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ABSTRACT

Managerial know-how shapes the productivity of firms by defining the set of available technologies, production choices, and market opportunities. This know-how can be reallocated across countries as managers acquire control of factors of production abroad. In this paper, we construct a quantitative model of cross-country income differences to study the aggregate consequences of international mobility of managerial know-how. We use the model and aggregate data to infer the relative scarcity of this form of know-how for a sample of developing countries. We also conduct policy counterfactuals and find that on average, developing countries gain up to 23% in output and 9% in consumption when they eliminate all barriers to foreign control of domestic factors of production.

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1. Introduction

The diffusion of productive knowledge plays an important role in the literature on cross-country income differences (e.g., Barro and Sala-i-Martin 1998 and Klenow and Rodriguez-Clare 2005). Much of the attention has been focused on flows of knowledge embedded in capital goods and in patents, and on the role of international trade and imitation in the diffusion of ideas. Less attention has been given to the transfer of know-how that takes place when management crosses borders to directly control inputs in a foreign country. Such transfers, however, appear to be important in light of the large and fast growing multinational activity observed in recent years.[1] In this paper, we construct a quantitative model of cross-country income differences to study the aggregate consequences of foreign management and control of inputs in host countries.

There is a long tradition of linking the productivity of firms to the quality of their management.[2] Managerial know-how shapes the productivity of firms by governing the set of available technologies, production choices, and market opportunities. This know-how is costly to reproduce but can be imported from abroad as foreign management acquires control of local inputs. To evaluate the consequences of policies that restrict the international mobility of managerial know-how, it is essential to separate this component of productivity from other complementary factors that are fixed in each country.

We refer to those factors which are immobile across countries and that impact the productivity of all firms operating in the country, as "country-embedded productivity". It includes, for example, the infrastructure, regulations, natural amenities, and the quality of the local labor force and other inputs that are fixed in the country. We refer to the know-how of the individuals in control of the firm as "firm-embedded productivity". Because of its human aspect this factor has two important characteristics. First, it is a "rival" factor that is in limited supply. At any point in time, employing the skills of an individual in one task or location precludes them from being used in another one. Second, firm-embedded productivity can be reallocated across sectors, regions and, albeit imperfectly, across countries.

Consider the case of wine production. Making wine is mostly a matter of the choices made

[1] See chapter 1 of Barba Navaretti and Venables (2004) and references therein for an account of the impressive growth of multinational firms during the last two decades of the 20th century.

[2] See, for example, Kaldor (1934), Lucas (1978), Oi (1983), Prescott and Visscher (1980), and Rosen (1982). Bloom and Van Reenen (2006) provide survey evidence that managerial practice is strongly associated with firm-level performance.

during each phase of production, from choosing the grapes to bottling and marketing the finished product. Country-embedded productivity includes the quality of the soil, rainfall, sunlight, water, as well as appellations, seals of origin, and other amenities. Firm-embedded productivity is given by the viticultural and enological know-how of winemakers, as well as their connections and knowledge of the relevant markets. The international mobility of firm-embedded productivity is illustrated by winemakers such as Gallo, Mondavi, and Rothschild, who export their know-how to produce wine faraway from their traditional 'terroirs'.[3]

The mobility of firm-embedded productivity across countries conforms with the observation that multinational firms in developing countries rely largely on expatriates from the source country for "senior management positions and key technical and engineering jobs to execute sophisticated or specialized production tasks" (UNCTAD 1994, p. 238).[4] Bloom, Sadun and Van Reenen (2007) provide direct evidence that multinational firms transplant their organization structure and managerial practices, and this shapes their productivity abroad. Indeed, Bloom (2007) documents that foreign operations of firms from developed countries (e.g., U.S. and Japan) are better managed than domestic firms in developing countries (e.g., China and India).

At the aggregate level, country- and firm-embedded productivity cannot be directly separated. For given levels of capital and labor, a combination of high country- and low firm-embedded productivity can lead to the same observed output level as a combination of low country- and high firm-embedded productivity. Firm-embedded productivity, however, is a rival factor that can be reallocated across countries. To equalize the marginal product across countries, firm-embedded productivity must flow from countries where it is relatively abundant to countries where it is scarce. Therefore, for the same measured level of output, a high observed share of capital and labor controlled by foreign know-how indicates a high ratio of country- to firm-embedded productivity.

We formalize this logic in a standard model of cross-country income differences, extended with internationally mobile managerial know-how. We use the model and aggregate data to disentangle country- and firm-embedded productivities for a sample of developing countries,

[3]For example, The Economist ("Vino Twin Peaks", March 15, 2007) describes how the arrival of foreign winemakers in Argentina led to a large increase of high quality wine exports over recent years. See Fisher (1999) for a broader discussion on the globalization in wine production.

[4]The UNCTAD report provides evidence that the reliance on expatriates is greater in developing countries than in developed countries. It also highlights the important role of foreign personnel in organizing the early phases of the enterprise as well as training the local workers.

and to conduct policy counterfactuals on changes in the barriers to foreign control of local factors of production.

In our model, production is organized in teams composed of a top-level manager leading a set of inputs. Inputs include middle managers, workers, and capital services. As in Lucas (1978), we refer to these teams as "firms." Firms have decreasing returns to scale in the inputs controlled by the top manager. The productivity of a firm is the product of two Hicks-neutral factors: the location of the firm (country-embedded productivity) and the know-how of its top-level manager (firm-embedded productivity). Firm leaders from one country can reallocate their know-how to another country and form teams with local inputs and capital. We refer to such teams as foreign firms.[5]

Firms maximize profits by choosing locations with high country-embedded productivity and low factor prices. The worldwide equilibrium allocates firm-embedded productivity by equalizing its marginal product (the firms' profits) across countries. Everything else equal, a host country attracts more foreign firms, the higher its country-embedded productivity and the lower its domestic firm-embedded productivity, both of which reduce the production costs of foreign firms. This implication of our model echoes the result in Helpman (1984), that inflows of vertical multinational firms are more prevalent in countries that are relatively scarce in factors intensively used by headquarter services (e.g., management, marketing and R&D) and relatively rich in factors intensively used in production activities (e.g., labor).

We use the model and aggregate data to separately measure the domestic endowment of firm-embedded productivity and the level of country-embedded productivity. Observing a higher share of factors controlled by foreign firms indicates, everything else the same, a higher ratio of country-to-firm-embedded productivity. Similarly, a higher tax rate on foreign profits (for the same share of factors controlled by foreign firms) indicates a higher ratio of country-to-firm-embedded productivity. In our model, we also allow for geographic barriers that reduce the productivity of foreign firms, physical capital accumulation, and mobility across occupations (workers, middle managers, and top managers) within countries.

In our quantitative analysis, we measure the aggregate share of inputs controlled by foreign firms in host countries as the ratio of the stock of inward foreign direct investment (FDI) to the stock of physical capital in each country. The measurement of FDI in the data is closely connected to the cross-country reallocation of managerial know-how and control in our

[5]In this paper we assume a bounded aggregate supply of managerial know-how in each country. Monge-Naranjo (2007) studies the dynamic accumulation of this factor in a model where it can move across countries.

model, since it represents foreign investment undertaken with the objective of establishing a lasting interest in the country, a long-term relationship, and a significant influence on the management of the firm. As a robustness check, we also construct an alternative measure of inputs controlled by foreign firms based on the share of efficiency units of labor controlled by multinational firms (combining data on the wage bill of U.S. multinational firms and inward stocks of FDI). Despite some important limitations, which are discussed below, both measures can be constructed for a large set of host countries.

The average stocks of FDI for the period 1997-2000 (see Figure 1) show that most net sources of FDI are developed countries, while most recipients of FDI are developing or recently developed countries. In our quantitative analysis we construct a single net source of firm-embedded know-how by aggregating the data for the largest net sources of FDI, and use data for 38 individual net host countries.[6] To account for the observed flows of FDI, our inference implies that developing countries are relatively scarce in firm-embedded productivity. Under the inferred levels of country- and firm-embedded productivities, our model replicates the observed share of capital controlled by foreign firms in each host country. We abstract from the gross flows of FDI within net exporters of FDI – which account for the majority of gross-flows of FDI worldwide – because our model does not include trade frictions that play a key role in North-North multinational activity.[7]

We then perform accounting exercises using our model as an organizing framework. We quantify the importance of fixed country productivity factors (country-embedded productivity), internationally mobile productivity factors (firm-embedded productivity of home and foreign firms), and physical capital stocks in accounting for cross-country differences in per capita output observed in the data. We find, in our baseline calculations, that differences in country-embedded productivity, firm-embedded productivity of domestic firms, and firm-embedded productivity of foreign firms account, and capital/output ratios, account respectively, for 61%, 27%, −5% and 17% of the output difference between source and host countries in the period 1997-2000. That is, the presence of foreign firms reduces the output gap between developed and developing countries by roughly 5%. We obtain similar num-

[6] Flows of FDI from developing to developed countries are small. For example, in 2001, 93% of all assets controlled by foreign affiliates in the U.S. were owned by nationals of other developed countries. Flows from developing to other developing countries also tend to be small. For example, during the 1990s, the fraction of inflows of FDI originated from developed countries was 91% in Mexico, and roughly 80% in Argentina, Costa Rica, and Peru (see Barba Navaretti and Venables 2004).

[7] See Helpman, Melitz, and Yeaple (2004) for a model of horizontal FDI in which firms establish foreign subsidiaries to serve the local market and avoid international trade costs.

bers when accounting for the output dispersion across host countries, and when using our alternative measures of the share of inputs controlled by foreign firms.

Next, we use our model to conduct policy counterfactuals. We quantify the aggregate impact in host countries of removing taxes on the profits of foreign firms. We identify three key margins that determine the magnitude of the gains in aggregate output and welfare: (i) the response in the inflow of firms, which largely depends on the degree of decreasing returns to scale at the firm level; (ii) the response of capital accumulation, which depends on the output share of capital; and (iii) the reallocation of agents across occupations, which depends on the shape of the cross-section distribution of managerial skills. Under our parameterization, the gains for host countries of moving from autarky to openness to foreign firms can be substantial. When margins (ii)–(iii) are shut-down, the average gains in output and welfare are 5% and 1%, respectively. When margins (ii)-(iii) are incorporated, the average gains increase to 23% and 9%, respectively.

In related work, Ramondo (2006) constructs a quantitative model of multinational activity in which firm-embedded productivity is a nonrival factor that can be simultaneously used in many countries. Therefore, in contrast to our model, productivity inflows in host countries do not involve productivity outflows in source countries. Antras, Garicano, and Rossi-Hansberg (2006a and 2006b) model managerial knowledge as a rival factor, but their focus is on the implications of North-South multinational activity on the assignment of individuals to tasks, and on the distribution of income. Our attention on the managerial know-how of foreign-controlled firms also conforms with a large literature on multinational activity that highlights the role of firm-specific intangible assets.[8] Since prolonged and continuous physical presence is not essential for effective management and control, our framework is also consistent with the model of Helpman (1984) in which headquarters provide managerial services to foreign affiliates.

In this paper we provide a contribution towards an aggregate quantitative framework of multinational activity and cross-country income differences. In doing so, we have abstracted from some interesting issues regarding the international mobility of firms. For example, our model does not deal with the endogenous choice of organization, either on the cross-country within-firm allocation of skills and tasks, or on the choice between outsourcing and integration (e.g., Helpman 1984, Grossman and Helpman 2003, Antras and Helpman 2004,

[8] See, for example, Barba-Navarretti and Venables (2004), Helleiner (1989), and Markusen (2004).

and Grossman and Rossi-Hansberg 2006). Our analysis also abstracts from the cross-country mobility of workers (e.g., Rauch 1991, and Klein and Ventura 2006).

The remainder of the paper is organized as follows. Section 2 uses a simple version of our model to illustrate the equilibrium allocation of firm-embedded productivity and how country- and firm-embedded productivities can be inferred from observed aggregate data. Section 3 extends the basic model in three dimensions: geographic frictions and taxes, capital accumulation, and occupation choice. Section 4 analyzes the equilibrium and inference of country- and firm-embedded productivities in the extended model. Section 5 describes the multicountry quantitative model, its calibration, and the quantitative results on the inference of country and firm-embedded productivities. Section 6 presents the policy counterfactuals, and Section 7 concludes. The Appendix contains some details of the quantitative model omitted in the body of the paper.

2. A Basic Two-Country Model

In this section we use a simple model to illustrate the gains of reallocating managerial know-how, or "firm-embedded productivity", across countries. We also show how to use aggregate data to infer the relative scarcity of firm-embedded productivity.

2.1. The Model

Consider a world of two countries, indexed by $i = 1, 2$ and a single, freely traded consumption good. The population L^i in each country is divided into a fraction ω of managers and a fraction $1 - \omega$ of workers, each endowed with one unit of time.

