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「Foreign Direct Investment and Country-Specific Human Capital」

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Workers who are educated abroad acquire human capital specific to the country of foreign study (for example, language capital and country-specific knowledge on firm organization and on social system) which makes them more productive than domestically educated workers when both types of workers are employed by subsidiaries of multinational firms headquartered in the country of foreign study. An increase in foreign-educated labor in an FDI-host country thus attracts more FDI from the country of foreign study. We find evidence from bilateral FDI and foreign-student data for 63 countries over the period of 1963-1998 that strongly supports this prediction. Our findings suggest that foreign-educated labor may account for a sizable portion of growth in FDI flows during the sample period.

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ABSTRACT

Workers who are educated abroad acquire human capital specific to the country of foreign study (for example, language capital and country-specific knowledge on firm organization and on social system) which makes them more productive than domestically educated workers when both types of workers are employed by subsidiaries of multinational firms headquartered in the country of foreign study. An increase in foreign-educated labor in an FDI-host country thus attracts more FDI from the country of foreign study. We find evidence from bilateral FDI and foreign-student data for 63 countries over the period of 1963-1998 that strongly supports this prediction. Our findings suggest that foreign-educated labor may account for a sizable portion of growth in FDI flows during the sample period.

I. Introduction

The past two decades have witnessed an unprecedented increase in foreign direct investment (FDI) in the world; annual worldwide FDI flows have increased fifteen-fold from 1980 to 1998 while world trade merely tripled during the same period. The share of FDI in total international capital flow has climbed up from 12% in the early 1980s to 29.5% in 1998.[1] As FDI has gained importance in the international movement of capital, a variety of theoretical and empirical studies on FDI have investigated the factors that determine FDI.[2] In this paper, we offer an important but under-studied determinant of FDI: foreign-educated labor in FDI-host countries. More specifically, we examine theoretically and empirically whether labor in an FDI-host country that is educated abroad attracts foreign direct investment from the country of foreign study.

Production involves the process of combining physical capital and the human capital of employees. Human capital includes not only general skills but also the knowledge of firm-specific technology, managerial skills specific to the organization, and efficient communication skills with co-workers. Consequently, labor that possesses these firm-specific skills can be more productive in the respective firm than in other firms (Becker, 1993). When a firm invests in a foreign country through a subsidiary that shares the technology of the parent firm, labor that has acquired various types of human capital specific to the parent firm and, thus to the subsidiary, can be more productive in the foreign subsidiary. For instance, local managers in a foreign subsidiary firm who speak the same language as the managers of a parent firm, or who know how the parent firm and its subsidiaries are organized and operated, can be more productively

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[1] *International Financial Statistics*, IMF, 2001.
[2] See Edwards (1990), and Markusen and Maskus (2001) for literature surveys on the determinants of FDI and multinational firm activities.

utilized in the subsidiary firm. Since human capital specific to a firm and its foreign subsidiaries can be acquired through education provided in the country of the parent firm, the availability of workers in a potential FDI-host country who have studied in the parent-firm country can be an important factor for a firm deciding to invest abroad through its foreign subsidiary.[3]

Foreign training can form various types of country-specific human capital that enhances the productivity of labor more when employed in firms from the host country of training than in firms from other countries. Country-specific human capital includes language capital which has been shown by numerous studies to be of considerable importance in labor market performances (Chiswick and Miller, 1993; Lazear, 1999). Knowledge on firm organization and social system is another example of country-specific human capital that can be acquired through foreign training (see Prescott and Visscher, 1980, for discussions on organizational capital). Foreign education can also enhance the productivity of students hired in firms of the host country, because it provides information about the ability and potential of the students in a form that can be more easily processed by the firms in the host country. Greater knowledge regarding employees allows firms to utilize manpower more efficiently and to raise workers' productivities (Becker, 1993). Becker (1993) discusses low worker mobility across countries as evidence on the importance of country-specific training.

Early theoretical models in international trade (e.g., MacDougall, 1960) attribute international capital movement to the difference in factor endowment measured by physical

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[3] Parent firms often train local labor hired in subsidiaries out of their own expense in order to develop firm-specific skills (see Laabs 1993 for the example of Gillette Corporation). However, some skill training, such as foreign language education, is general enough that they are typically acquired through foreign education paid in part by students.

capital per worker.[4]   Empirical findings, however, show that the actual capital flows fall short of

the theoretical prediction that capital moves from developed economies toward developing

economies in order to take advantage of higher rates of returns to capital.[5]   Lucas (1990)

suggests that, assuming human capital and physical capital are complementary in production,

physical capital fails to flow into developing economies due to the lack of human capital

endowments in those economies.[6]   We argue in this paper that the availability of country-

specific foreign-educated human capital, not just human capital in general, is important in

attracting country-specific FDI, because human capital specific to an FDI-source country

available in a host country can be more conducive to the operations of subsidiaries from the FDI-

source country.

Using bilateral panel data for 63 developed and developing countries over the period of

1963-1998, we find that the population share of foreign-educated students has a positive effect

on FDI inflow from the foreign country where the students were educated.   This effect is

robustly present when we control for such factors as transportation cost, market sizes and

growths in FDI-host and source countries, bilateral trades, and dyad-specific idiosyncratic effects.

This paper is organized as follows.   Section 2 lays out a simple theoretical model linking

foreign-educated labor with FDI.   Section 3 describes the variables and the empirical

methodology used in this study.   The empirical findings and implications are addressed in

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[4] With the industrial organization approach to trade, such theoretical models as Helpman and Krugman (1985) predict that a multinational firm will extend its business to countries that differ significantly in relative endowments, but not to very similar countries. Other early trade models (e.g., Kemp, 1966; Jones, 1967) consider technology differences as the major factor in capital movements.

[5] To explain larger flows of FDI between developed economies than between developed and developing economies, "horizontal" models presented in Markusen (1984), Brainard (1993), and Markusen and Venables (1998, 2000) suggest that, given moderate to high trade costs and plant-level as well as firm-level scale economies, multinational firm activity will arise between similar countries.

