these results is the aggregate transport cost argument and the second is the factor-price effect of Figure 2. Moving down a column of Figure 4, we expect an inverted u-shaped relationship between investment and differences in relative endowments as suggested by Figure 2.[5]

The lower panel of Figure 4 indicates that country f is an exporter of X when the endowment difference are moderate to large except when it is very small in the northeast corner of the diagram. The results of both panels indicate that the difference in relative endowments at which trade in X reverses direction (lower panel) and at which production in f stops (top panel) is increasing as country f becomes smaller. Referring back to Figure 2, as country f becomes smaller, the zero-profit locus of potential type-m firms shifts inward. The right-hand intersection of this locus with the zero-profit locus for Y in the top panel (endowment ratio ß) slides to the left and point ß in the lower diagram slides to the right. At this end of the inverted u-shaped relationship, country f must become more unlike country h to support X production as country f becomes smaller. When country f is very small in the northeast corner of Figure 4, we see the other end of the inverted u-shaped relationship come into the diagram. Production of X in a very small country f stops when

[5]The region "less than one" in the top panel of Figure 4 contains some points with positive production of X in country f, because the number of firms is a continuous variable, and in some cases takes on a value between zero and one in equilibrium. Thus the border between regions type-d only and type-d plus type-m in Figure 3 does not correspond precisely to the border between regions 1-4 and less-than-one in Figure 4.

the endowment difference becomes too large, ratio α in Figure 2.[6]

It is somewhat hard to interpret the results of Figure 4, particularly in moving to the right along a row: country f is becoming smaller, so of course the number of type-m firms should fall. Figure 5 therefore graphs the number of type-m firms active divided by country f's GNP, moving to the right along row 10 (top panel) and down column 10 (bottom panel). In the top panel, we see that after an initial rise, the number of type-m firms falls not just absolutely, but in relation to country f's GNP. In the bottom panel, we see the inverted-u shaped relationship suggested by the partial equilibrium analysis of Figure 2.[7] These results fit well with the data presented earlier in Tables 1 and 2. Inward direct investment will be smallest for the least developed (proxied here by relative endowments), smallest countries.

5. Summary and Conclusions

The purpose of this paper was to consider explanations for the very low level of direct investment into the small, least-developed countries. We believe that there at least

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[6]One result here that is possibly puzzling is the non-monotonicity moving down a column of the top panel yet only a single reversal in the bottom panel. Consider column 5 for example, where the trade direction is opposite at the top and bottom of the column despite roughly the same number of type-m firms. This is largely explained by a firm scale effect. In the model, the output per firm is increasing in the ratio of fixed to variable cost. Since fixed costs are largely in skilled labor and variable costs entirely in unskilled labor, this ratio is higher at the top of a column, implying that output per type-m firm is higher at the top of a column. While total output of X country f has the same inverted-u shape as the number of firms, it is much less extreme, with total output significantly higher at the top of a column than at the bottom of a column. This accounts for the apparent difference between the two panels of Figure 4.

[7]The initial rise in the top panel of Figure 5 is due to the fact that, with country h extremely small, its skilled labor endowment is a constraint on producing Z, thus leading to a smaller world output of X than when the countries are somewhat more equal in size. With respect to the bottom panel, we note again that the graph of output in country f is much flatter to the left of the maximum point (and reaches a maximum to the left of that for the number of firms) due to the firm-scale effect noted earlier.

two explanations, one involving direct costs and factor requirements of firms and the other indirect requirements. The first involves multinationals' needs for local skilled labor, ranging from managers, to technicians and engineers, to accountants and so forth. The second involves public or private infrastructure, ranging from utilities to telecommunications, to transport services to legal systems. These are not competing explanations, and both could surely be important at the same time.

Our model tends to focus on the first factor, the direct factor requirements, but of course this could be interpreted as firms generating there own local inputs such as electricity and transport. The model is constrained in that we assume that a necessary intermediate input can only be produced in the "developed" country, but that final production can take place in either country, using only unskilled labor for marginal costs. But local skilled labor is required in fixed costs. Any final output produced in the "developing country" is endogenously divided between supply to the local market and shipments back to the multinational's home market.