Production is organized in firms. A firm is a team of a manager and a set of workers under his or her control. The productivity of a firm depends on two factors. The first factor is determined by the country where the firm operates. The second is determined by the know-how of the manager.[9]

The first factor is what we call "country-embedded productivity", z^i. It is a Hicksian shift in the productivity of all the firms producing in the country. It captures the infrastructure, regulation, natural amenities, unmeasured human capital of workers, and any other

[9] In our model, there are no gains or losses of consolidating many teams into one. Hence, we can re-interpret any collection of teams as a firm, or equivalently we can re-interpret each team as a subset of the operations of a firm. For examples of models in which integrating teams is not neutral, see Rosen (1982), and Antras, Garicano and Rossi-Hansberg (2006b).

nontradeable factor of production of the country.

The second factor, x, is what we call firm-embedded productivity. It is the know-how embedded in the manager that leads the team. Managers use their know-how in making and implementing the critical technological, production, and marketing decisions relevant to a firm. This know-how can be reallocated across countries. The firm-embedded productivity x is also a Hicksian shift in the firm's productivity. We assume for now that all managers from country i are endowed with the same value $x^i > 0$.

Specifically, output y of a firm with n workers and firm-embedded productivity x is

$$y = z^i x^{1-\nu} n^{\nu}. \tag{2.1}$$

The parameter $\nu \in (0,1)$ determines the degree of diminishing returns to scale to the manager's control of other inputs.

In a competitive equilibrium, managers hire workers and earn the profits of the firm. For our purposes, it is instructive to examine world competitive equilibria under two different scenarios. In the first, referred to as "autarky," only local managers can lead firms in each country. In the second scenario, referred to as "international firm mobility," managers are free to lead teams in any of the two countries. We always maintain the assumption that workers are internationally immobile.

2.2. Autarky

Within countries, each identical manager controls $n = (1-\omega)/\omega$ units of labor. Summing up over the output of individual units, aggregate output in each country i is

$$Y^i = \mu \left[z^i \left(x^i\right)^{1-\nu} \right] L^i \ , \tag{2.2}$$

where $\mu \equiv \omega^{1-\nu} (1-\omega)^{\nu}$. Notice that the term $z^i \left(x^i\right)^{1-\nu}$ pins down per capita output in each country. Note also that in autarky, z^i and x^i are indistinguishable.

World total output is

$$Y^w = \mu \left\{ \left[z^1 \left(x^1\right)^{1-\nu} \right] L^1 + \left[z^2 \left(x^2\right)^{1-\nu} \right] L^2 \right\}. \tag{2.3}$$

It is determined in part by the sorting of z^i and x^i across countries, since these two factors are complementary. In general, there can be gains from reallocating managerial know-how from countries where x^i/z^i is high, to countries where x^i/z^i is low.

2.3. International Firm Mobility

Assume now that managers can be reallocated across countries. For now assume that, regardless of location, country i managers carry their firm-embedded productivity x^i to either country in which they operate.

Suppose that a fraction $m \in (0,1)$ of country 1 managers operates in country 2. Assume also that all managers from country 2 operate in country 2. Therefore, with $(1-m)\,\omega L^1$ managers operating in country 1, each one controls $n_1^1 = (1-\omega)/[\omega(1-m)]$ workers. Aggregate output in country 1 is

$$\begin{aligned} Y^1 &= (1-m)\,\omega L^1 z^1 \left(x^1\right)^{1-\nu} \left(n_1^1\right)^{\nu} \\ &= \mu z^1 \left(x^1\right)^{1-\nu} (1-m)^{1-\nu} L^1. \end{aligned} \tag{2.4}$$

Country 2 hosts both domestic and foreign managers. Each domestic manager hires n_2^2 workers, and each foreign manager hires n_1^2 workers. Equalization of marginal products of labor across firms implies that employment in each firm is proportional to firm-embedded productivity. Therefore:

$$n_2^2 = \left(x^2/x^1\right) n_1^2. \tag{2.5}$$

The total labor used by domestic and foreign firms must equate the aggregate endowment in country 2:

$$\omega m L^1 n_1^2 + \omega L^2 n_2^2 = (1-\omega)\, L^2. \tag{2.6}$$

Adding up output from domestic and foreign firms, and using (2.5) and (2.6), aggregate output in country 2 is

$$\begin{aligned} Y^2 &= z^2 \left[\omega m L^1 \left(x^1\right)^{1-\nu} \left(n_2^1\right)^{\nu} + \omega L^2 \left(x^2\right)^{1-\nu} \left(n_2^2\right)^{\nu}\right] \\ &= \mu z^2 \left[m L^1 x^1 + L^2 x^2\right]^{1-\nu} \left(L^2\right)^{\nu}. \end{aligned} \tag{2.7}$$

We solve for the international allocation of managerial know-how that maximizes world output and show that it is also the outcome of a competitive equilibrium. The efficient allocation m^* maximizes world output by equating the marginal product of managers across locations, $\partial Y^1/\partial m + \partial Y^2/\partial m = 0$. The solution is

$$m^* = \frac{1 - \left(\frac{x^2}{x^1}\right)\left(\frac{z^1}{z^2}\right)^{1/\nu}}{1 + \left(\frac{L_1}{L_2}\right)\left(\frac{z^1}{z^2}\right)^{1/\nu}}. \tag{2.8}$$

Notice that a sufficient and necessary condition for country 2 to receive foreign managers ($m^* > 0$) is

$$R \equiv \left(\frac{x^2}{x^1}\right)\left(\frac{z^1}{z^2}\right)^{1/\nu} < 1. \tag{2.9}$$

The ratio R provides the precise basis for comparing the relative scarcity of firm-embedded productivity across countries. If the ratio is less than one, firm-embedded productivity is scarce in country 2, and a social planner would transfer some of the managerial know-how from country 1 to country 2. Observe that the host country attracts foreign firms either because it is a relatively productive location (high z^2/z^1), or because it has a relatively low endowment of firm-embedded productivity (low x^2/x^1). Relative population sizes also shape the magnitude of inflows of foreign firms. If country 1 is relatively large, a smaller fraction of its firm-embedded productivity needs to be reallocated to country 2 to equate the marginal productivity of managers.

The world as a whole has an endowment of firm-embedded productivity equal to $\omega\left(L^1x^1 + L^2x^2\right)$, and managers of both countries are perfect substitutes (at a rate x^2/x^1). In this setup, the optimal allocation only pins down the net reallocation of managerial know-how. Many alternative patterns of gross flows have the same output and welfare implications as long as they imply the same aggregates of firm-embedded productivity allocated to each country. Our assumption that $m > 0$ and that all country 2 managers operate in country 2 is without loss of generality as long as country 2 is a net recipient.

Using expressions (2.4), (2.7), and (2.8), aggregate output under the efficient allocation of firms is

$$Y^i = \mu\left(\frac{x^1L^1 + x^2L^2}{\left(z^1\right)^{1/\nu}L_1 + \left(z^2\right)^{1/\nu}L^2}\right)^{1-\nu}\left[L^i\left(z^i\right)^{1/\nu}\right], \; i = 1, 2. \tag{2.10}$$

The first term is common to both countries. With firm mobility, relative output levels depend only on immobile country factors (which are z^i and L^i).

For the world as a whole, output is

$$Y^w = \mu\left(x^1L^1 + x^2L^2\right)^{1-\nu}\left[L^1\left(z^1\right)^{1/\nu} + L^2\left(z^2\right)^{1/\nu}\right]^{\nu}. \tag{2.11}$$

Note that world output depends on the world endowment of firm-embedded productivity, and not on how it is initially distributed across countries. Moreover, world output is still affected by the sorting of populations L^i and country-embedded productivities z^i, which are fixed in each country.

For our exercises, it is useful to compute the share of inputs that foreign firms control in host countries. Given any m, the share of labor that country 1 firms control of the aggregate labor in country 2 is denoted by s and given by

$$\begin{aligned} s &= \frac{\omega m L^1 n_1^2}{\omega m L^1 n_1^2 + \omega L^2 n_2^2} \\ &= \frac{m L^1 x^1}{m L^1 x^1 + L^2 x^2}. \end{aligned} \tag{2.12}$$

We can use (2.12) to re-express output of country 2 in (2.7) as

$$Y^2 = \mu z^2 \left(x^2\right)^{1-\nu} \left(\frac{1}{1-s}\right)^{1-\nu} L^2. \tag{2.13}$$

The higher the share s, the higher the output in country 2, as it is hosting a larger amount of firm-embedded productivity. Likewise, an increase in s lowers output in country 1. Note that a larger output share of firm-embedded productivity, $1-\nu$, raises the impact of an increase in s on aggregate output.

Consumption in each country equals the sum of labor income and the profits of its firms:

$$C^1 = Y^1 + (1-\nu)\, sY^2, \text{ and } C^2 = \left[1-(1-\nu)\, s\right] Y^2. \tag{2.14}$$

An increase in s leads to a larger increase in consumption than output in country 1 (output actually falls), and a smaller increase in consumption than output in country 2.

To get a first sense of magnitudes, let $\nu = 0.85$ (which we justify below). Consider raising s from zero (autarky) to 25% (roughly the share of factors that foreign firms controlled in Dominican Republic on average during 1997-2000, based on the measures discussed below). The resulting increment in output and consumption is 4.4% and 0.5%, respectively. These gains are significantly higher (up to 10 times for consumption) in the extended model that includes capital accumulation, and endogenous occupation choice.

Efficient allocations coincide with those in a competitive equilibria. To see this, let w^i be the wage in country i and π_i^j be the profits of firms from country i operating in country j, given by

$$\begin{aligned} \pi_i^j &= \max_{\{n_i^j\}} \left\{ z^j \left(x^i\right)^{1-\nu} \left(n_i^j\right)^{\nu} - n_i^j w^j \right\} \\ &= \kappa \left(z^j\right)^{\frac{1}{1-\nu}} x^i / \left(w^j\right)^{\frac{\nu}{1-\nu}}, \end{aligned} \tag{2.15}$$

where $\kappa = \nu^{\frac{\nu}{1-\nu}} \left[1-\nu\right] > 0$. Managers from both countries strictly prefer to operate in country 2 if $\left(w^2/w^1\right) < \left(z^2/z^1\right)^{1/\nu}$. In an interior equilibrium, managers are indifferent between operating in the two locations, and therefore relative wages are pinned down by relative country-embedded productivities.

Given m, we can solve for the equilibrium wages by combining the optimal labor choices and market clearing in both labor markets:

$$w^1 = \frac{\nu\mu}{1-\nu} z^1 \left(x^1\right)^{1-\nu} (1-m)^{1-\nu} \tag{2.16}$$

and

$$w^2 = \frac{\nu\mu}{1-\nu} z^2 \left[x^2 L^2 + m x^1 L^1\right]^{1-\nu}. \tag{2.17}$$

It is straightforward to see that the value of m that implies $(w^2/w^1) = \left(z^2/z^1\right)^{1/\nu}$, or $\pi_1^1 = \pi_1^2$, coincides with the efficient m^*.

2.4. Using Observed $\{Y^i, L^i, s\}$ to Infer x^i and z^i

The endowments of country- and firm-embedded productivities, x^i and z^i, are not observed. Inferring their values is essential to determine the output and consumption gains of international firm mobility. Note that, from expression (2.13), a given level of aggregate output can result from many combinations of x^i and z^i, for a given share s. We now show how the equilibrium determination of s allows us to separately infer x^i and z^i from aggregate data.

First, we can use the expression for equilibrium output, (2.10), to obtain an expression for relative country-embedded productivities in terms of relative per capita output levels:

$$\left(\frac{z^2}{z^1}\right) = \left(\frac{Y^2/L^2}{Y^1/L^1}\right)^{\nu}. \tag{2.18}$$

This expression shows that, since mobile factors are being allocated to equalize their marginal return across countries, output levels are entirely pinned down by factors that are immobile across countries (z^i and L^i).

Second, we can infer relative firm-embedded productivities from the equalization of marginal products of managerial know-how across countries. Namely, combining the expression for the equilibrium determination of m, (2.8), the definition of s, (2.12), and (2.18) we obtain

$$\left(\frac{x^2}{x^1}\right) = \frac{(1-s)}{\left(\frac{Y^1}{L^1}\right) / \left(\frac{Y^2}{L^2}\right) + s\left(\frac{L^2}{L^1}\right)}. \tag{2.19}$$

This expression indicates that the higher the fraction of inputs controlled by foreign firms, the lower must be the national endowment of managerial know-how. Also, a higher output per capita in the host country indicates a higher value of z^2/z^1, making the host country more attractive to foreign firms. Therefore, for the same level of s, domestic firms must be more productive to compete with foreign firms. Finally, notice that country size also matters because for a given share of inputs s, a larger host country requires a larger inflow of firms from the source country. Everything else constant, this can only take place if firm-embedded productivity is relatively lower in the host country.

We now show that this basic idea of using observed aggregate data $\{Y^i, L^i, s\}$ to infer x^i and z^i carries out much more generally than in this basic model.

3. Model Extensions

We extend the basic model along three dimensions that are important to quantify the gains of internationally reallocating firm-embedded productivity. First, we consider geographic and policy barriers. Second, we introduce physical capital accumulation. Finally, we endogenize the number of firms and introduce two layers of management.