[6] Zhang and Markusen (1999) also provide a model where the availability of skilled labor in the host country influences the volume of FDI inflows. Empirical evidence for the effect of human capital on FDI has been scarce with mixed results. See Root and Ahmed (1979), Benhabib and Spiegel (1994), and Noorbakhsh et al. (2001).

Section 4.   Section 5 concludes with policy implications and a discussion of the importance of foreign-educated labor in explaining observed time-series change in FDI since 1980.

II. Theoretical Model

2.1 Basic model

We formalize our ideas along the lines of the "horizontal models" of multinational firm activities in Brainard (1993) and Markusen and Venable (1998).   We build on their models by allowing for labor inputs with country-specific human capital.   We start with a representative firm in country 1 that sells a product at home and abroad.   The firm has its headquarters in its home country, which requires some fixed cost but no variable cost.   The firm sets up plants which can be located in home country and/or in other countries.   Operating a plant in country i (=1, 2,…, N) incurs a fixed cost of operation $g(\varpi_i, z_i)$, where ϖ_i is a vector of input prices in country i, and z_i represents such factors as business environment, agglomeration effect, and degree of hospitability to foreign business operation.[7]   The representative firm is assumed to be a price taker in input prices.   When the firm builds a plant in home country and exports, a trade cost $\tau(d_{1i}, s)$ is incurred, where d_{1i} is the index of bilateral trade cost between countries 1 and i, and parameter s reflects the degree of inconvenience to transport the firm's products to another country.   The parameter s is good-specific, and therefore, firm-specific.   Without loss of generality, we assume $\partial \tau / \partial d_{1i} > 0$ and $\partial \tau / \partial s > 0$.

As in Brainard (1993) and Barrell and Pain (1996), we assume that the representative firm produces a differentiated good with downward-sloping market demand curves in both home and

[7] The agglomeration effect refers to the benefit of locating economic units together, which can explain the presence of regional groupings of specialized service suppliers. Wheeler and Mody (1992) find that the agglomeration effect has a dominant effect in attracting FDI.

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foreign markets. The good is produced with physical capital and two types of labor: labor with human capital specific to home country 1 and labor with human capital specific to foreign countries. Physical capital is assumed perfectly mobile across borders at a constant cost of capital. The production function for a plant located in country i (=1, 2,…, N) takes the following CES form with the constant returns to scale (CRS) technology.

$$(2.1) \quad q_i = \left(\alpha l_{i1}^{\rho} + \sum_{j=2}^{N} \beta l_{ij}^{\rho} + \gamma k_i^{\rho} \right)^{1/\rho},$$

where q_i is output and k_i is physical capital. l_{i1} and l_{ij} denote effective units of labor in country i with human capital specific to country 1 and with human capital specific to country j (=2,…, N), respectively. α, β, and γ are positive constants and $\rho \in [-\infty, 1)$. For simplicity, we have assumed that the different types of labor are imperfect substitutes due to country-specific skills and that the factor intensities are different between l_{i1} and l_{ij}, but are the same across all types of labor with foreign-country-specific human capital (l_{ij}, $j=2,…,N$). Following Lucas (1990), physical capital and labor are assumed to be imperfect substitutes in production with the elasticity of substitution, $1/(1-\rho) < \infty$.

Compared with other types of labor (l_{ij}, $j=2,…,N$), the labor with human capital specific to country 1 (l_{i1}) may have the advantage in productivity when employed by a firm from country 1 due to the existence of organizational capital, language or firm-specific technologies. We thus assume that the marginal product of labor for l_{i1} is higher than that for l_{ij} at the point where two labor inputs are equal, which implies that $\alpha > \beta$.

2.2 Choice of production location

The representative firm in country 1 serves the demands for its product at home and

foreign markets. Serving the market demand in a foreign country, the firm chooses the location

of a production plant to maximize its profit.[8] For analytical simplicity, we hereafter consider a

case where the firm in country 1 can set up a plant in countries 1, 2, or 3, and country 2 receives

FDI only from country 1. To serve the market in country 2, the firm in country 1 thus has three

options: to produce at home and export, to set up a plant in country 2 to serve the local market, or

to set up a plant in an alternative country and export to country 2. The alternative country with

the lowest production cost is indexed as country 3. Due to the CES production technology and

the assumption of input-price taking behavior, the unit marginal cost of production for a plant is

invariant to production scale at each location, and only one location will be chosen to meet the

market demand in country 2.

The profits from the three options in plant location are

(A) Set up a plant in country 1 and export to country 2[9]: $P_2(q_1^*)q_1^* - v(\varpi_1)\tau(d_{12}, s)q_1^*$,

(B) Set up a plant in country 2 as a foreign subsidiary: $P_2(q_2^*)q_2^* - v(\varpi_2)q_2^* - g(\varpi_2, z_2)$,

(C) Set up a plant in country 3 and export to country 2: $P_2(q_3^*)q_3^* - v(\varpi_3)\tau(d_{32}, s)q_3^* - g(\varpi_3, z_3)$,

where $P_2(\cdot)$ is the market demand in country 2 for the firm from country 1, q_i^* is the optimal

output at a plant set up in country i, and $v(\cdot)$ is the unit variable cost for a plant in country i.

$\varpi_i \equiv (w_{i1}, w_{i2}, w_{i3}, r)$ is the factor price vector in country i where w_{ij} is the wage rate for labor

in country i with human capital specific to country j, and r is the cost of capital. $g(\cdot)$ and $\tau(\cdot)$

are the fixed cost and the trade cost as defined in section 2.1, respectively.

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[8] Plant location decision to serve the market at home is analyzed in the following section 2.3.
[9] The profits for this case do not include the fixed cost term since the fixed cost is shared with the home plant producing for home market. This assumption is taken to illustrate the benefits of economies of scale in the "horizontal models" of multinational activity. However, our main conclusion regarding the country-specific human capital still holds without this assumption.