Results predict that the number of multinational firms active in the developing country relative to that country's GNP bears an inverted u-shaped relationship to the relative endowment differences between the two countries. In particular, investment falls to zero as the developing country becomes extremely scare in skilled labor. The second result is that this inward investment to GNP ratio is generally decreasing in country f's size. Small countries get no investment even relative to their small GNP. The reason is that potential assembly plants would be shipping almost all of their output back to the developed country, thus incurring very high aggregate transport costs relative to a situation where a

significant proportion of the output remains in the developing country. This may help up to understand, for example, why there is such a large investment boom into China, relative to other much smaller countries with the same per-capita income levels.

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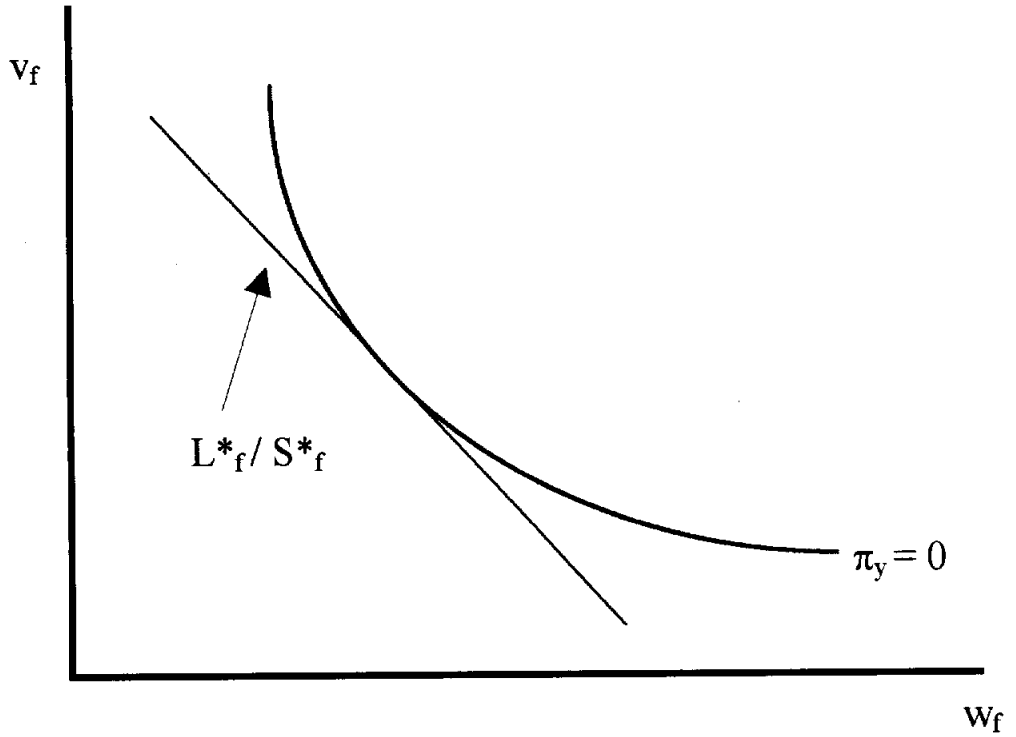
Figure 1: Zero-profit loci for Y and X in country f