We consider each extension in isolation and show how they affect the world equilibrium. We then combine all the extensions and show how to infer the country- and firm-embedded productivities using aggregate data and the equilibrium conditions of the model.

3.1. Geographic and Policy Barriers

In the basic model we assumed that managers have the same know-how when they operate in their home country or in a foreign country. In reality, we can expect that firm-embedded productivity may erode when firms operate abroad due to geographic and cultural barriers in the host country, or lost connections and local knowledge from their home country. These geographic barriers, or "gravity" considerations, are not part of the country-embedded productivity because they do not affect domestic firms.

We incorporate these considerations into the model by assuming that output of a firm from country 1 operating in country 2 is $z^2 \left(\theta x^1\right)^{1-\nu} n^{\nu}$. Here, if $\theta < 1$ there is a home bias in the location of firms since moving a firm from country 1 to country 2 entails an efficiency loss. For a given m, aggregate output in country 2 is

$$Y^2 = z^2 \mu \left(mL^1 \theta x^1 + x^2 L^2\right)^{1-\nu} \left(L^2\right)^{\nu}. \tag{3.1}$$

We also assume that countries differ in their tax on firms' profits. The government of country i imposes a tax rate $\tau_F^i \in [0,1]$ on the profits of foreign firms and a tax rate $\tau_D^i \in [0,1]$

on the profits of home firms. We assume that taxes collected by each government are rebated in a lump-sum fashion to national households. We view τ_F^i as proxying for a variety of barriers faced by firms operating in a foreign country. As taxes are applied to profits, they affect only the location of firms and not their hiring of inputs. The counterfactual quantitative exercises reported below are based on variations in these tax rates.

In an interior equilibrium, the number of foreign managers in country 2 is determined by

$$\left(1-\tau_F^2\right)\pi_1^2=\left(1-\tau_D^1\right)\pi_1^1. \tag{3.2}$$

If in addition, taxes are such that $(1-\tau_F^2)/(1-\tau_D^1)\leq(1-\tau_D^2)/(1-\tau_F^1)$, then managers from country 2 will prefer (strictly if the inequality is strong) to remain in country 2, eliminating the possibility of two-way flows.

In equilibrium, the fraction of country 1 managers operating in country 2 is

$$m^*=\frac{1-\left(\frac{x^2}{x^1\theta}\right)\left(\frac{1-\tau_D^1}{1-\tau_F^2}\right)^{1/\nu}\left(\frac{z^1}{z^2\theta^{1-\nu}}\right)^{1/\nu}}{1+\left(\frac{L_1}{L_2}\right)\left(\frac{1-\tau_D^1}{1-\tau_F^2}\right)^{1/\nu}\left(\frac{z^1}{z^2\theta^{1-\nu}}\right)^{1/\nu}}. \tag{3.3}$$

Here, the terms $z^1/z^2\theta^{1-\nu}$ and $x^2/x^1\theta$ take the place of z^1/z^2 and x^2/x^1 in expression (2.8) of the basic model. A low θ negatively impacts output and has exactly the same effect on m^* as a reduction in z^2 and x^1. Only the terms $z^1/z^2\theta^{1-\nu}$ and $x^2/x^1\theta$ are relevant in assessing the output and welfare gains of firm mobility.

Notice that if $\tau_F^2>\tau_D^1$, then fewer firms flow from country 1 to country 2 compared to the undistorted case. Similarly, m^* is higher if country 2 promotes the presence of foreign firms by charging a tax rate $\tau_F^2<\tau_D^1$. Note also that a decrease in ν, by increasing the weight of firm-embedded productivity in production, increases the response of m^* to a change in taxes.

3.2. Physical Capital

When firm-embedded productivity can be reallocated across countries, the return of other factors of production will be affected as well. Consequently, an inflow of foreign firms will boost capital accumulation in the host country importing foreign firms. This complementarity magnifies the output and welfare gains of allowing international mobility of firms.

Assume now that output y of a firm is given by

$$y=z^ix^{1-\nu}\left(k^\alpha n^{1-\alpha}\right)^\nu, \tag{3.4}$$

where k are units of capital services and $\alpha\nu$ is the output share of capital.

Households own the aggregate stock of capital in each country. Capital follows the law of motion

$$K_t^i = (1-\delta)K_{t-1}^i + I_t^i \ , \tag{3.5}$$

where I_t^i denotes investment in country i, K_{t-1}^i denotes the previous period capital stock, and $\delta \in [0,1]$ is the depreciation rate of capital.

All firms face the same factor prices and country- and firm-embedded productivities are Hicks-neutral. Therefore, the share of capital controlled by foreign firms is also equal to their share on labor. With this, for any given m, aggregate outputs (abstracting from time t subscripts) are

$$Y^1 = \mu z^1 (1-m)^{1-\nu} \left(x^1\right)^{1-\nu} \left(\frac{K^1}{L^1}\right)^{\alpha\nu} L^1 \text{ , and} \tag{3.6}$$

$$Y^2 = \mu z^2 \left(mL^1\theta x^1 + x^2 L^2\right)^{1-\nu} \left(\frac{K^2}{L^2}\right)^{\alpha\nu} \left(L^2\right)^{\nu} . \tag{3.7}$$

Notice that a higher capital stock is similar to a higher z^i in that it raises the returns to both foreign and domestic firms. For given capital stocks in each country, the allocation of firms that maximizes world output is

$$m^* = \frac{1 - \left(\frac{x^2}{x^1}\right)\left(\frac{z^1}{z^2}\right)^{1/\nu}\left(\frac{K^1}{L^1}/\frac{K^2}{L^2}\right)^{\alpha}}{1 + \left(\frac{L_1}{L_2}\right)\left(\frac{z^1}{z^2}\right)^{1/\nu}\left(\frac{K^1}{L^1}/\frac{K^2}{L^2}\right)^{\alpha}}. \tag{3.8}$$

A higher capital-labor ratio in the host country increases m^* by attracting more firms from the source country.

Over time, capital stocks will endogenously respond to the international reallocation of firms. From equations (3.6) and (3.7), a higher m raises the marginal product of capital in the host country and reduces it in the source country. In a steady state with no country-specific distortions on capital accumulation, the marginal products of capital ($\alpha\nu Y^i/K^i$) are equal in both countries. The steady-state optimal reallocation of firms m_{ss}^* is

$$m_{ss}^* = \frac{1 - \left(\frac{x^2}{x^1}\right)\left(\frac{z^1}{z^2}\right)^{1/(1-\alpha)\nu}}{1 + \left(\frac{L_1}{L_2}\right)\left(\frac{z^1}{z^2}\right)^{1/(1-\alpha)\nu}}. \tag{3.9}$$

If we start in a steady state with no firm mobility and it is optimal to reallocate firms to country 2, then the output gains will be magnified by the enhanced rate of return and accumulation of capital.

3.3. Heterogeneity, Occupation Choice, and Local Management

We now endogenize the number of firms in each country so that firms are in bounded but elastic supply. We assume that individuals are heterogeneous in their managerial skills, and each decides between managing firms or working for other firms. We also consider firms with two layers of management. The first layer is composed of "top managers" and determines the level of firm-embedded productivity. The second layer consists of "middle-level managers," which we assume are internationally immobile. In this way, we capture the fact that multinational operations are typically directed by managers from the source country and lower ranks of management are conducted by nationals of the host country. Indeed, the availability of highly qualified mid-level managers is often cited by multinational firms as one of the main factors in picking a particular host country.[10]

Assume that the firm's production function is extended to include "mid-level administration" services, denoted by a,

$$y = z^i x^{1-\nu} \left(a^\gamma n^{1-\gamma}\right)^\nu , \tag{3.10}$$

where x is the know-how of the top manager that leads the firm.

The average skill of top managers (or the average firm-embedded productivity) in country i is x^i, and the average skill of middle-level managers is x_a^i. Within each country, individuals draw an idiosyncratic skill level e with c.d.f. F, support $[0, \infty)$, and mean one. Individuals choose between becoming a top manager, a middle manager, or a worker. As a top manager, an individual with idiosyncratic skill e controls a firm with firm-embedded productivity $x^i e$ and earns its profits. As a middle manager, the individual supplies $x_a^i e$ units of intermediate managerial services, which, multiplied by the market wage for mid-management services, determines his income. As a worker, he supplies one unit of labor services and receives a wage independent of e.

Given that earnings of managers (both top and middle level) are increasing in e while earnings of workers are not, there is a unique threshold $\bar{e}_0^i$ such that individuals with $e \leq \bar{e}_0^i$ are employed as workers, as in Lucas (1978). Since the earnings of middle and top managers are both proportional to e, there is an indeterminacy in the allocation of individuals between top and middle management occupations.[11] However, the equilibrium uniquely pins down

[10] See, for example, Larrain, Lopez-Calva and Rodriguez-Clare (2001). Antras, Garicano, and Rossi-Hansberg (2006b) also study the role of locally provided middle-level management in multinational activity.

[11] This indeterminacy is also discussed in Jovanovic (1994). It results from the fact that returns to middle

the mass of middle and top management skills, denoted by ξ_0^i and ξ_1^i, as well as the other aggregates of the model (such as Y^i and s). One particular way of attaining these aggregate masses ξ_0^i and ξ_1^i is allocating individuals with $e > \bar{e}_1^i$ to top managerial positions and individuals with $\bar{e}_0^i < e < \bar{e}_1^i$ to middle manager positions, implying that $\xi_0^i = \int_{\bar{e}_0^i}^{\bar{e}_1^i} edF(e)$ and $\xi_1^i = \int_{\bar{e}_1^i}^{\infty} edF(e)$. Throughout our analysis, we only need to determine the equilibrium values of ξ_0^i and ξ_1^i regardless of how they are formed, with $\bar{e}_0^i$, ξ_0^i, and ξ_1^i satisfying the resource constraints

$$\int_0^{\bar{e}_0^i} edF(e) + \xi_0^i + \xi_1^i = 1 \ , \ i = 1, 2. \tag{3.11}$$

With heterogeneous firms we reinterpret m as the fraction of aggregate firm-embedded productivity (or top managerial skills) that country 1 exports to country 2.[12] For any m, aggregate outputs are

$$Y^1 = z^1 \left[\left(x_a^1 \xi_0^1 \right)^{\gamma} F\left(\bar{e}_0^1 \right)^{(1-\gamma)} \right]^{\nu} \left[(1-m) L^1 x^1 \xi_1^1 \right]^{1-\nu} \left(L^1 \right)^{\nu} \ \text{, and} \tag{3.12}$$

$$Y^2 = z^2 \left[\left(x_a^2 \xi_0^2 \right)^{\gamma} F\left(\bar{e}_0^2 \right)^{(1-\gamma)} \right]^{\nu} \left[L^2 x^2 \xi_1^2 + m L^1 x^1 \xi_1^1 \right]^{1-\nu} \left(L^2 \right)^{\nu} . \tag{3.13}$$

The values of $\bar{e}_0^i$, ξ_0^i, and ξ_1^i that maximize global output, $Y^1 + Y^2$, subject to (3.11), are the unique fixed points of

$$\bar{e}_0^i = \frac{(1-\gamma)}{\gamma} \frac{\xi_0^i}{F\left(\bar{e}_0^i\right)}, \ i = 1, 2 \ , \tag{3.14}$$

$$\xi_0^1 = \frac{\nu\gamma}{1-\nu} (1-m) \xi_1^1 \ , \tag{3.15}$$

$$\xi_0^2 = \frac{\nu\gamma}{1-\nu} \left[\xi_1^2 + m \frac{x^1 L^1}{x^2 L^2} \xi_1^1 \right] , \tag{3.16}$$

and (3.11). Here m is given by expression (2.8) of the basic model, where $z^i \left[\left(x_a^i \xi_0^i \right)^{\gamma} F\left(\bar{e}_0^i \right)^{(1-\gamma)} \right]^{\nu}$ and $x^i \xi_1^i$ are the effective productivities that take the role of z^i and x^i, respectively.[13]

The quality of local mid-level managers, $x_a^i \xi_0^i$, and the abundance of workers, $F\left(\bar{e}_0^i\right)$, operate as a country-embedded factor. Note that if $x_a^i = x^i$, a higher x^i augments both the

and top managers are perfectly correlated. If we assumed that the exponent on x in the production function was 1 instead of $1 - \nu$, then the model would imply a unique allocation of individuals across occupations. Our quantitative results are invariant to this alternative assumption.

[12] For similar reasons as in the basic model (profits are proportional to firm-embedded productivity), we can only determine the net fraction of aggregate firm-embedded productivity flowing between countries. The cross-section distribution of reallocated skills is indeterminate.

[13] In the fully extended model, we will assume that all occupations face the same tax τ_D^i, and therefore, occupation choices are not distorted. See Cagetti and De Nardi (2006) for an analysis of taxation and the distortions on occupational choice. We also abstract from other within-country distortions across domestic firms (see, for example, Restuccia and Rogerson 2003, Caselli and Gennaioli 2005, and Guner, Ventura, and Yi 2006).

effective country-embedded productivity (attracting foreign firms) and the firm-embedded productivity of domestic firms (repelling foreign firms). The second force always dominates (see expression 2.8), so that a higher x^2/x^1 implies a lowers m^*, as in the benchmark model.