Given its production function in (2.1) and the input prices, the firm's unit variable cost function is

$$(2.2) \quad v(\varpi_i) = \left[\alpha(w_{i1}/\alpha)^{\rho/(\rho-1)} + \beta(w_{i2}/\beta)^{\rho/(\rho-1)} + \beta(w_{i3}/\beta)^{\rho/(\rho-1)} + \gamma(r/\gamma)^{\rho/(\rho-1)}\right]^{(\rho-1)/\rho}.$$

For each plant location, the optimal quantity $q_i^* = q_i(\varpi_i, d_{i2}, s)$ can be derived from the condition that $P_2'(q_i^*)q_i^* + P_2(q_i^*) = v(\varpi_i)\tau(d_{i2}, s)$ where $\tau(d_{22}, s) = 1$. Each equilibrium quantity is a decreasing function with respect to the wages in the country of location and the transaction cost of d_{i2}.

The firm from country 1 will set up a foreign subsidiary plant in country 2 if the following two inequalities hold.

$$(2.3) \quad P_2(q_2^*)q_2^* - v(\varpi_2)q_2^* - g(\varpi_2, z_2) > P_2(q_1^*)q_1^* - v(\varpi_1)\tau(d_{12}, s)q_1^*, \text{ and}$$

$$(2.4) \quad P_2(q_2^*)q_2^* - v(\varpi_2)q_2^* - g(\varpi_2, z_2) > P_2(q_3^*)q_3^* - v(\varpi_3)\tau(d_{32}, s)q_3^* - g(\varpi_3, z_3).$$

Similar to the findings in Brainard (1993), Markusen (1997), and Markusen and Venable (1998), the decision on establishing a plant in country 2 will be affected by wage differentials, fixed operating cost of foreign plant (g), the attractiveness of country 2 as an FDI-host country (z_2), trade costs (d_{12}, d_{32}), and individual characteristics of the good that the firm produces (s). Given that there are demands for a spectrum of tradable goods indexed with $s \in [\underline{s}, \bar{s}]$ in country 2, there will be a critical value $s^* = \max[s_1, s_2]$ where s_1 and s_2 are the values of s that equate the two sides in (2.3) and (2.4), respectively, with all other factors constant. Any good with $s > s^*$ will be produced in country 2. We can show that lower wages in country 2 relative to those in country 1 or in country 3, lower fixed cost of plant, more FDI-hospitable environment in country 2, or lower trade cost lowers s^*, which will induce some firms to switch either from export or from production in country 3 to FDI production in country 2. Moreover, if the factor

price in country 2 (ϖ_2) falls, the equilibrium quantities for the existing subsidiary production in country 2 will rise since the marginal cost falls.

2.3 Vertically-motivated multinational firm activity

We recognize that multinational firm activity may arise even for the sole purpose of serving the home market. Fulfilling the home market demand, the representative firm in country 1 needs to decide whether to produce at home or to set up a foreign subsidiary and import the goods back home. The latter option (i.e. foreign direct investment) will be chosen if

$$(2.5) \quad P_1(q_m^*)q_m^* - v(\varpi_m)\tau(d_{1m},s)q_m^* - g(\varpi_m,z_m) > P_1(q_1^*)q_1^* - v(\varpi_1)q_1^* - g(\varpi_1,z_1),$$

where country m is the most profitable location choice among all foreign countries. This decision will be influenced by wage differentials, trade cost (d_{1m}), and differentials in z (z_m and z_1). Particularly interesting in this case is that FDI will rise as the trade cost diminishes, which is the contrary to the case of horizontally-motivated FDI in serving foreign market demand as discussed in section 2.2. Like the case in section 2.2, however, low factor cost in country m relative to country 1 will raise foreign subsidiary production.

2.4 Increase in foreign-educated labor and FDI

Suppose the composition of the labor pool in country 2 has changed so that the labor with human capital specific to country 1, or foreign-educated labor educated in country 1 (L_{21}), increases while the labor with human capital specific to country 2 or 3 falls, given the labor force in country 2 constant (i.e. $dL_{21} = -dL_{22} - dL_{23}$). The supply curve shifts in each labor market, which may lead to a fall in the wage rate w_{21} and a rise in the wage rates w_{22} and w_{23}. Totally differentiating the variable cost function, we have

(2.6) $dv(\varpi_2) = V^{-1/\rho}[(w_{21}/\alpha)^{1/(\rho-1)}dw_{21} + (w_{22}/\beta)^{1/(\rho-1)}dw_{22} + (w_{23}/\beta)^{1/(\rho-1)}dw_{23}]$,

where $V = \left[\alpha(w_{21}/\alpha)^{\rho/(\rho-1)} + \beta(w_{22}/\beta)^{\rho/(\rho-1)} + \beta(w_{23}/\beta)^{\rho/(\rho-1)} + \gamma(r/\gamma)^{\rho/(\rho-1)}\right]$.

The variable cost will fall if

(2.7) $[(\alpha/\beta)^{1/(1-\rho)}dw_{21} + (w_{21}/w_{22})^{1/(1-\rho)}dw_{22} + (w_{21}/w_{23})^{1/(1-\rho)}dw_{23}] < 0.$

Since $\rho < 1$, if α is sufficiently greater than β, or the magnitude of the fall in w_{21} is larger than that of the rise in w_{22} or w_{23}, inequality (2.7) will hold. If the variable cost falls in country 2, the analyses in sections 2.2 and 2.3 indicate that it will lead to greater subsidiary plant production in country 2.

We can show that the demand for capital in a subsidiary production plant located in country 2 is $k_2 = \left(\mathcal{W}(\varpi_2)/r\right)^{1/(1-\rho)}q_2^*$. With the cost of capital constant at the international market rate of r, less capital will be used as there will be substitution of foreign-educated labor for capital when w_{21} falls. On the other hand, since the optimal level of output for the subsidiary plant rises, there can be an increase in demand for capital (scale effect). Furthermore, there can be new capital demand for subsidiary plant production by the firms that switch the production location to country 2 (new entrant effect) as w_{21} falls. If the latter two effects (scale and new entrant effects) are not dominated by the substitution effect, total capital used in subsidiary plants in country 2 for firms from country 1 can increase.