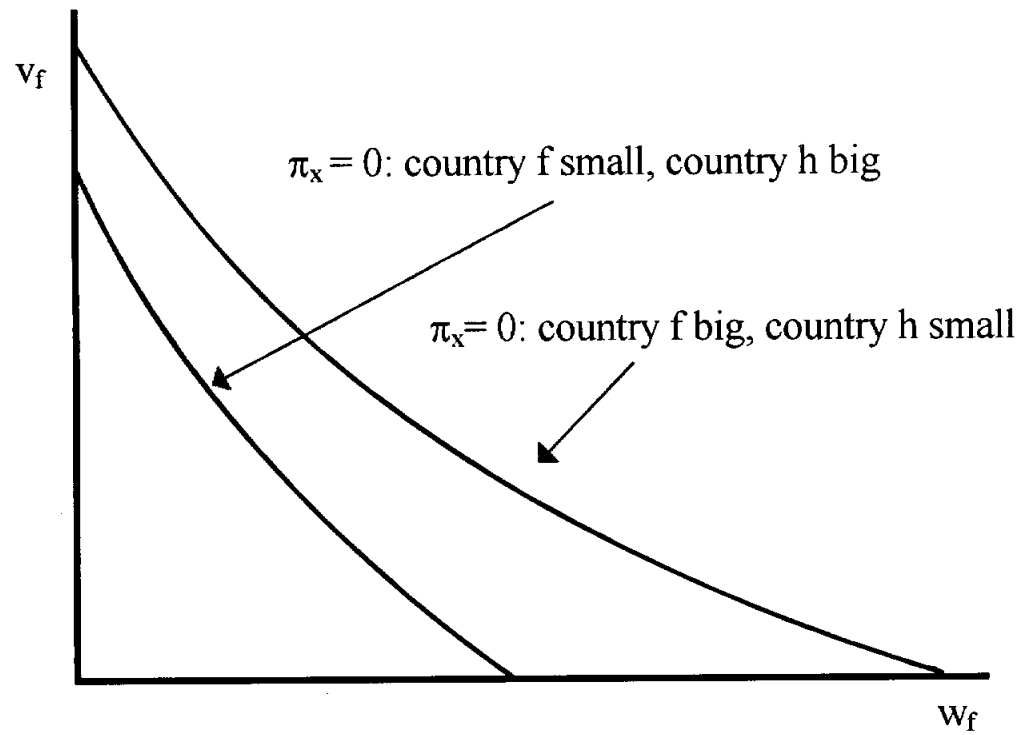
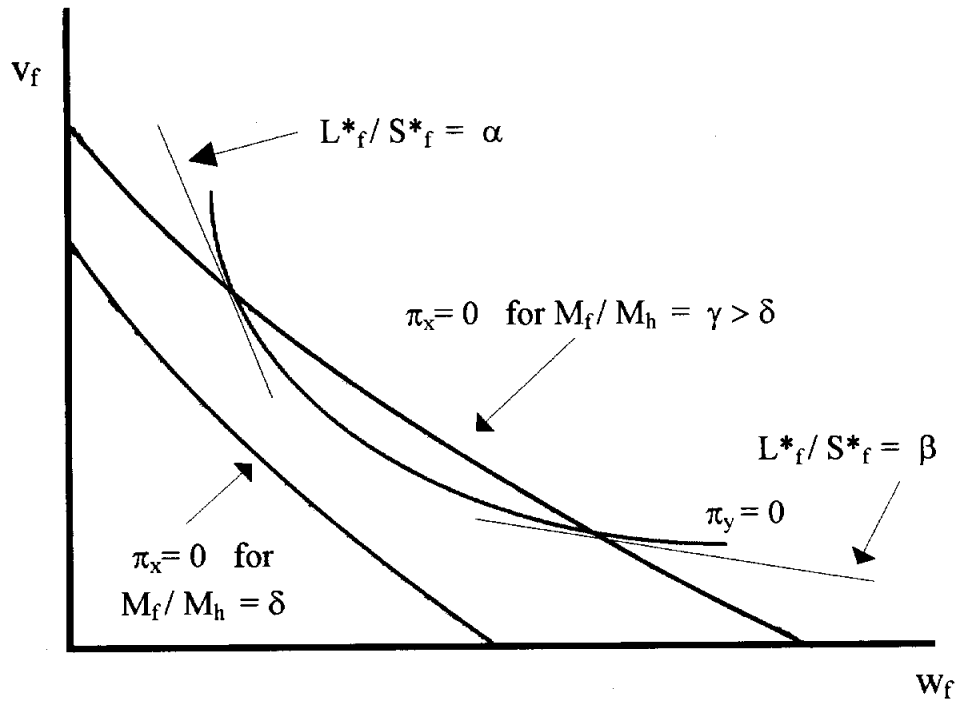


Figure 2: Range of endowments permitting positive X production in country f



At country size ratio $M_f / M_h = \gamma$
type-m firms are supported for endowment ratios
$\beta < L^*_f / S^*_f < \alpha$