The reallocation of top managers across countries interacts with the allocation of individuals across occupations within each country. From the expressions above, we can see that $\partial\bar{e}_0^1/\partial m < 0$, $\partial\xi_0^1/\partial m < 0$, $\partial\xi_1^1/\partial m > 0$, $\partial\bar{e}_0^2/\partial m > 0$, $\partial\xi_0^2/\partial m > 0$, and $\partial\xi_1^2/\partial m < 0$. A higher m reduces the fraction of top managerial units remaining in country 1, increasing the marginal product of top managers and lowering the marginal product of middle managers and workers. Some workers will switch to managerial positions, and the mass of managerial skills will be reallocated from middle to top positions. In country 2, the reallocation of occupations and skills is in the opposite direction. The inflow of foreign top managerial skills lowers the marginal product of home top managers and increases the marginal product of middle managers and workers. Therefore, some managers switch to worker occupations, and part of the mass of managerial skills is reallocated from top- to middle-level positions.

The reallocation of occupations within each country reinforces the reallocation of firms between countries. To see this, suppose we fix $\bar{e}_0^i$, ξ_0^i, and ξ_1^i at their autarky level. Let m^A be the resulting fraction of country 1 firms that move to country 2 under these occupation choices. When we let $\bar{e}_0^i$, ξ_0^i, and ξ_1^i optimally adjust according to (3.14), (3.15), and (3.16) the resulting m^* is larger than m^A. Therefore, fixing $\bar{e}_0^i$, ξ_0^i, and ξ_1^i at their autarky levels is a lower bound on the gains of allowing firms to reallocate across countries. This margin plays an important role when evaluating the gains of firm international mobility.

Finally, it is straightforward to verify that the resulting allocations $\bar{e}_0^i$, ξ_0^i, and ξ_1^i also arise in a competitive equilibrium in which individuals take as given the international returns of top-managerial skills, and the national wages of mid-level managerial skills and labor services.

4. Inferring Country- and Firm-Embedded Productivities in the Extended Model

We now briefly discuss the equilibrium allocations and our inference of z^i and x^i using aggregate data in the fully extended model.

4.1. Equilibrium

For given capital stocks and fraction of foreign firms $m > 0$, aggregate output in each country is

$$Y^1 = \widetilde{z}^1 \left[(1-m) L^1 \widetilde{x}^1\right]^{1-\nu} \left(L^1\right)^{(1-\alpha)\nu} \left(K^1\right)^{\alpha\nu}, \text{ and} \tag{4.1}$$

$$Y^2 = \widetilde{z}^2 \left[L^2 \widetilde{x}^2 + m\theta L^1 \widetilde{x}^1\right]^{1-\nu} \left(L^2\right)^{(1-\alpha)\nu} \left(K^2\right)^{\alpha\nu}, \tag{4.2}$$

where $\widetilde{z}^i$ and $\widetilde{x}^i$ are the *effective* country- and firm-embedded productivities in country i defined as

$$\begin{aligned} \widetilde{z}^i &\equiv z^i \left[\left(x_a^i \xi_0^i\right)^{\gamma} F\left(\bar{e}_0^i\right)^{(1-\gamma-\alpha)}\right]^{\nu}, \text{ and} \\ \widetilde{x}^i &\equiv x^i \xi_1^i . \end{aligned} \tag{4.3}$$

Following similar steps as in the basic model, the fraction m^* that equates the net-of-taxes returns to managers in both countries is

$$m^* = \frac{1 - \left(\frac{1-\tau_D^1}{1-\tau_F^2}\right)^{1/\nu} \left(\frac{\widetilde{x}^2}{\theta \widetilde{x}^1}\right) \left(\frac{\widetilde{z}^1}{\widetilde{z}^2 \theta^{1-\nu}}\right)^{1/\nu} \left(\frac{K^1}{L^1} / \frac{K^2}{L^2}\right)^{\alpha}}{1 + \left(\frac{L_1}{L_2}\right) \left(\frac{1-\tau_D^1}{1-\tau_F^2}\right)^{1/\nu} \left(\frac{\widetilde{z}^1}{\widetilde{z}^2 \theta^{1-\nu}}\right)^{1/\nu} \left(\frac{K^1}{L^1} / \frac{K^2}{L^2}\right)^{\alpha}}. \tag{4.4}$$

The terms ξ_0^i, ξ_1^i, $F\left(\bar{e}_0^i\right)$ are pinned down using expressions (3.15) and (3.16) and

$$\bar{e}_0^i = \frac{(1-\gamma-\alpha)}{\gamma} \frac{\xi_0^i}{F\left(\bar{e}_0^i\right)}, \; i = 1, 2. \tag{4.5}$$

This condition is the analog of (3.14) extended to take into account the presence of capital.

Up until here, the capital stocks are exogenously given. If instead we consider a steady state with no country-specific barriers to capital accumulation, then capital stocks will adjust until marginal products are equalized in both countries, and the steady-state fraction of country 1 firms operating in country 2 is

$$m_{ss}^* = \frac{1 - \left(\frac{1-\tau_D^1}{1-\tau_F^2}\right)^{1/\nu} \left(\frac{\widetilde{x}^2}{\theta \widetilde{x}^1}\right) \left(\frac{\widetilde{z}^1}{\widetilde{z}^2 \theta^{1-\nu}}\right)^{1/(1-\alpha)\nu}}{1 + \left(\frac{1-\tau_D^1}{1-\tau_F^2}\right)^{1/\nu} \left(\frac{L_1}{L_2}\right) \left(\frac{\widetilde{z}^1}{\widetilde{z}^2 \theta^{1-\nu}}\right)^{1/(1-\alpha)\nu}}. \tag{4.6}$$

Notice that with endogenous capital accumulation, the effective country-embedded productivity has a bigger impact on the fraction of foreign firms in country 2 (its exponent is $1/\left(1-\alpha\right)\nu$ instead of $1/\nu$).

4.2. Using Observed $\{Y^i, L^i, K^i, s, \tau_F^i, \tau_D^i\}$ to Infer x^i and z^i

We now describe, as we did in the basic model, how the equilibrium conditions of the fully extended model allow us to infer the relative values of x^i and z^i.

Using expressions (4.1), (4.2), and (4.4), we obtain the ratio of effective country-embedded productivities:

$$\frac{\widetilde{z}^2 \theta^{1-\nu}}{\widetilde{z}^1} = \left(\frac{Y^2/L^2}{Y^1/L^1}\right)^{\nu(1-\alpha)} \left(\frac{Y^2/K^2}{Y^1/K^1}\right)^{\alpha\nu} \left(\frac{1-\tau_D^1}{1-\tau_F^2}\right)^{1-\nu} \tag{4.7}$$

and the ratio of effective firm-embedded productivities:

$$\frac{\widetilde{x}^2}{\theta \widetilde{x}^1} = \frac{(1-s)}{\left(\frac{Y^1/L^1}{Y^2/L^2}\right)\left(\frac{1-\tau_D^1}{1-\tau_F^2}\right) + s\left(\frac{L^2}{L^1}\right)}. \tag{4.8}$$

Each extension generates additional considerations for our inference of country- and firm-embedded productivities.

First, under geographic barriers ($\theta < 1$), the host country is not a level playing field for foreign firms. We can only infer the ratio of domestic to foreign firm-embedded productivities that effectively operates in country 2, $\widetilde{x}^2/\theta\widetilde{x}^1$. Similarly, we can only infer $\widetilde{z}^2\theta^{1-\nu}$ because changes in $\widetilde{z}^2$ and θ have symmetric effects on observable aggregate variables Y^2 and s. Therefore, the inferred levels of $\widetilde{z}^1/\widetilde{z}^2\theta^{1-\nu}$ and $\widetilde{x}^2/\theta\widetilde{x}^1$ are independent of θ, so the presence of geographic considerations do not change our calculations on the output and welfare gains from firm mobility. To save on notation, we assume from now on that $\theta = 1$.

Second, the presence of taxes modifies our inference of $\widetilde{z}^1/\widetilde{z}^2$ and $\widetilde{x}^2/\widetilde{x}^1$. The higher the tax rate τ_F^2, the higher must be the country-embedded productivity of the host country and the lower must be the firm-embedded productivity of its local firms for the equilibrium to imply the same fraction s of inputs controlled by foreign firms. Therefore, with measures of τ_F^2 and τ_D^1, we can proceed with our inference.

Third, the presence of capital does not modify the inference of $\widetilde{x}^2/\widetilde{x}^1$ since it affects symmetrically both domestic and foreign firms. Moreover, given that the capital stock affects productivity of all firms, we need to include measures of Y^i/K^i to infer $\widetilde{z}^1/\widetilde{z}^2$. Note that with $\widetilde{z}^1/\widetilde{z}^2$ and $\widetilde{x}^2/\widetilde{x}^1$, we can also compute the gains of firm mobility across steady states using expression (3.9).

Fourth, if we include top- and middle- level management but abstract from occupation reallocation after a shift in policy, then $\widetilde{z}^i$ and $\widetilde{x}^i$ are also fixed and we do not require assumptions on $F(\cdot)$ and γ to compute the equilibrium m and s. When individuals can reallocate among occupations, we need additional assumptions on γ and F, which parametrize how substitutable individuals are across occupations. Using the occupation choice conditions (3.15), (3.16), and (4.5), we can solve for the values of ξ_0^i, ξ_1^i, and $F(\bar{e}_0^i)$, and with those at hand we can pin down $z^i (x_a^i)^{\gamma\nu}$ and x^i.

5. Quantitative Analysis

We now proceed to the quantitative analysis, first extending the model to a multicountry setting, then describing the data and parameter values, and then reporting the country- and firm-embedded productivity obtained from the model.

5.1. The Multicountry Model

Consider now a world economy composed of I countries. Country $i = 1$ is the only source country of foreign firms, and countries $i = 2, 3, ...I$ are the host countries. In our quantitative exercises, country 1 is an aggregate of 16 net source countries which happen to be mostly developed countries, and countries $2, 3, ...I$ are net recipient, mostly developing countries.

We assume perfect capital markets within each country. Therefore, the consumption of all individuals in country i at time t is equal to aggregate consumption divided by the population, C_t^i/L_t^i. Preferences of the representative household are:

$$\sum_{t=0}^{\infty} \beta^t L_t^i \frac{(C_t^i/L_t^i)^{1-\sigma}}{1-\sigma} , \tag{5.1}$$

where $0 < \beta < 1$.

The representative agent in each country can borrow and lend at the world risk-free rate r^*, and we assume the standard no-Ponzi-game condition. The discount factor is equal to the inverse of the world interest rate. Countries start with a zero position of net foreign assets. This assumption only affects the allocation of consumption and not the determination of output and the inference of z^i and x^i. For simplicity, we abstract from the world equilibrium determination of the interest rate r^*.

The model boils down to a multicountry neoclassical growth model together with the endogenous determination of the share s_t^i of inputs controlled by country 1 firms in country i in period t. The representative household in each country i chooses consumption, capital accumulation, and the purchase of foreign assets, which are financed by aggregate returns to labor, physical capital, financial assets, and the profits of the firms. Tax rates in each country are rebated lump-sum to national households. All those details are standard, and we explain them in Appendix A.

5.2. Equilibrium

We consider equilibria in which country 1 is the single source country. The equilibrium determines the vector of fractions $\{m^1, m^2, ..., m^I\}$ of country 1 firms, where m^i denotes the fraction of country 1 firms operating in country i.

Solving for the equilibrium in a multicountry setting is conceptually identical as in the two-country case. The fraction m^1 determines the profits π_1^1 of firms remaining in country 1, and after-tax profits $(1-\tau_D^1)\,\pi_1^1$ are the benchmark for all potential host countries. For any two host countries j, $l \neq 1$ that host foreign firms, we have

$$\left(1-\tau_F^j\right)\pi_1^j = \left(1-\tau_F^l\right)\pi_1^l = \left(1-\tau_D^1\right)\pi_1^1 \ , \tag{5.2}$$

where π_1^i denotes profits of country 1 firms in country 1. All the general equilibrium interactions between host countries is via π_1^1. For example, a change in τ_F^j, impacts country l through changes in the returns of foreign managers in the source country.

Appendix B describes a simple algorithm to solve for m^i and s^i in each country.