Although increased capital demand can be financed in many different ways as discussed in Barrell and Pain (1996), if the multinational firm wants to maintain a desired leverage ratio as well as the majority ownership of the firm, there will be an increase in direct investment from country 1 to country 2.

III. Empirical Implementation

Against bilateral FDI and student flow panel data, we test whether an FDI-host country that has more labor with human capital specific to an FDI-source country attracts more FDI from the respective FDI-source country. We estimate a reduced-form regression model with a share of foreign direct investment in GDP as our dependent variable. A set of explanatory variables includes the population share of students abroad and other factors from the model.

3.1 Description of Variables

The data for annual foreign direct investment inflows and outflows are taken from *International Direct Investment Statistics Yearbook* (OECD, 1999), which covers 63 developed and developing countries for the period of 1980 to 1998. The countries are listed in Appendix A. Our dependent variable is FDI from a source country i to a host country j as a share of source country i's GDP (FDIY).

For measuring labor inputs with different types of country-specific human capital, we use the data on students abroad. Our data on students abroad are taken from the UNESCO's *Statistical Yearbooks*. The data contain annual bilateral flows of students studying abroad at the tertiary level. The data are available in 63 countries over the period of 1963-1996, but not for all years in some countries.

Students studying abroad acquire human capital specific to the country of foreign study in addition to their human capital specific to the country of origin. One issue involving the use of student data to measure labor inputs with different types of human capital in an FDI-host country has to do with the fact that some students return to their home countries while others stay after completion of study abroad. A home-returning student will contribute to labor in her home

country with human capital specific to the country of study, which may be conducive to FDI *from the country of study*.   On the other hand, a non-returning student will contribute to labor in the country of study with human capital specific to her home country, which may be conducive to FDI *from her home country*.

We find that students abroad are more likely to be associated with FDI from the country of study because of two reasons.   First, Glaser (1979) reports, based on the thirteen surveys of 6,500 foreign students that were carried out in eleven countries, that most students plan to return home, that some professionals now working in host countries plan to return home eventually, and that few of those who return plan subsequently to emigrate.[10]   Second, when foreign subsidiaries employ labor with human capital specific to their country of origin, they may look for skilled labor who can work at the management level.   Home-retuning students who acquire higher education in the foreign subsidiaries' country of origin provide human capital specific to the subsidiaries' country of origin at higher skill level for the foreign subsidiaries.   On the other hand, non-returning students may only be able to provide lower-skilled human capital specific to the students' country of origin for the subsidiaries from the students' country of origin.   This implies that returning students should be more relevant to the FDI location decision.

We test therefore whether more students abroad from an FDI-host country attracts more FDI from the country of foreign study, using the population share of the students from FDI-host country *j* who studied abroad in FDI-source country *i* (STDT) as our regressor.   Evidently, we cannot rule out the possibility that students abroad draw FDI from the students' country of origin

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[10] The study also reports that many students work temporarily abroad after having completed their education, and that host countries differ in the extent to which they retain foreign students after their education. The non-return rate among foreign students in the United States was significantly higher than the other host countries. As a robustness check, we report later the estimated relationship between students abroad and FDI in the sub-sample that excludes the U.S.

to the country of foreign study.   We thus try an alternative specification that relates students abroad from country i to country j and FDI from country i to country j.

To control for the factors affecting fixed costs in operating a subsidiary plant, our explanatory variables include the GDP shares of domestic investment (I) and government spending (G) in an FDI-host country.   Earlier studies have suggested that greater share of domestic investment may reflect the atmosphere in a host country favorable towards private enterprise, implying a positive correlation between domestic investment and FDI.   On the other hand, FDI and domestic investment can be negatively correlated, since goods produced by foreign subsidiary firms can be substitutable with those domestically produced.   The GDP share of government spending in an FDI-host country may represent the involvement of government in the economy, which may shape the environment for private business and foreign direct investment.[11]

The relative wages are proxied by the ratio of per capita GDP in an FDI-host country to that in an FDI-source country (RELPCGDP).   Moreover, per capita income in the FDI-source country may proxy the demand for a clean environment, which can be a push factor for FDI to relocate polluting manufacturing facilities to other countries.   In both effects, the per capita GDP ratio is expected to have an adverse effect on FDI.[12]

To control for the market size and the market growth potentials, we include as regressors real GDP in an FDI-host country (GDP2) and the per-capita GDP growth rates in both countries

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[11] See Edwards (1990), Wheeler and Mody (1992), and Hines (1996) for the role of government in attracting FDI.
[12] Corporate income tax rate is another important factor which may influence the cost of multinational firm activity. However, we have not included tax variables in our regressions since the availability of data on income tax rates (especially, marginal rates) is very limited in the number of countries, which greatly restricts cross-country variations in our analysis. The share of government spending may proxy the overall tax rates of the FDI-host country.

(GROW1, GROW2).[13]   Real GDP level in an FDI host country is expected to have the effect of scale economies and thus a positive association with FDI.   A faster-growing economy may attract more FDI due to a potential market growth in the future.[14]

The earlier discussion in section 2.2 suggests that FDI can be a substitute for exports. We include as regressors the average tariff rate (TARIFF) and the real exchange rate in an FDI-host country (EXCHANGE) to control for trade costs.   Higher tariff will raise the relative cost of exports and thus increase FDI.   On the other hand, an increase in tariff may exert an adverse effect on FDI as higher tariff can raise the import prices of intermediate goods used by multinational firms.   Moreover, higher tariff can be associated with lower FDI if the tariff rate reflects the degree of economic and political openness.   Our regressors include the real exchange rate of an FDI-host country as a proxy for international competitiveness. Theoretically, real exchange rate appreciation may lead to a reduction in FDI if FDI and exports are substitutes.   However, a fall in the import prices of intermediate goods for foreign subsidiary plants located in the FDI-host country may induce more FDI.[15]

To control for unobserved bilateral relationship between countries which may be the underlying reason for the observed relationship between STDT and FDIY, we include the distance between a source country and a host country (DISTANCE), and three binary variables for whether the same language is used in two countries (LANGUAGE), whether they practice the same religion (RELIGION), and whether one country was once a colony of the other

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[13] Refer to Wheeler and Mody (1992) and Barrell and Pain (1996) for the discussion of the roles of various macroeconomic variables included in our analysis on FDI.
[14] Williamson (1975), Dunning (1981), and Edwards (1990) show that foreign subsidiaries are more likely to choose countries with larger market size or greater growth potentials.
[15] See Cushman (1985), Caves (1989), Froot and Stein (1991), Goldberg and Kolstad (1995), and Blonigen (1997) for discussion on the effect of the real exchange rate on FDI. The real exchange rate index in our study is the price level of GDP, relative to the US prices. An increase in the index implies rising overvaluation in the real exchange rate.