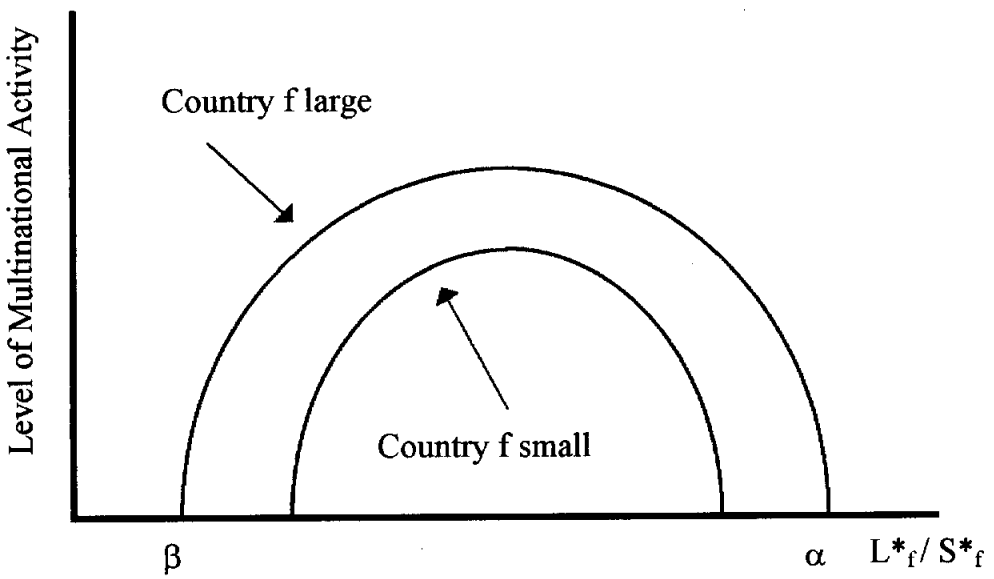


Figure 3: Equilibrium Regime, Transport Costs t = u = .05

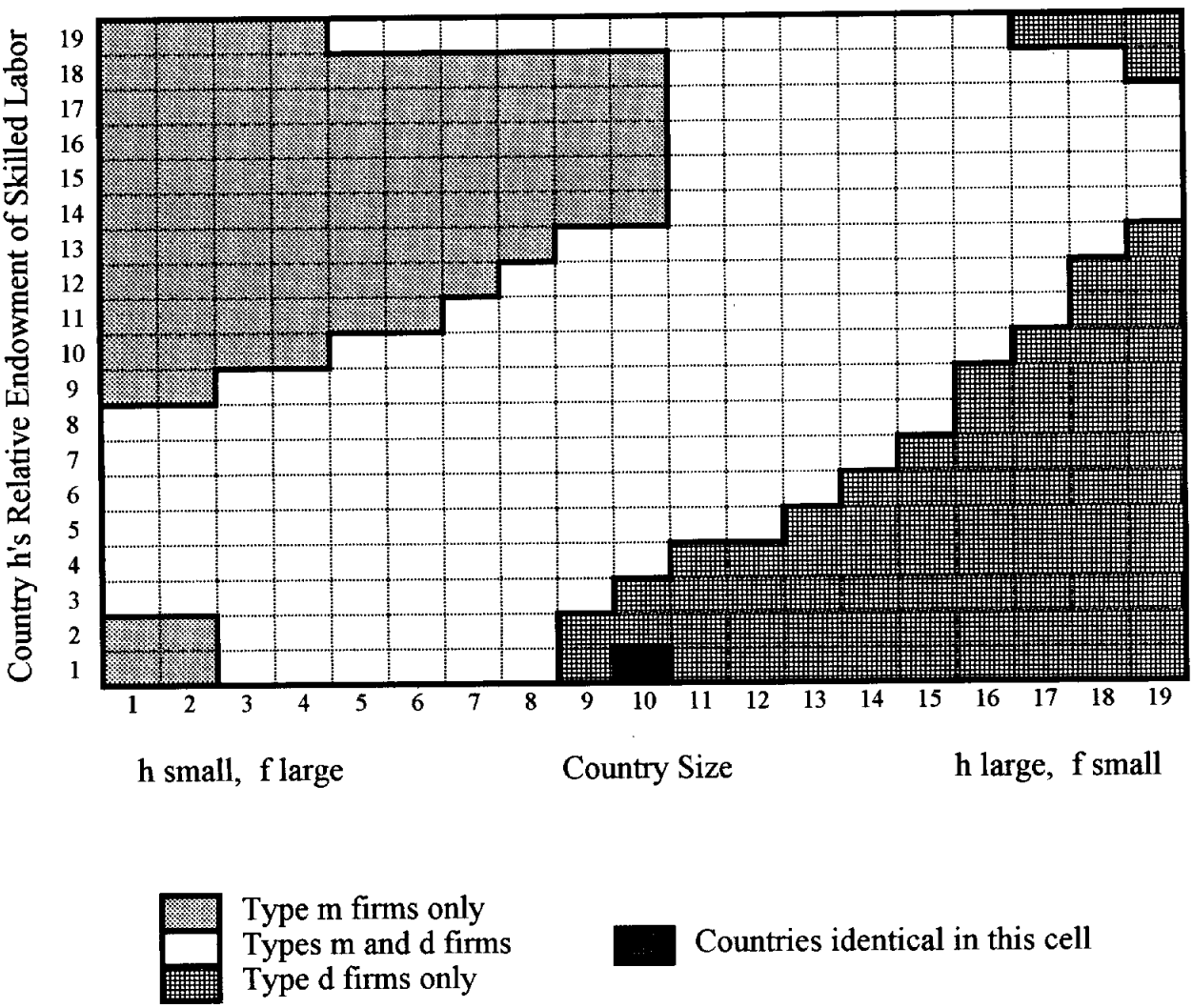


Figure 4: Number of Type-m