5.3. Inferring z^i and x^i

As before, we can infer the unique values of $\widetilde{z}^i/\widetilde{z}^1$ and $\widetilde{x}^i/\widetilde{x}^1$ consistent with observed data on $\{Y^i, L^i, K^i, s^i, \tau_F^i, \tau_D^i\}$. In Appendix C we describe the steps, which are virtually the same as in the two-country model, that lead to the following expressions for $\widetilde{z}^i/\widetilde{z}^1$ and $\tilde{x}^i/\tilde{x}^1$:

$$\widetilde{z}^i/\widetilde{z}^1 = \left(\frac{Y^i/L^i}{Y^1/L^1}\right)^{(1-\alpha)\nu}\left(\frac{Y^i/K^i}{Y^1/K^1}\right)^{\alpha\nu}\left(\frac{1-\tau_D^1}{1-\tau_F^i}\right)^{1-\nu} \text{, and} \tag{5.3}$$

$$\tilde{x}^i/\tilde{x}^1 = m^1\left(1-s^i\right)\frac{Y^i/L^i}{Y^1/L^1}\left(\frac{1-\tau_F^i}{1-\tau_D^1}\right). \tag{5.4}$$

As in the previous section, the optimality conditions for occupation choice pin down the values of ξ_0^i, ξ_1^i, and $F\left(\bar{e}_0^i\right)$, and with those the values of $z^i\left(x_a^i\right)^{\gamma\nu}$ and x^i.

We now derive a simple condition, in terms of observable data, under which country i is an attractive location for country 1 firms. A host country is attractive if a social planner that maximizes world output reallocates some country 1 foreign firms to country i when all other host countries remain in autarky.

Taking K^i and K^1 as given, a social planner would move a firm from country 1 to country i iff

$$R^i_{\text{static}} \equiv \left(\frac{\tilde{z}^1}{\tilde{z}^i}\right)^{\frac{1}{\nu}} \left(\frac{\tilde{x}^i}{\tilde{x}^1}\right) \left(\frac{K^1/L^1}{K^i/L^i}\right)^{\alpha} < 1. \tag{5.5}$$

This is the condition under which the marginal product of a firm is higher in country i than in country 1.

In Appendix C we show that, using expressions (5.3) and (5.4), a sufficient condition for $R^i_{\text{static}} < 1$ in terms of observable data is

$$\left(1 - s^i\right) \left(\frac{1-\tau^i_F}{1-\tau^1_D}\right)^{1/\nu} < 1. \tag{5.6}$$

Thus, if we observe a high s^i despite observing also a high τ^i_F, it must that the host country is attractive to foreign firms. Note that we can have $R^i_{\text{static}} > 1$ (so that the host country is not attractive) even if we observe $s^i > 0$, when τ^i_F is low relative to τ^1_D (i.e., when the host country is providing tax incentives to foreign firms).

Consider now facing the social planner with the same decision but allowing him to also adjust capital without country-specific barriers. The social planner would reallocate firms from country 1 to country i iff

$$R^i_{\text{SS}} = \left(\frac{\tilde{z}^1}{\tilde{z}^i}\right)^{\frac{1}{\nu(1-\alpha)}} \left(\frac{\tilde{x}^i}{\tilde{x}^1}\right) < 1. \tag{5.7}$$

In Appendix C we show that, using expressions (5.3) and (5.4), a sufficient condition for $R^i_{\text{SS}} < 1$ in terms of observable data is

$$\left(1 - s^i\right) \left(\frac{1-\tau^i_F}{1-\tau^1_D}\right)^{\frac{1-\alpha\nu}{\nu(1-\alpha)}} \left(\frac{K^i/Y^i}{K^1/Y^1}\right)^{\frac{\alpha}{1-\alpha}} < 1. \tag{5.8}$$

If despite the scarcity of capital in country i (low K^i/Y^i), we observe that it attracts foreign firms, then with undistorted accumulation of capital (that would lead to a higher K^i/Y^i) the country would become even more attractive.

In the data, a country might have a low capital-output ratio K^i/Y^i because it is far from the steady-state level of capital, or due to distortions (e.g., taxes) and other considerations (e.g., differences in relative prices) that affect the steady-state accumulation of capital. The cross-country variation in K^i/Y^i, which we use to infer R^i_{SS}, is outside the scope of our model, and we take it as exogenously given.

5.4. Data

We first discuss how we measure the share of inputs controlled by foreign firms in each country. In our model, top managers determine the productivity of factors of production under their control. Since firm-embedded productivity is a Hicks neutral term, the fraction of physical capital and the fraction of efficiency units of labor controlled by foreign firms are equal within each host country. Our benchmark measure is based on the share of capital controlled by foreign firms. As a robustness check, we also construct an alternative measure based on employment.

We use the stock of foreign direct investment (FDI) to proxy for the capital of those firms in which foreign managerial know-how has a direct influence on their activities. The notion of FDI in the data is closely connected to the cross-country reallocation of managerial know-how and control in our model since it represents investments undertaken with the objective of establishing a lasting interest in the country, a long-term relationship, and significant influence on the management of the firm. However, the stock of FDI is only an imperfect proxy for foreign controlled capital since some of the FDI may not carry any effective control by investors, and also some capital controlled by foreigners may not be registered as FDI. Moreover, FDI partly includes the purchase of assets such as intangibles or natural resources that are not usually counted as physical capital.

We use the stocks of FDI constructed by Lane and Milesi-Ferretti (2006) on the basis of cumulative FDI flows and reinvested profits. A country is a net recipient of FDI when the ratio of direct investment assets (outward FDI) to direct investment liabilities (inward FDI) is less than one. Figure 1 displays, for a large set of countries, the geometric average for the period 1997-2000 of the ratio of assets to liabilities. The figure shows that there is a sharp divide between developed countries (typically net sources of FDI) and developing countries (typically net hosts of FDI). While a handful of developed countries have very high ratios, most developing countries have ratios that are close to zero. Notice, however, that some developed countries, such as the United States, have both large assets and large liabilities.

We construct a single source country, indexed by $i = 1$, consolidating the data of the major 16 net source countries into our country 1. We consider 38 net hosts that are mainly developing countries or countries that have recently developed, such as Ireland and Spain. We abstract from flows from developing to developed countries or to other developing countries, since for the most part, they are minor sources of total FDI. The set of countries included in our analysis is listed in Appendix D.

For each host country, we construct the share of foreign-controlled capital as

$$s^i = \frac{\text{stock of inward FDI in country } i}{\text{total capital stock in country } i}.$$

Total capital stocks are constructed using the standard permanent inventory scheme on the investment reported in the Penn World Tables, Version 6.1 (PWT), assuming an annual depreciation rate of 6%.

Table 1 displays the shares s^i, as well as other aggregate variables including GDP, capital-output ratios, and the labor force (all three from PWT) for each host country relative to the net source aggregate. All the data corresponds to averages between 1997 and 2000. Columns 1–3 show that most net host countries are relatively poorer, smaller, and have lower capital-output ratios than the net source aggregate. Indeed, relative to source countries: (i) only Ireland has a higher per capita output; (ii) only China and India are close or larger in size; and (iii) only Thailand, Spain, and Greece have higher capital-output ratios. As can be seen in column 4, a significant share of the capital stock in these net host countries is controlled by foreign firms. The average share is 16%, and is as high as 49% in Ireland and as low as 2% in Iceland.

Our alternative measure of s^i is the ratio of total wages paid by multinationals to total wage payments in the host country. This measure indicates the share of efficiency units of labor controlled by multinationals. An important limitation in constructing this measure is that, for most host countries, we only have data on wage payments by U.S. multinational firms. To proxy for total wage payments by multinationals we assume that, consistent with the model, the ratio of US to total multinational wage payments is equal to the ratio of US to total inward stocks of FDI in each host country. Note that the possible biases of FDI as a measure of effective control will be mitigated if they do not systematically differ for inflows from the U.S. relative to the other source countries. Our alternative measure of s^i is then given by

$$s^i = \frac{\text{Wages paid by U.S. MNC in country } i}{\text{Total wages in country } i} \times \frac{\text{stock of inward FDI in country } i}{\text{stock of U.S. FDI in country } i}.$$

To construct this measure, we obtain the data on total wages and salaries payments by U.S. multinational firms and on the stock of outward US FDI in each host country from the Bureau of Economic Analysis (BEA). The total stock of inward FDI is from Lane and

Milesi-Ferretti (2006), and the total labor income in the host country from the World Bank Development Indicators.[14] Appendix D lists the reduced set of countries for which this alternative measure of s^i is available.

To measure the tax faced by domestic firms in the source countries, we set $\tau_D^1 = 0.3$, which is consistent with the average corporate tax rate in our set of developed countries reported in Ernst and Young's Worldwide Corporate Tax Guide for the year 2002. To measure the taxes on foreign profits we follow Desai, Foley, and Hines (2004), and calculate the effective income tax rates paid by foreign affiliates of U.S. Multinationals in each host country. We use the surveys of U.S. Direct Investment between 1982 and 2001 from the BEA, and define τ_F^i as

$$\tau_F^i = \frac{\text{foreign income taxes}}{\text{net foreign income} + \text{foreign income taxes}}.$$

Desai, Foley, and Hines (2004) and Gordon and Hines (2002) argue that this is an imperfect yet informative measure of the barriers on international firms. We take those taxes as also proxying for other policy barriers to foreign firms.[15] Column 5 in Table 1 shows that the average tax for the period 1997-2000 is 32%, only slightly higher than τ_D^1. However, there is significant variation across host countries, with $\tau_F = 56\%$ in India and 52% in Turkey, and $\tau_F = 9\%$ in Ireland.

We also conduct our inference and policy counterfactuals using two alternative measures of taxes. Under the first alternative we assume that, due to worldwide taxation clauses, country 1 firms face a minimum tax rate τ_D^1 on repatriated profits. In this case, the effective tax rate $\tau_F^{M,i}$ is

$$\tau_F^{M,i} \equiv \max\left\{\tau_D^1, \tau_F^i\right\}.$$

Under the second alternative we assume that foreign firms may be able to deliver foreign profits without paying taxes to the government in the source country. In this case, the effective tax rate $\tau_F^{m,i}$ on foreign profits is

$$\tau_F^{m,i} \equiv \min\left\{\tau_D^1, \tau_F^i\right\}.$$

[14] Consistent with our model and evidence in Gollin (2002), we assume a constant labor share of income across host countries.

[15] For example, starting in 1989, Mexico eliminated some restrictions on foreign ownership of firms. For a detailed discussion of this policy change, see Perez-Gonzales (2005).

5.5. Parameter Values

The key parameters of the model are those of the production function (ν, α, γ), and the distribution of skills $F(\cdot)$. They determine the gains of reallocating top managers across countries, individuals across occupations, and the gains from accumulating capital. These are the key margins in shaping the output and welfare consequences of changes in the barriers to foreign firms. To quantify the importance of each margin, we sequentially add one at a time.

The parameter ν is central in shaping the response in the inflow of foreign firms to a change in barriers. We do not use information about the change in the share s over time to infer ν because we lack independent information on changes in $\left(\theta^i, \tau_F^i, \tau_D^1\right)$. Neither do we use information on the relative size of domestic versus foreign firms in host countries, as the model determines only the aggregate ξ_1^i. We choose the value of ν based on existing estimates on the degree of decreasing returns to scale in span-of-control models applied to U.S. data. We set $\nu = 0.85$, and report the sensitivity of our results to assuming $\nu = 0.8$ and $\nu = 0.9$, which is roughly the range for ν in this literature.[16]

The parameter α is important in shaping the response of capital to the inflow of foreign firms. In our benchmark calibration, we set $\alpha = 0.35$ so that the output share of capital is roughly equal to the standard value of 0.3. We also report results assuming a lower value of α.

The shape of $F(\cdot)$ and the value of γ determine the quantitative importance of occupation reallocation in response to the inflow of foreign firms. We assume that F is a Pareto distribution with mean one and slope parameter $b = 1.25$. Under this parametrization, and assuming that high idiosyncratic ability individuals sort into top managerial positions,[17] the right-tail firm size distribution of the model is in line with the U.S. firm size distribution for middle- and large- sized firms.[18]

We set γ so that, in the equilibrium with the observed shares of foreign firms in host

[16] Atkeson, Kahn, and Ohanian (1996), Atkeson and Kehoe (2006), and Amaral and Quintin (2005) use $\nu = 0.85$. On the high side, Cagetti and De Nardi (2006) use $v = 0.9$. On the low side, Guner, Ventura, and Xu (2006) use $\nu \simeq 0.8$.

[17] This is the unique optimal sorting of the population in the presence of an infinitesimal fixed cost of setting up a production team.

[18] Luttmer (2006) discusses in detail how the right tail of the U.S. firm size distribution resembles a Pareto distribution. We choose the slope parameter b to target the employment-based right tail coefficient of size $2500 - 10000$, equal to -0.25 on average between 1999 and 2003. This slope coefficient is defined as $[\log(N10000) - \log(N2500)]/[\log(10000) - \log(2500)]$. Here, Nx corresponds to the total employment of firms of size larger than x.

countries, 10% of the labor force in the source country is in managerial positions (this is broadly motivated from U.S. data), which implies $\gamma = 0.1$.[19] These parameter values also imply that $\gamma / (1 - v + \gamma)$, the share of middle managers in total managerial compensation, is roughly 40%. We also report our results assuming a lower value of γ.

Other parameters are set as follows. Taking each time period as a year, we set the interest rate at 5% and the depreciation rate δ at 6%. The curvature parameter σ of the utility function does not have any impact on our calculations given that r^* is assumed to be constant.