(COLONY). Strong bilateral relationship in trade between two countries may facilitate the flow of FDI as well as the flow of students between the two countries, which may result in a spurious correlation between STDT and FDIY without the causal influence of STDT on FDIY as recognized in our story. We introduce both export flows from an FDI-source country to a host country as a share of the source country's GDP (TRADE) and export flows in the reverse direction (TRADE_RVS) as our regressors. The data sources of all the control variables are presented in Appendix A.

3.2 Econometric Model Specification

Our baseline specification is a log-linear model with country-specific fixed effects:

$$\ln(FDIY_{ijt}) = d_i + d_j + \beta_0 \ln(STDT_{ijt-15}) + \beta' X_{ijt} + \varepsilon_{ijt} ,$$

where $FDIY_{ijt}$ is FDI from country i to country j in year t as a share of country i's GDP, and $STDT_{ijt-15}$ is the number of students abroad from country j who studied in country i in year t-15 as a share of country j's population. FDIY and STDT are paired in a reverse direction as is discussed in section 3.1: FDI from country i to country j and students from country j to country i. To test the hypothesis that capitals from students' countries of origin may be attracted to the students' countries of foreign study due to non-returning students, we try an alternative specification where FDI from country i to country j as a share of country i's GDP is regressed on STDT from country i to country j.

Note that we have paired the number of students abroad 15 years ago with FDI of the current year to account for the time needed to acquire education and to return home. This time lag will also help avoid the reverse causality problem and the endogeneity problem of STDT in our FDIY regressions. We have chosen STDT with a 15-year lag for our baseline specification

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since the specification with the 15-year lag reports the highest R-squared value among the regressions each of which includes STDT with a different lag (ranging from 10 to 20 years) given the same number of observations and the same set of regressors. With the 15-year lag in students abroad, we use the foreign student data over the period of 1965-1983 to match with the FDI data for 1980-1998. This implies that the findings in Glaser (1979) in section 3.1 are relevant in characterizing the students in our empirical study.

X_{ijt} is a vector of all the explanatory variables discussed in the previous section. All variables are entered in logs except for the binary variables. d_i and d_j are the country-specific fixed-effect terms for an FDI-source country and for a host country, respectively. The error term ε_{ijt} is assumed to be distributed i.i.d. with zero mean.

Unobserved ties between certain pairs of countries may be argued as the underlying source of both greater educational exchange and higher FDI, resulting in an omitted variable bias. To control for unobserved bilateral relationship, we have included dummy variables for common language, religion, and colonial ties as regressors in our baseline specification. In addition to our baseline specification, we also employ an alternative specification where we include the dyad-specific fixed-effects constants instead of country-specific fixed effects. In order to capture the within-dyad variations in the explanatory variables, we have used the dyads series which have more than 5 years of observation for both FDIY and STDT for the alternative specification as well as for the baseline specification with country-specific fixed effects.[16] Furthermore, we introduce export flows from an FDI-source country to an FDI-host country as a share of the source country's GDP as well as the export flows in the reverse direction as additional regressors. These

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[16] The number of years per dyad in our data set ranges from 6 to 19 with the average number at 9.1. The estimation results without dyad-specific constants, but based on the full data with at least one observation for each dyad, are qualitatively similar to those reported in section 4.

trade variables should control not only for the variations in bilateral ties of the two countries between country pairs but also for the variations within country pairs.   These export variables can be endogenous variables in our FDIY regressions, and we treat them as such.

IV. Empirical Findings

Table 2 shows our estimation results regarding determinants of FDI decision, employing the country-specific fixed effects model as described in section 3.2.   Model 1 presents the baseline model estimates.   In models 2 – 4, we introduce the export flow variables as additional regressors to further isolate the autonomous effect of STDT on FDIY.   To test the sensitivity of our results to different lags of STDT, model 3 has the student flows with 10-year lag instead of our baseline 15-year lag.   In model 4, time trend is added as a regressor.

In table 2, we find that the effect of STDT on FDIY is statistically significant and consistent with our story: more foreign direct investment flows into a country with more students abroad who studied in an FDI-source country.   STDT has a statistically significant effect, even when we introduce the export flow variables in both directions and the time trend variable.

Consistent with the predictions in section 3.1, larger market size and lower relative per capita GDP in an FDI-host country are shown to raise FDIY in table 2.   The market growth, the GDP share of domestic investment, and the GDP share of government spending in an FDI-host country do not show consistent effects on FDIY.   Real exchange rate appreciation and lower tariff rates of an FDI-host country are shown in our results to have significantly positive effects on FDIY.

Bilateral ties such as shorter distance, using the same language, and having the same religion may increase foreign direct investment flows.   This prediction is confirmed by the

results in table 2.   The estimated effect of students abroad on FDIY, thus, cannot be ascribed to geographical and cultural proximity of countries, which will generate a bias toward a positive association between students abroad and FDIY.   The results in table 2 suggest that having been colonies of an FDI-source country does not have a significant effect on FDIY.

To control for the unobserved bilateral relationship, we introduce export flows between an FDI-source and a host country in both directions as additional regressors in all models except model 1.   Both trade variables are statistically significant implying that a country has more direct investment in the regions where it exports or imports more.[17]   More importantly, a positive and significant effect of STDT on FDIY is observed even when both trade variables are introduced to the regression model.   The estimated effect of STDT cannot be attributed, therefore, to higher trade volume between two countries, and ultimately to various factors that influence their trade relationship.