Firms and Net Trade in X

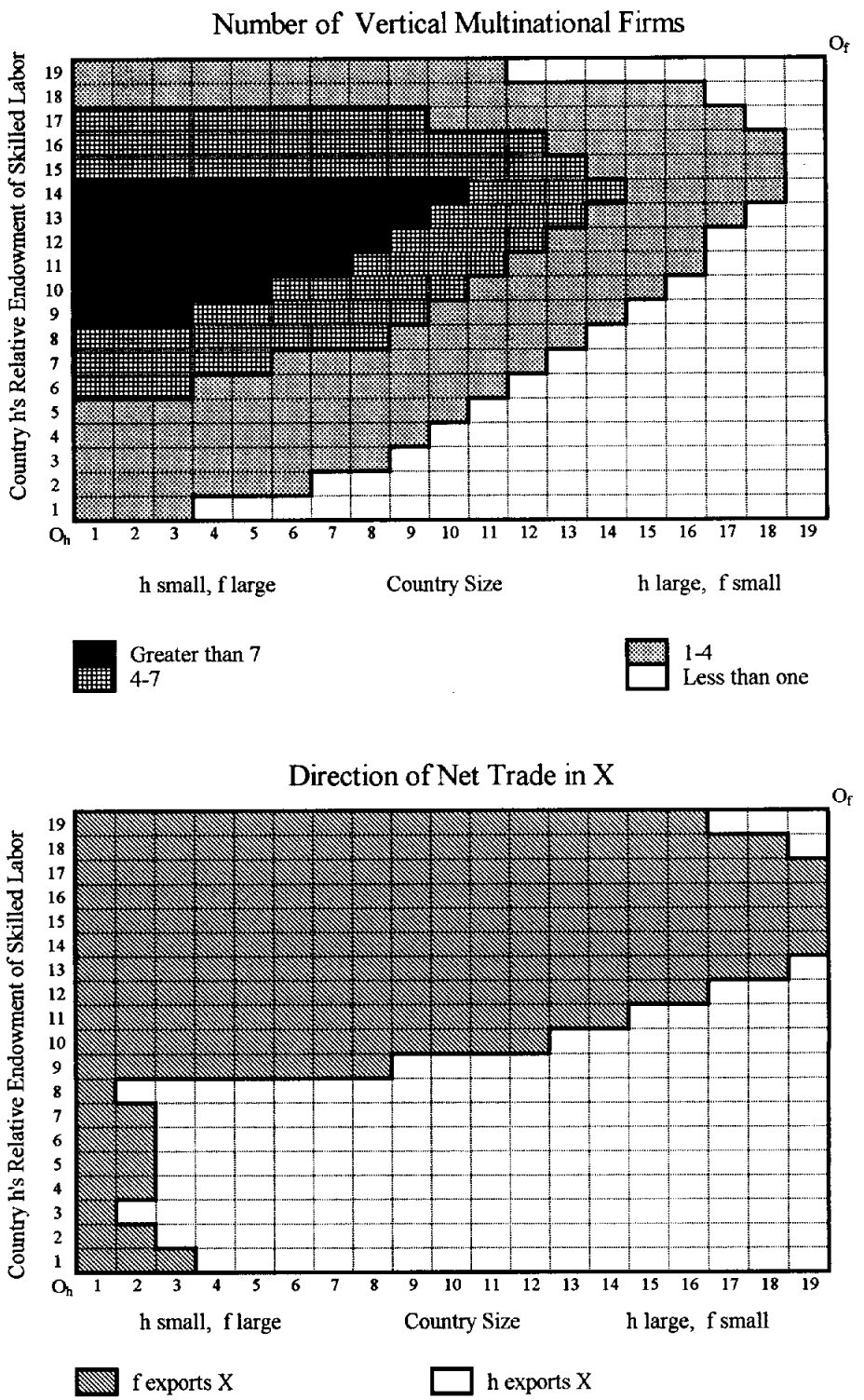


Figure 5: Country f's inward investment to GNP ratio as a function of f's size: row 10 of Figures 3-4