5.6. Inferred Country- and Firm-Embedded Productivities

Table 2 reports the inferred values of $\tilde{z}^i/\tilde{z}^1$, $\tilde{x}^i/\tilde{x}^1$, z^i/z^1, x^i/x^1, R^i_{static}, and R^i_{SS} using our procedure described above and aggregate data for the period 1997-2000.

Columns 1–2 show that the inferred values of $\tilde{z}^i/\tilde{z}^1$ and $\tilde{x}^i/\tilde{x}^1$ are uniformly lower than one (except for $\tilde{z}^{Ireland}/\tilde{z}^1 = 1.2$). This suggests that both country- and firm-embedded productivities contribute to lower incomes in net host countries relative to net source countries. Notice also that for most countries, the values of z^i/z^1 and x^i/x^1 observed in columns 3–4 are higher than $\tilde{z}^i/\tilde{z}^1$ and $\tilde{x}^i/\tilde{x}^1$ in columns 1–2. This suggests that host countries use managerial skills more intensively in mid-management or worker positions, both of which complement the skills imported from abroad.

In order to quantify the relative variation in country- and firm-embedded productivity, it is useful to express output per person of a host country relative to source countries as

$$\left(\frac{Y^i/L^i}{Y^1/L^1}\right) = \left(\frac{\widetilde{z}^i}{\widetilde{z}^1}\right)^{\frac{1}{1-\alpha\nu}} \left(\frac{\widetilde{x}^i}{\widetilde{x}^1}\right)^{\frac{1-\nu}{1-\alpha\nu}} \left(\frac{1}{(1-s^i)\, m^1}\right)^{\frac{1-\nu}{1-\alpha\nu}} \left(\frac{K^i/Y^i}{K^1/Y^1}\right)^{\frac{\alpha\nu}{1-\alpha\nu}} \tag{5.9}$$

Variation in output per capita can be accounted for by differences in four factors: (i) effective country-embedded productivity $\widetilde{z}$; (ii) effective firm-embedded productivity of domestic firms $\widetilde{x}$; (iii) effective firm-embedded productivity of foreign firms as proxied by the share of

[19] The number of managerial occupations as a fraction of all non-self-employed workers in 2005 in the U.S. is 5%, as reported by the Bureau of Labor Statistics. Cagetti and De Nardi (2006), and Chari, Golosov, and Tsyvinski (2004) report a fraction of self-employed workers of roughly 11%. From these figures, the fraction of managers would be close to 15%. However, many of the self-employed are not likely to correspond to our concept of managers. To be conservative, we assume that 50% of self-employed individuals are actual managers of their own businesses. This results in a share of managers in the labor force of 10%. The lower this fraction, the lower the implied value for γ, which reduces the gains from reallocating managers across top and middle positions in the presence of international firm mobility.

factors controlled by foreign firms s^i (a higher s^i and a lower m^1 contribute to a higher $(Y^i/L^i)\,/\,(Y^1/L^1)$); and (iv) capital-output ratio K/Y.

Table 3 reports the relative importance of each of the four factors in (5.9) in accounting for differences in output per capita between host and source countries (upper panel), and variation within host countries (lower panel), under our benchmark parametrization of the model. The gap in per capita output in the period 1997-2000 for source relative to host countries can be decomposed as follows: 61% of the gap is accounted for by higher country-embedded productivities, 27% from higher firm-embedded productivities of domestic firms and 17% from higher capital-output ratios. Moreover, by importing foreign firms from source countries, the host countries close the gap by 5%. The lower panel in Table 3 reports the variance decomposition (a la Klenow and Rodriguez-Clare 1997) of the logarithm of output per capita across the group of host countries. We find that the share of each term in (5.9) in accounting for the variance of output per capita in the period $1997-2000$ is roughly 67%, 23%, 0.3% and 10%, respectively. These results remain roughly unchanged under our two alternative measures of s^i, for the reduced sample of host countries for which both measures are available. We also report the results under alternative values of ν (0.8 and 0.9). The relative importance of firm-embedded productivity (both domestic and foreign) in accounting for output per capita difference grows as we lower ν.

Before performing our counterfactuals, we can observe in columns 5–6, Table 2, the inferred ratios R^i_{static} and R^i_{SS} that summarize the attractiveness of host countries to foreign firms. The ratios R^i_{static} are lower than one in most countries (30 out of 38), making these host countries attractive in the absence of other distortions. Moreover, $R^i_{\text{static}} > R^i_{\text{SS}}$ for most host countries, which results from low observed capital-output ratios. If differences in capital-output ratios stem from variation in distortions to capital accumulation, our analysis serves to quantify the role of these distortions in making host countries more or less attractive to foreign firms.

We can use expressions (5.5) and (5.7) to quantify the contribution of each variable that shapes the cross-country variation in R^i_{static} and R^i_{SS}. Figure 2, panel A, plots R^i_{static} separately against the two factors in the right-hand side of (5.5). Note that variation in taxes accounts for much of the variations in R^i_{static}, but variation in s is also significant. Figure 2, panel B, plots R^i_{SS} against the three terms in the right-hand side of expression (5.7). The figure shows that while variation in all factors is significant, differences in capital-output ratios are the leading factor in accounting for variation in R^i_{SS}.

6. Quantifying the Gains from International Firm Mobility

In this section, we quantitatively assess the output and welfare consequences for the host countries of eliminating barriers to foreign control of local factors of production.

We focus on the following counterfactual experiment. We assume that initially all countries are in autarky, and then consider the consequences of opening-up, such that foreign firms are equally taxed at home and abroad. That is, τ^i_F changes from 100% to $\tau^1_D = 30\%$. We consider two alternative experiments. In the first, each country opens-up unilaterally and the rest remains in autarky. In the second experiment, all host countries open-up simultaneously. With these two experiments we quantify the gains for each country in isolation and in a global liberalization.

In all cases we use the values of x^i and z^i inferred from the equilibrium of the parametrized model, as described above, using the 1997-2000 data on output, labor, capital stocks, shares of capital controlled by foreign firms, and measure of effective taxes τ^i_F.

To isolate the role of various margins of response, we consider three alternative cases: (i) fixed capital stocks at their measured 1997-2000 levels (obs. K) and fixed occupation choice (fixed OC); (ii) capital stocks at their steady-state levels (SS K) and fixed OC; and (iii) SS K and reallocation of occupations (flex. OC). In cases (ii) and (iii), our reported gains in consumption take into account the investment required to increase the capital stock, and the transition dynamics.

6.1. Unilateral Openness to Foreign Firms

Columns 1–2 in Table 4 report the results for case (i). The average gains across countries are 5% for output and 1% for consumption. There is large variation in the gains, with some countries gaining as much as 5% in consumption (Tunisia) and other countries not gaining at all (e.g., Brazil, Venezuela, and Iceland). Figure 3, panel A, displays a strong negative relationship between output and consumption gains and the inferred ratios R^i_{static}, which summarize the relevant information on shares and taxes to assess the attractiveness of a given country as a host of foreign firms.

Capital accumulation greatly enhances the gains in both output and consumption. This is because the inflow of foreign firms raises the return to capital accumulation. Columns

3–4 display the gains under case (ii), where capital adjusts to the steady-state level. The average gains are 14% and 6% for output and consumption, respectively. Figure 3, panel B, illustrates the negative relationship between the gains to each country and R^i_{SS}. Countries with a lower R^i_{SS} stand to gain much more by allowing foreign firms to operate within their territory.

Reallocating individuals across occupations also magnifies the gains of firm mobility. Shifting skills from top positions in domestic firms to middle management in foreign firms complements the returns to importing foreign managerial know-how. Columns 5–6 display the gains under case (iii). The average gains rise to 23% for output and 9% for consumption.

To help put these welfare gains in perspective, we compare them with those from alternative policy experiments that have received much attention in the literature on the gains from globalization. One the one hand, we obtain larger gains than those from reallocating physical capital over time. Gourinchas and Jeanne (2006) report an average consumption gain of 1% for non-OECD countries switching from financial autarky to perfect financial integration. On the other hand, we obtain smaller gains than those in models where productivity is non-rival, such as Alvarez and Lucas (2004) and Eaton and Kortum (2002) (reductions in trade barriers) and Ramondo (2006) (reductions in barriers to multinational activity). In those models, in contrast to ours, productivity inflows in host countries do not involve productivity outflows in source countries.

6.2. Global Openness to Foreign Firms

We now compute the gains when all host countries start in autarky and simultaneously move to international mobility of firms, where now firms are taxed at equal rates across countries.

Table 5 reports the results under the same three cases as for the unilateral policy changes. As expected, the gains are smaller than under unilateral policy changes because host countries, by competing with each other to attract the limited supply of country 1 firms, increase the value of π_1. The average output and consumption gains for the host countries are, respectively, 4% and 0.7% under case (i), 9% and 3% under case (ii), and 16% and 6% under case (iii). Notice that, in spite of the competition among host countries, the average gains from firm mobility are still quite significant.

6.3. Sensitivity Analysis

In this subsection, based on the uncertainty regarding the value of some parameters and measures of foreign control, we perform a sensitivity analysis. We report the gains from the policy counterfactuals under our two alternative measures of input shares controlled by foreign firms, as well as under our two alternative tax measures discussed in Section 5.4. We also explore the sensitivity of the results to variations in parameters ν, α and γ. In all these cases, we infer z^i and x^i using our inference procedure under each alternative parametrization, and calculate the average output and consumption gains for each host country of unilateral openness under case (iii) (i.e., allowing adjustment of capital and reallocations of individuals across occupations). The results are reported in Table 6.

The gains are higher when we use $\tau_F^{M,i} = \max\{\tau_D^1, \tau_F^i\}$ – columns 3–4, as our measure of taxes on foreign firms in the identification scheme. Now the barriers on foreign firms are larger than under our benchmark parametrization, so our identification scheme infers that host countries are more attractive (i.e., lower levels of R_{SS}^i). The average output gain increases from 23% to 26%, and the average consumption gain increases from 9% to 10%. On the contrary, if we use $\tau_F^{M,i} = \max\{\tau_D^1, \tau_F^i\}$ – columns 5–6, output and consumption gains are reduced to 17% and 6%, respectively.

As discussed above, there is some uncertainty regarding the output share of firm-embedded productivity, $1-\nu$. We report the sensitivity of our quantitative findings to assuming $\nu = 0.8$ and $\nu = 0.9$, which is roughly the range for ν in the literature that calibrates similar span-of-control models using US data. Assuming $\nu = 0.8$ – columns 7–8, the gains rise to an average of 30% in output and 12% in consumption. Assuming $\nu = 0.9$ – columns 9–10, the gains fall to 16% and 7%, respectively.

We now consider a lower value of the output share of capital and mid-level managers. If we assume a value of α such that the capital share in output is 20% (as in Atkeson and Kehoe 2005) – columns 11–12, the output and consumption gains fall to 15% and 5%, respectively. A lower share of capital in output reduces the gains of firm mobility by reducing the ability of the host economy to complement the inflow of foreign firms with capital accumulation.

Assuming $\gamma = 0.05$ – columns 13–14, the output and consumption gains fall to 19% and 8%, respectively. A lower γ reduces the ability of the host economy to reallocate the skills from top managers of local firms to mid-level managerial positions in foreign firms and labor, both of which are complementary to foreign firm-embedded productivity.

Finally, we compare the gains under our two alternative measures of s^i, for the reduced set of countries for which both measures are available – columns 15–18. Under the FDI stocks-based shares, the average gains are 18% for output and 7% for consumption. Under the employment-based shares, the gains are 17% for output and 6% for consumption.

Overall, the alternative parameterizations and measures of foreign controlled inputs and taxes still imply large gains in output and consumption that are on the same range as those under our baseline parameterization.

7. Concluding Remarks

In this paper we construct a multicountry model of cross-country income difference to study the international flows of managerial know-how and control from developed to developing countries. Using the model and aggregate data, we decompose cross-country productivity differences into components that can be moved across countries and components that cannot be moved across countries. Based on this decomposition, we conduct policy counterfactuals that suggest significant output and welfare gains of eliminating barriers to foreign control of local factors of production.

Using our framework, we back-out the relative endowments of firm-embedded productivity that can account for observed measures of foreign control of inputs in developing countries. Our paper is silent about the accumulation of this component of productivity. An important area for further research is to characterize the gains of reallocating firm-embedded productivity across countries in models in which it can be accumulated.

Our aggregate quantitative framework does not encompass many interesting issues related with multinational activity, such as differences in the organization of production, financial structure, and export behavior across countries, sectors, and firms. In future research, we plan to extend our framework to address some of these features and, in combination with more detailed information at the level of sectors and firms, provide a better understanding of the measured differences in country- and firm embedded productivities, and the impact of institutional frictions on the aggregate productivity of host countries.