To test the sensitivity of our results to different lags in STDT, we have tried alternative specifications in each of which $STDT_{t-s}$ with a different lag (s = 10,…,20) is included as a regressor in place of our baseline variable $STDT_{t-15}$, based on the same number of observations and the same set of regressors.   In each specification, we have found that the effect of STDT with a different lag is significantly pronounced (results not shown to save space, except the case with 10-year lag in model 3).   The estimated values of the coefficient on STDT show an inverted U-shape relationship with the number of lags, reaching a peak at a 15-year lag.   This may reflect the fact that those students abroad who have acquired foreign education recently or long ago do not contribute to the present pool of labor that is conducive to current foreign direct

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[17]   Using the data on the U.S. and Japanese exports, imports, and inward and outward FDI flows with approximately 100 countries over 1985-1990, Eaton and Tamura (1994) find that the same covariates that explain international trade in a gravity framework are determinants of FDI, suggesting complementarity between FDI and trade.

investment.[18]

To check if the trends in FDIY and in STDT drive their positive relationship in table 2, we add a time trend variable T as a regressor in model 4, the coefficient of which shows a positive trend in FDI.   Even with the time trend included, the result in model 4 indicates that STDT has a significant effect on FDI.

Although we do include many variables in our analysis to control for dyad-specific characteristics in our data such as DISTANCE and TRADE, there may potentially be other important dyad-specific factors that are omitted in our analysis.   In table 3, we employ an alternative specification with dyad-specific effects to control for unobserved bilateral relationship.   Table 3 starts with model 1 with dyad-specific fixed effects which is based on within-dyad variations in all regressors over time.   Models 2 and 3 present the regression results from the models with dyad-specific random effects, and with between effects, respectively.   In model 3 we run the regression exclusively based on cross-dyad variations, which eliminate any influence of common time trends.   In the last model of this table, the specification includes the time trend variable as an additional regressor with dyad-specific fixed effects.   In all four models, our main results remain robust.

There is no theoretical validation in our model specification for a particular lag between STDT and FDIY, although we have tried various lags for sensitivity.   It is also possible that the effect of STDT on FDIY may last for several years to warrant a dynamic panel-data model.   The between-effects model can offer an estimate for the aggregate effect of the numbers of students with various lags on the dyad-specific aggregate of FDIY, as the between-effects regression is

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[18] When we employ dyad-specific fixed effects instead of country-specific fixed effects, the magnitude of the coefficient on STDT shows the same inverted U-shape pattern. However, the effect of STDT is only significant when the lag is between 13 and 17.

performed based on the dyad-specific means of the dependent variable and the regressors.   Note that in the between-effects model our dependent variable is the average value of ln(FDIY) over the period 1980-98, while the student variable is averaged over the period 1965-83, which helps avoid the problem of the endogeneity in the student variable.

As additional sensitivity tests of our main findings, table 4 presents the results under alternative model specifications with dyad-specific fixed effects.   Model 1 reports the regression result with the two-stage least squares method to account for the possible endogeneity of STDT and the two trade variables, since one may argue that countries with high FDI activities can more easily afford foreign education with the cash reserves from foreign subsidiaries.   The instrumental variables used for deriving the estimated values of STDT and of the export variables include the population share of the age cohort of 20 to 29 in a student-sending country as well as one-year lagged STDT, TRADE, TRADE_RVS, other included exogenous regressors, and dyad-specific dummies.   The cohort population variable is intended to account for the effect of the population size at ages for higher education on STDT.   Hausman's tests reject the endogeneity of STDT and TRADE_RVS, but not of TRADE.   We therefore treat STDT and TRADE_RVS as exogenous regressors in model 1.   Comparing with the OLS estimates of Table 3 where TRADE is treated as exogenous, the effect of STDT remains equally significant and positive whereas the effect of TRADE shows a significant increase in its magnitude.

As discussed in section 3.1, capital from students' home countries may move to their countries of foreign education in order to take advantage of the students' human capital specific to their home countries when students remain at the countries of foreign education.   This hypothesis is not supported by our data since STDT from country i to country j does not show a significantly positive effect on FDI from country i to country j in model 2.

A rise in the number of foreign-educated students who studied in one country may have an influence on FDI inflow from other countries of foreign study. In model 3 of table 4, we include the total number of students from country j who studied in foreign countries other than country i (STDT_REST) as a regressor in addition to STDT. Model 3 shows that STDT_REST has a negative impact on the FDI inflow from country i to country j, while the effect of STDT is significantly positive. The negative cross effect may be due to the fact that there is competition amongst FDI-source countries. Although any rise in country-specific foreign-educated labor will make a favorable environment for all FDI inflows to the host country, it will be most favorable for the FDI from the country where the workers were educated. The competition may then crowd out the opportunity for investment from the rest of the countries.

In order to investigate whether our results have been dominantly influenced by the inclusion of China and the United States that are the largest sender of students abroad and the largest source of foreign direct investment, respectively, all observations involving the two countries are excluded in model 4 of table 4. The U.S. observations are excluded with the additional concern of high non-returning rate among foreign students, as discussed in footnote 10. Even in this sub-sample regression, the effect of STDT on FDIY is quantitatively robust.

As an additional test to check the validity of our hypothesis on the FDI effect of students abroad, we have run a regression with the GDP share of total portfolio investments to an FDI-host country as the dependent variable, instead of FDIY.[19] Interestingly, the coefficient associated with STDT in this regression was insignificant. This finding lends potent support to our story that country-specific human capital attracts FDI, not necessarily other types of international capital flow.

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[19] The regression result is not reported to save space. Total portfolio investments were used since data on bilateral portfolio investment flows were not available.

V. Concluding Remarks

Our paper develops a simple model considering labor with country-specific human capital as an important determinant of FDI inflows. We use bilateral FDI and foreign student data for 63 developed and developing countries over the period 1963-1998 to test our proposition that an increase in students abroad will raise FDI inflow from the foreign country where the students were educated.