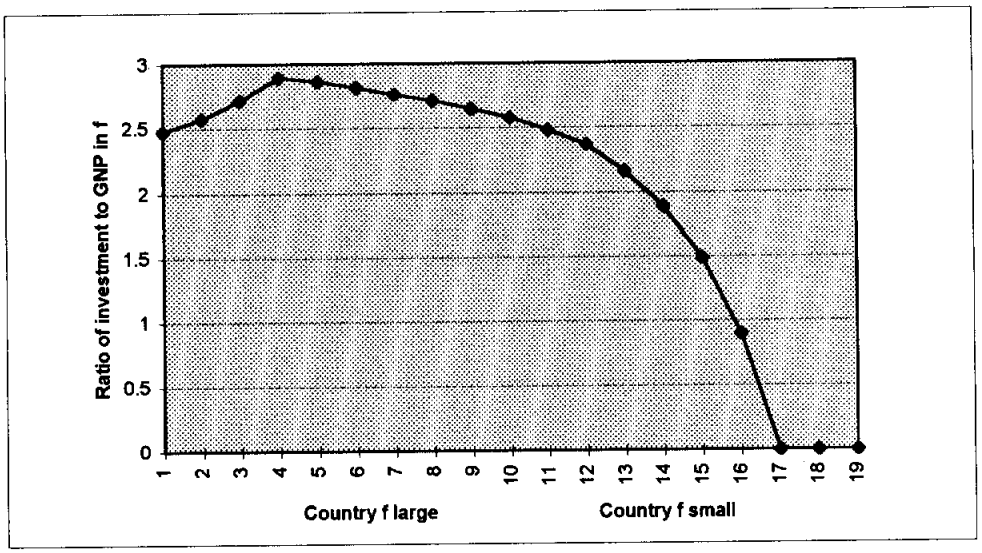
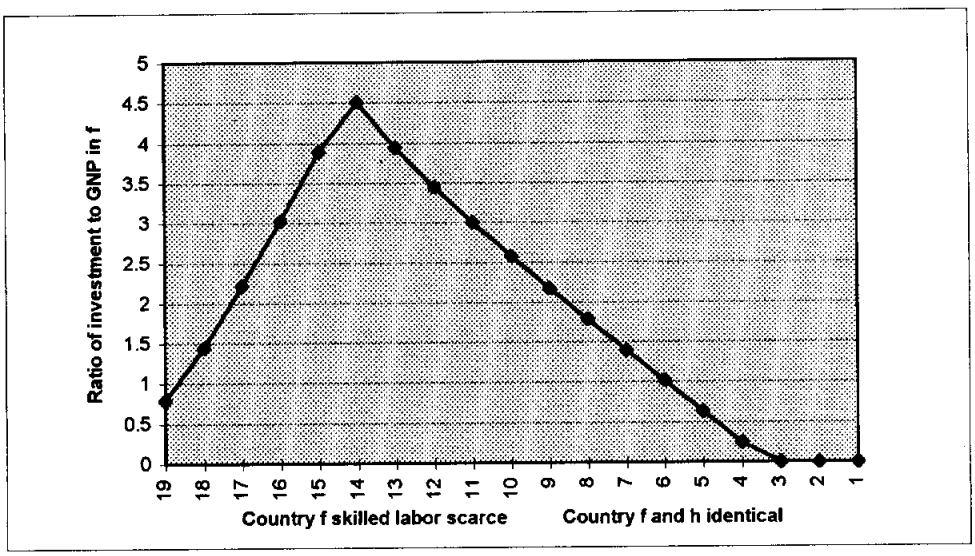


Figure 6: Country f's inward investment to GNP ratio as a function of f's relative endowment: column 10 of Figures 3-4



N.B. "Investment" is measured simply by the number of type-m firms active in equilibrium