Appendices

A. Characterizing Equilibria in the Multi-Country Model

Preferences are defined by (5.1), resource constraints are

$$A^i_{t+1} + C^i_t + I^i_t = \left[1 - \left(1 - \tau^i_{F,t}\right)(1-\nu)\, s^i_t\right] Y^i_t + (1+r^*)\, A^i_t \ ,\ i = 2, ..., I \tag{A.1}$$

$$A^1_{t+1} + C^1_t + I^1_t = Y^1_t + (1+r^*)\, A^1_t \ + (1-\nu) \sum_{i=2}^{I} \left(1 - \tau^i_{Ft}\right) s^i_t Y^i_t \ , \tag{A.2}$$

the law of motion of capital is given by (3.5), and the law of motion of x^i_t is given by (**??**). The initial capital stocks K^i_0 and foreign assets A^i_0 are given.

Assuming $\beta(1+r^*) = 1$ and perfect foresight, the level of foreign assets can be solved for using the optimality condition $\left(C^i_t\right)^{-\sigma} = \left(C^i_{t+1}\right)^{-\sigma}$. The optimal capital choice satisfies $1 = \beta\left[1 - \delta + \alpha\nu Y^i_t / K^i_t\right]$.

The occupation choice thresholds in country 1, $\bar{e}^1_0$, ξ^1_0, and ξ^1_1, are determined from

$$\bar{e}^1_0 = \frac{(1-\gamma)}{\gamma} \frac{\xi^1_0}{F\left(\bar{e}^1_0\right)}, \tag{A.3}$$

$$\xi^1_0 = \frac{\nu\gamma}{1-\nu} m^1 \xi^1_1, \tag{A.4}$$

and those in country $i > 1$ are determined from

$$\bar{e}^i_0 = \frac{(1-\gamma)}{\gamma} \frac{\xi^i_0}{F\left(\bar{e}^i_0\right)}, \tag{A.5}$$

$$\xi^i_0 = \frac{\nu\gamma}{1-\nu} \frac{\xi^i_1}{1 - s^i}, \tag{A.6}$$

plus the additional adding-up constraint $\xi^i_0 + \xi^i_1 + \int_0^{\bar{e}^i_0} e dF(e) = 1$.

Aggregate output levels in each country are

$$Y^1_t = z^1 \left(x^1 \xi^1_{1t}\right)^{1-\nu} \left[\left(x^1_a \xi^1_{0t}\right)^{\gamma} F\left(\bar{e}^1_{0t}\right)^{(1-\gamma-\alpha)}\right]^{\nu} \left(m^1_t\right)^{1-\nu} \left(K^1_t / L^1\right)^{\alpha\nu} L^1 \tag{A.7}$$

$$Y^i_t = z^i_t \left(x^i \xi^i_{1t}\right)^{1-\nu} \left[\left(x^i_a \xi^i_{0t}\right)^{\gamma} F\left(\bar{e}^i_{0t}\right)^{(1-\gamma-\alpha)}\right]^{\nu} \left[\frac{1}{1 - s^i_t}\right]^{1-\nu} \left(K^i_t / L^i\right)^{\alpha\nu} L^i \ ,\ i = 2, ..., I. \tag{A.8}$$

Profits in country 1 of a domestic manager with idiosyncratic skill $e = 1$ are

$$\pi^1_{1t} = (1-\nu)\, z^1 \left(x^1 \xi^1_{1t}\right)^{-\nu} \left[\left(x^1_a \xi^1_{0t}\right)^{\gamma} F\left(\bar{e}^1_{0t}\right)^{(1-\gamma-\alpha)}\right]^{\nu} \left(m^1_t\right)^{-\nu} \left(K^1_t / L^1\right)^{\alpha\nu}. \tag{A.9}$$

The share of factors controlled by country 1 managers in country i is

$$s_t^i = \max\left\{1 - \frac{\xi_{1t}^i x^i}{\theta x^1}\frac{\left(1-\tau_D^1\right)}{\left(1-\tau_F^i\right)}\frac{\left(1-\tau_D^1\right)\pi_{1t}^1}{\left(1-\nu\right)Y_t^i/L^i}, 0\right\}. \tag{A.10}$$

The fraction of country 1 managers in country i can be backed out using

$$m_t^i = \frac{s_t^i}{1-s_t^i}\frac{x_t^i \xi_{1,t}^i L_t^i}{\theta x_t^1 \xi_{1,t}^1 L_t^1}, \tag{A.11}$$

and the fraction of country 1 managers remaining in country 1 is $m_t^1 = 1 - \sum_{i=2}^I m_t^i$.

B. Separating z^1/z^i from x^i/x^1 in the Multicountry Model

Suppose we make assumptions on α, γ, ν, $F(.)$ and we observe data on $\{Y^i, L^i, K^i, s^i, \tau_D^i, \tau_F^i\}$ at a point in time. We now describe the algorithm to uncouple z^1/z^i from x^i/x^1. We normalize $x^1 = 1$, and we always assume interior solutions.

1. Guess m^1.

2. Solve thresholds in country 1:

$$\bar{e}_0^1 = \frac{(1-\gamma)}{\gamma}\frac{\xi_0^1}{F\left(\bar{e}_0^1\right)}, \text{ and } \xi_0^1 = \frac{\nu\gamma}{1-\nu} m^1 \xi_1^1. \tag{B.1}$$

3. Solve for z^1 using

$$Y^1 = z^1\left(x^1\xi_1^1\right)^{1-\nu}\left[\left(x^1\xi^1\right)^\gamma F\left(\bar{e}_0^1\right)^{(1-\gamma-\alpha)}\right]^\nu \left(m^1\right)^{1-\nu}\left(K^1/L^1\right)^{\alpha\nu} L^1. \tag{B.2}$$

4. Solve for thresholds and aggregate managerial skills in country i:

$$\bar{e}_0^i = \frac{(1-\gamma)}{\gamma}\frac{\xi_0^i}{F\left(\bar{e}_0^i\right)}, \; \xi_0^i = \frac{\nu\gamma}{1-\nu}\frac{\xi_1^i}{1-s^i}, \tag{B.3}$$

   and $\xi_0^i + \xi_1^i + \int_0^{\bar{e}_0^i} e dF(e) = 1$.

5. Solve for x^i/x^1, $i > 1$:

$$\tilde{x}^i/\tilde{x}^1\theta = m^1\left(1-s^i\right)\frac{Y^i/L^i}{Y^1/L^1}\left(\frac{1-\tau_F^i}{1-\tau_D^1}\right) \tag{B.4}$$

   and $\widetilde{x}^i = x^i \xi_1^i$.

6. Solve z^i, $i > 1$, from

$$\left(\tilde{z}^1/\tilde{z}^i\theta^{1-\nu}\right)^{1/\nu} = \left[\frac{Y^1/L^1}{Y^i/L^i}\right]^{1-\alpha}\left[\frac{Y^1/K^1}{Y^i/K^i}\right]^{\alpha}\left[\frac{1-\tau_F^i}{1-\tau_D^1}\right]^{\frac{1-\nu}{\nu}} \tag{B.5}$$

and $\tilde{z}^i = z^i\left[\left(x^i\xi_0^i\right)^{\gamma} F\left(\bar{e}_0^i\right)^{(1-\gamma-\alpha)}\right]^{\nu}$.

7. Solve m^i for $i > 1$:

$$m^i = \frac{s^i}{1-s^i}\frac{\tilde{x}^i L^i}{\theta\tilde{x}^1 L^1} \tag{B.6}$$

8. Adjust m^1 until $\sum_{i=1}^{I} m^i = 1$.

C. Inferring R^i_{static} and R^i_{SS}

The condition that equalizes the net-of-tax marginal product of country 1 firms in countries 1 and i, using (A.7) and (A.8), is

$$\left(\frac{1-\tau_D^1}{1-\tau_F^i}\right)\tilde{z}^1/\tilde{z}^i\theta^{1-\nu}\left(\tilde{x}^i/\tilde{x}^1\theta+\frac{L^1}{L^i}m^i\right)^{\nu}\left(\frac{K^1/L^1}{K^i/L^i}\right)^{\alpha\nu} = \left(m^1\right)^{\nu}. \tag{C.1}$$

For simplicity but without loss of generality, we will assume that occupation margins are fixed. Suppose that country i is in autarky in the sense that there are no foreign firms operating therein ($m^i = 0$, and $m^1 = m_A^1$). Suppose that $\tau_D^1 = \tau_F^i$, and the capital stocks are fixed. Then, using (C.1), foreign firms will want to move to country i (that is, $m^i > 0$) if and only if

$$R^i_{\text{static}} = \frac{1}{m_A^1}\left(\tilde{z}^1/\tilde{z}^i\theta^{1-\nu}\right)^{1/\nu}\left(\tilde{x}^i/\tilde{x}^i\theta\right)\left(\frac{K^i/L^i}{K^1/L^1}\right)^{-\alpha} < 1. \tag{C.2}$$

Recall that we inferred $\tilde{z}^1/\tilde{z}^i$ and $\tilde{x}^i/\tilde{x}^1$ in the data using expressions (B.4) and (B.5), which imply

$$\frac{1}{m_M^1}\left(\tilde{z}^1/\tilde{z}^i\theta^{1-\nu}\right)^{1/\nu}\left(\tilde{x}^i/\tilde{x}^1\theta\right)\left(\frac{K^i/L^i}{K^1/L^1}\right)^{-\alpha} = \left(1-s^i\right)\left(\frac{1-\tau_F^i}{1-\tau_D^1}\right)^{1/\nu}, \tag{C.3}$$

where m_M^1 corresponds to the level of m^1 in the algorithm described in Appendix B. Note that $m_A^1 > m_M^1$, if the remaining countries maintain the same policies and capital stocks that we use to infer $\tilde{z}^1/\tilde{z}^i$ and $\tilde{x}^i/\tilde{x}^1$. Then, we have

$$R^i_{\text{static}} < \left(1-s^i\right)\left(\frac{1-\tau_F^i}{1-\tau_D^1}\right)^{1/\nu}. \tag{C.4}$$

In the body of the paper, we can use this condition to quantify the sources of variation in R^i_{static}.

Now suppose that, in the model, the capital stock adjusts every period so that the marginal product of capital is equal in every country, $Y^i/K^i = Y^1/K^1$. Then, condition (C.1) is

$$\left(\frac{1-\tau_D^1}{1-\tau_F^i}\right)\left(\tilde{z}^1/\tilde{z}^i\theta^{1-\nu}\right)^{\frac{1}{1-\alpha\nu}}\left(\tilde{x}^i/\tilde{x}^1\theta+\frac{L^1}{L^i}m^i\right)^{\frac{\nu(1-\alpha)}{1-\alpha\nu}}=\left[m^1\right]^{\frac{\nu(1-\alpha)}{1-\alpha\nu}}. \tag{C.5}$$

Suppose that country i is in autarky in the sense that no foreign firms are operating therein ($m^i = 0$, and $m^1 = m_A^1$). Suppose that $\tau_D^1 = \tau_F^i$, and the capital stocks adjust every period to equalize world-wide marginal products of capital. Then, using (C.5), foreign firms will want to move to country i (that is, $m^i > 0$) if and only if

$$R_{\text{SS}}^i=\frac{1}{m_A^1}\left(\tilde{z}^1/\tilde{z}^i\theta^{1-\nu}\right)^{\frac{1}{\nu(1-\alpha)}}\left(\tilde{x}^i/\tilde{x}^1\theta\right)<1. \tag{C.6}$$

Expressions (B.4) and (B.5) for $\tilde{z}^1/\tilde{z}^i$ and $\tilde{x}^i/\tilde{x}^1$ imply

$$\frac{1}{m_M^1}\left(\tilde{z}^1/\tilde{z}^i\theta^{1-\nu}\right)^{\frac{1}{\nu(1-\alpha)}}\left(\tilde{x}^i/\tilde{x}^1\theta\right)=\left(1-s^i\right)\left(\frac{Y^1/K^1}{Y^i/K^i}\right)^{\frac{\alpha}{1-\alpha}}\left(\frac{1-\tau_F^i}{1-\tau_D^1}\right)^{\frac{1-\alpha\nu}{\nu(1-\alpha)}}. \tag{C.7}$$

Using the same argument as before, we have

$$R_{\text{SS}}^i<\left(1-s^i\right)\left(\frac{Y^1/K^1}{Y^i/K^i}\right)^{\frac{\alpha}{1-\alpha}}\left(\frac{1-\tau_F^i}{1-\tau_D^1}\right)^{\frac{1-\alpha\nu}{\nu(1-\alpha)}}. \tag{C.8}$$

D. Sample of Countries

Country 1: It is constructed as the aggregate of 16 developed countries: Austria, Belgium, Canada, Switzerland, Denmark, Finland, France, Germany, Great Britain, Italy, Japan, South Korea, Netherlands, Norway, Sweden, and the United States.

Host countries $i = 2, ..., 38$: Argentina, Bolivia, Brazil, Chile, Colombia, Costa Rica, Dominican Republic, Ecuador, Guatemala, Honduras, Jamaica, Mexico, Nicaragua, Peru, Paraguay, El Salvador, Uruguay, Venezuela, China, Egypt, Indonesia, India, Israel, Jordan, Malaysia, Pakistan, Philippines, Syria, Thailand, Botswana, Morocco, Tunisia, Spain, Greece, Ireland, Iceland, Portugal, Turkey.[20]

Reduced set of host countries (when using measure of s^i based on employment shares): Argentina, Brazil, Chile, Colombia, Costa Rica, Ecuador, Guatemala, Honduras,

[20] Countries such as Greece, Ireland, Portugal, and Spain are clearly more developed than the other countries in the group. These countries, however, are net recipients of foreign direct investment. We excluded New Zealand and Australia from the sample even if they are also large recipients of foreign firms, because their FDI is mostly horizontally motivated.