Despite the limitations of our data, the empirical evidence in this paper strongly confirms our proposition under various alternative specifications, controlling for the determinants recognized in the literature. Our results also indicate that country-specific foreign-educated labor only attracts FDI from the host country of foreign education. In fact, the FDI inflows from other countries are crowded out. Consistent with our story, we have evidence that foreign-educated labor attracts FDI, but not necessarily other types of foreign capital.

The estimated effect of students abroad on FDI, which is presented in tables $2 - 4$, is not only statistically significant, but also quantitatively so. According to our simple calibration exercise, the change in ln(STDT) can explain approximately 15.0% of the actual change in ln(FDIY) from 1980 to 1998 (see Appendix B for the calculation method).

Needless to say, we have left a number of issues unaddressed in this paper. Our model can be extended to include a theoretical discussion of employment location decision as well as the educational choices of the individuals in a dynamic setting. On the empirical side, more extensive survey of data on non-return rates of students abroad and bilateral flows of foreign labor would provide us with a more accurate measure of the foreign-educated labor in our empirical implementation. We leave the study of these issues to future work.

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Appendix A

The 63 countries included in this study are Algeria, Argentina, Australia, Austria, Belgium-Luxembourg, Brazil, Bulgaria, Canada, Chile, China, Colombia, Costa Rica, Czech Republic, Czechoslovakia, Denmark, Egypt, Finland, France, Germany, Greece, Hong Kong, Hungary, Iceland, India, Indonesia, Iran, Ireland, Israel, Italy, Japan, Korea, Kuwait, Libya, Malaysia, Mexico, Morocco, Netherlands, Netherlands Antilles, New Zealand, Norway, Panama, Philippines, Poland, Portugal, Romania, Russia, Saudi Arabia, Singapore, Slovakia, Slovenia, South Africa, Spain, Sweden, Switzerland, Taiwan, Thailand, Turkey, Ukraine, United Arab Emirates, United Kingdom, United States, USSR, and Venezuela.

Data on language, religion, and colony are from *Encyclopedia Britannica.* Data on distance are from the internet map search engine at www.indo.com/distance. Per capita GDP, total GDP, GDP shares of domestic investment and government spending, and real exchange rates are obtained from *Penn World Tables* (Mark 6). Bilateral trade flow data for 67 countries over 1976–1999 are taken from World Bank Institute's *Trade and Production Database*. Data on tariff rates are available in *Trends in Average Tariff Rates for Developing and Industrial Countries 1980-99* of World Bank Institute. Total portfolio investments are from *International Financial Statistics* (IFS), published by IMF (2001).

Appendix B

In our data, the actual sample mean values of ln(FDIY) were -6.001 in 1980 and -4.919 in 1998, while the corresponding sample mean values of ln(STDT) were -5.964 and -5.303, respectively. Using the estimated coefficients in model 1 of Table 2, and assuming that all variables other than FDIY and STDT are constant at the sample mean values of the variables in 1980, we calculate the predicted change in the mean value of ln(FDIY) from 1980 to 1998 that is explained by the change in the sample mean value of ln(STDT) from 1965 to 1983. The predicted change in the mean value of ln(FDIY) from 1980 to 1998 is 0.161, whereas the actual change in the sample mean value of ln(FDIY) during the same period was 1.081. This calculation suggests that the change in ln(STDT) can explain 15.0% (=0.161/1.081) of the actual change in ln(FDIY) during this period.

Table 1.   Descriptions and Summary Statistics of Variables

Variable	Description	Mean	St. Dev.
$STDT_{ijt-15}$	Number of students from country j who were enrolled at institutions of higher education in country i, as a share of the population in country j, in year (t-15)	.0439	.1646
$FDIY_{ijt}$	FDI from country i to country j as a share of country i's GDP in year t	.0267	.0975
DISTANCE	Distance between the capitals of FDI-source and host countries (100 km)	58.45	48.02
LANGUAGE	Binary variable for the same language (=1 if the most popular languages in both countries are the same.)	.2054	.4040
RELIGION	Binary variable for the same religion (=1 if the most popular religions in both countries are the same.)	.3283	.4696
COLONY	Binary variable for colony (=1 if the FDI-host country used to be a colony of the source country.)	.0225	.1482
GDP2	Real GDP of an FDI-host country (1991 US $)	8.10e+8	1.39e+9
RELPCGDP	Ratio of per capita real GDP of an FDI-host country to that of a source country	.9711	1.269
GROW1 (GROW2)	Real GDP growth rate of an FDI-source (host) country	.0395 (.0578)	.1267 (.3334)
I	Domestic investment rate of an FDI-host country	21.71	6.764
G	GDP Share of government spending in an FDI-host country	17.35	5.354
EXCHANGE	Real exchange rate of an FDI-host country	82.37	36.58
TARIFF	Average tariff rate of an FDI-host country	13.24	12.38
$TRADE_{ijt}$	Real exports of country i to country j (1991 US $ million) as a share of country i's GDP in year t	3.927	8.656

Table 2. FDI Regressions: Country-Specific Fixed Effects

Dependent variable: ln(FDIY)   **Country-Specific Fixed Effects**

	(1) Baseline		(2) With Trade		(3) 10-year Lag		(4) With Time Trend	
	Coef.	t-stat	Coef.	t-stat	Coef.	t-stat	Coef.	t-stat
ln(STDT)	0.2429	9.18	0.1624	6.02			0.1619	6.02
ln(STDT10)					0.1010	4.07		
ln(DISTANCE)	-0.4658	-10.92	-0.0252	-0.44	-0.1426	-2.59	-0.0146	-0.25
LANGUAGE	0.2036	2.52	0.1821	2.31	0.1332	1.67	0.1739	2.21
RELIGION	0.3439	4.90	0.2758	3.99	0.2536	3.71	0.2699	3.92
COLONY	0.0270	0.15	0.0518	0.30	0.2742	1.58	0.0444	0.25
ln(GDP2)	1.3682	5.17	1.4027	5.42	1.6951	6.79	-0.0097	-0.02
ln(RELPCGDP)	-0.4050	-1.15	-0.5941	-1.72	-0.6336	-1.94	0.1861	0.45
ln(GROW1)	0.0348	1.03	0.0342	1.03	0.0852	2.54	0.0533	1.59
ln(GROW2)	0.0460	1.24	0.0290	0.80	0.0096	0.27	0.0277	0.76
ln(I)	0.5869	2.15	0.3765	1.40	0.1420	0.54	0.6012	2.18
ln(G)	0.4881	2.10	0.5809	2.53	0.7082	3.07	0.3305	1.38
ln(EXCHANGE)	0.9930	5.08	1.0363	5.41	1.0531	5.45	0.9194	4.74
ln(TARIFF)	-0.4876	-3.64	-0.4875	-3.71	-0.4890	-3.82	-0.3092	-2.19
ln(TRADE)			0.4610	7.48	0.5265	8.63	0.4668	7.60
ln(TRADE_RVS)			0.1354	2.60	0.0406	0.80	0.1391	2.68
T							0.0678	3.42
Observations	2153		2129		2129		2129	
Adjusted R-sq	0.7061		0.7230		0.7146		0.7244	

Notes: The dependent variable in table 2 is the log of the GDP share of FDI. All models include unreported country-specific constants.

Table 3.   FDI Regressions: Dyad-Specific Effects

Dependent variable: ln(FDIY)							Dyad-Specific Effects	
	(1) Fixed Effects		(2) Random Effects		(3) Between Effects		(4) Fixed Effects With T	
	Coef.	t-stat	Coef.	t-stat	Coef.	t-stat	Coef.	t-stat
ln(STDT)	0.1291	2.52	0.2291	7.02	0.1647	3.52	0.1269	2.49
ln(DISTANCE)			0.0402	0.54	0.1923	2.41		
LANGUAGE			0.0210	0.11	0.0100	0.05		
RELIGION			0.3355	1.93	0.2117	1.18		
COLONY			0.6627	1.27	0.4655	0.89		
ln(GDP2)	1.5239	6.47	0.4979	7.45	0.0800	0.83	0.1401	0.32
ln(RELPCGDP)	-0.7768	-2.48	-0.5097	-3.66	-0.1260	-0.45	-0.0093	-0.02
ln(GROW1)	0.0473	1.58	0.0391	1.33	-0.3581	-1.62	0.0651	2.16
ln(GROW2)	0.0101	0.31	0.0391	1.20	0.3152	1.58	0.0087	0.27
ln(I)	0.4801	1.96	0.4397	2.48	-0.7567	-2.44	0.6957	2.77
ln(G)	0.3906	1.89	0.4791	2.77	1.0423	3.23	0.1428	0.66
ln(EXCHANGE)	1.0888	6.28	1.0494	6.89	1.4504	3.74	0.9777	5.58
ln(TARIFF)	-0.3975	-3.31	-0.6219	-7.62	-0.4262	-2.44	-0.2205	-1.71
ln(TRADE)	0.3972	4.30	0.5992	8.45	0.7164	5.67	0.4065	4.42
ln(TRADE_RVS)	-0.0190	-0.23	-0.0413	-0.64	0.1409	1.13	0.0013	0.02
T							0.0664	3.74
Observations	2129		2129		2129		2129	
Adjusted R-sq	0.1991		0.4491		0.6039		0.2051	

Notes: The dependent variable in table 3 is the log of the GDP share of FDI. Models (1) and (4) include unreported dyad-specific constants. Model (2) and (3) include an unreported constant. Model (3) captures only between-dyad variations in regressors.

Table 4. FDI Regressions: Additional Sensitivity Tests

Dependent variable: ln(FDIY)							Dyad-Specific Fixed Effects	
	(1)		(2)		(3)		(4)	
	2SLS		Reverse Student Flows		STDT from the Rest of Countries		Without China and the U.S.	
	Coef.	t-stat	Coef.	t-stat	Coef.	t-stat	Coef.	t-stat
ln(STDT)	0.1338	2.60			0.1477	2.56	0.1382	2.49
ln(STDT_RVS)			0.0154	0.28				
ln(STDT_REST)					-0.2212	-4.22		
ln(GDP2)	1.5061	6.38	1.7703	4.56	1.2851	4.92	1.4553	5.47
ln(RELPCGDP)	-0.8399	-2.65	-0.6877	-1.75	-0.6768	-1.91	-0.6656	-1.90
ln(GROW1)	0.0514	1.71	0.0256	0.70	0.0657	1.84	0.0428	1.32
ln(GROW2)	0.0066	0.20	0.0157	0.39	0.0313	0.77	-0.0024	-0.07
ln(I)	0.4067	1.62	0.2995	0.84	0.5075	1.83	0.6122	2.19
ln(G)	0.4182	2.02	0.3107	1.15	0.0612	0.25	0.4306	1.89
ln(EXCHANGE)	1.1030	6.35	1.2804	4.48	0.9667	4.79	0.9911	5.08
ln(TARIFF)	-0.3748	-3.10	-0.2826	-1.14	-0.3566	-2.62	-0.4195	-3.07
ln(TRADE)	0.5565	3.84	0.5178	3.00	0.3442	3.23	0.3818	3.82
ln(TRADE_RVS)	-0.0728	-0.81	0.2941	1.81	-0.0075	-0.08	-0.0100	-0.11
Observations	2129		1567		1555		1749	
Adjusted R-sq	0.1979		0.0971		0.2010		0.1898	

Notes: The dependent variable in table 4 is the log of the GDP share of FDI. All models include unreported dyad-specific constants. Variables DISTANCE, LANGUAGE, RELIGION, and COLONY are dropped in table 3 because they are collinear variables with dyad-specific constants. In model (1), the 2 stage least squares method (2SLS) is performed to account for the endogeneity of TRADE. Model (2) includes as a regressor the flow of students abroad in the same direction as FDI flow instead. In model (3) STDT_REST denotes the total number of students from country j who studied in foreign countries other than country i. China and the U.S. are excluded from the regression in model (4).