Jamaica, Mexico, Venezuela, China, Indonesia, India, Israel, Malaysia, Philippines, Thailand, Spain, Greece, Ireland, Iceland, Portugal, Turkey.

The BEA does not report affiliate information (used to construct our measure of effective taxes τ_F^i) for multiple years for the following countries in our sample: Bolivia, El Salvador, Uruguay, Nicaragua, Paraguay, Pakistan, Syria, Botswana, Egypt, Jordan, Morocco, Tunisia, and Iceland. For those countries, we use the average τ_F^i of the countries in the geographic regions for which the BEA does report this information.

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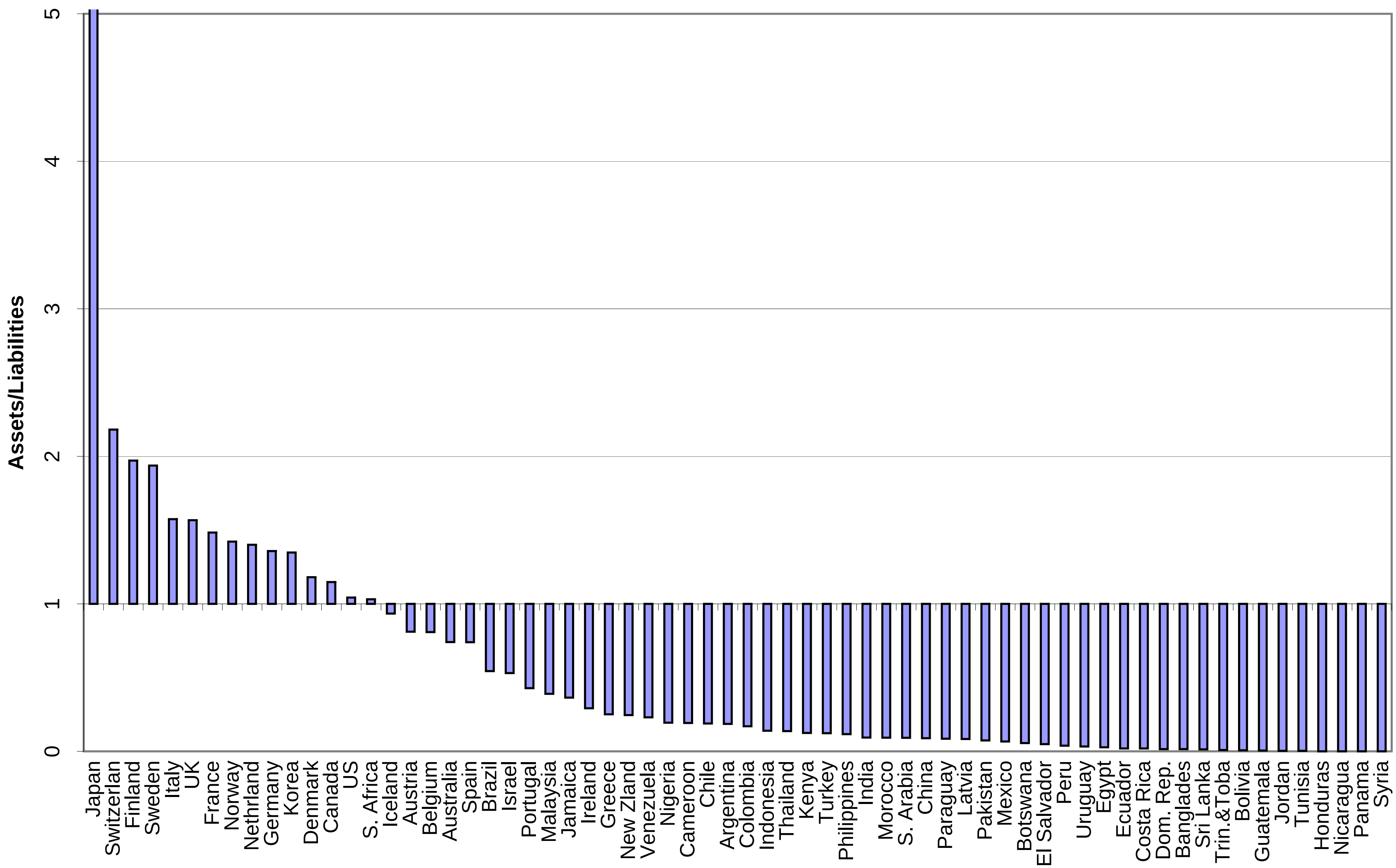
Figure 1: Net sources and net hosts of Foreign Direct Investment

Stock of FDI Assets / Stock of FDI Liabilities, Geometric Average 1997-2000



Source: Lane and Milesi-Ferretti (2006). A country is a net-host of FDI if the ratio of assets to liabilites is less than one.

Figure 2: Sources of variation of R in the data

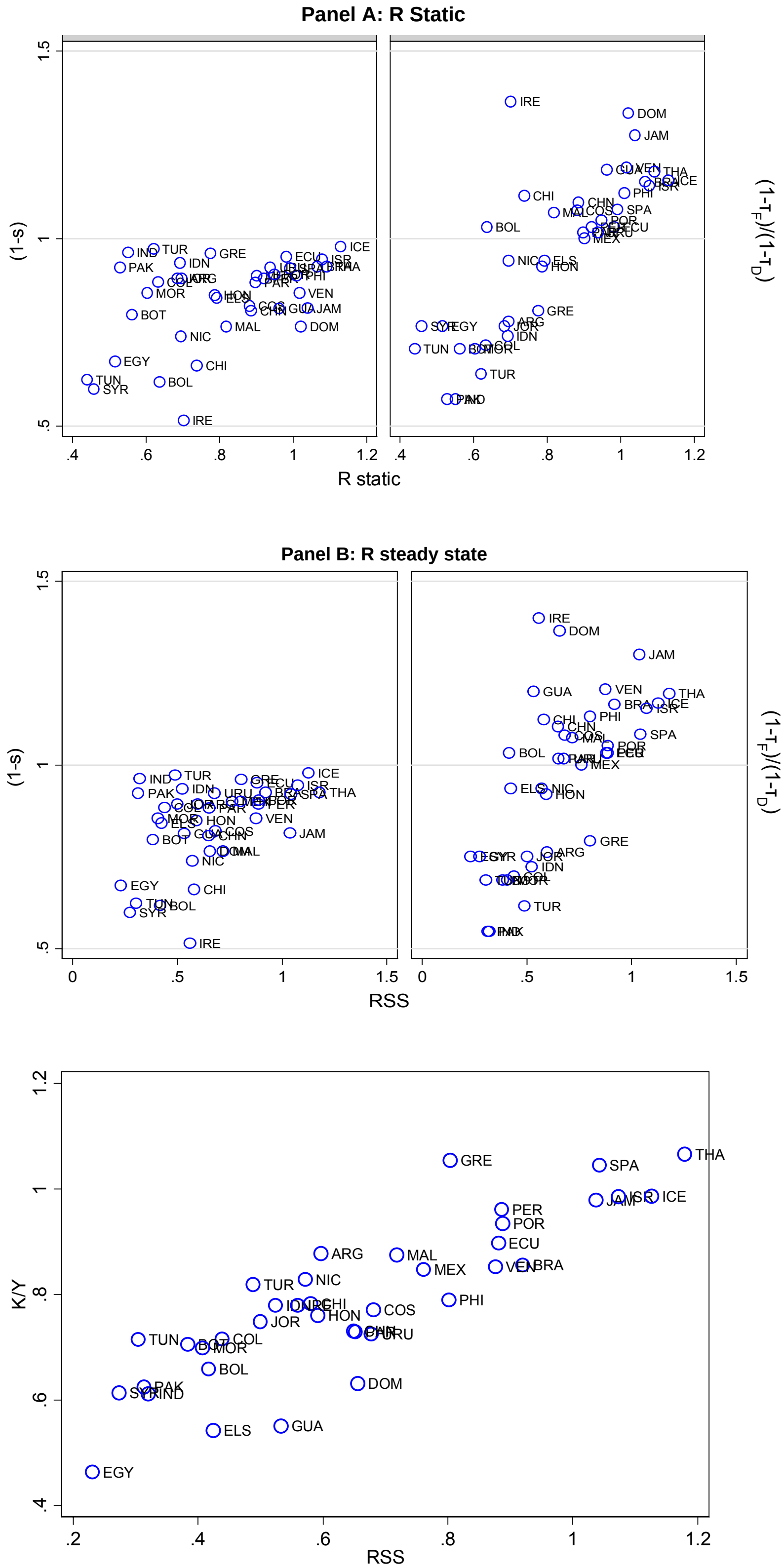


Figure 3: Gains for host countries from unilaterally moving from autarky to openness to foreign firms

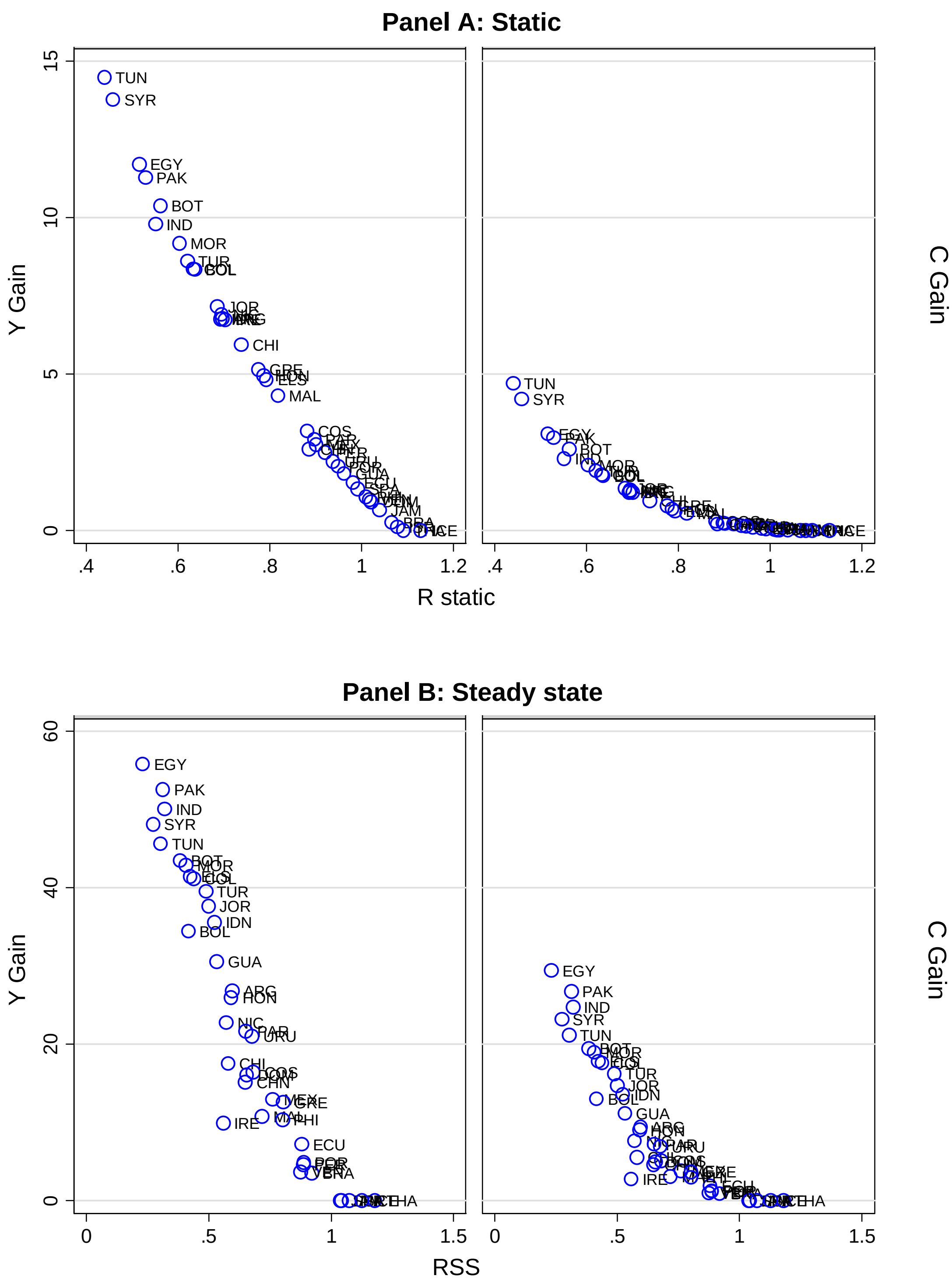


Table 1: Aggregate data for sample of net host countries, 1997-2000

	1	2	3	4	5
	Aggregate Data				
Host country	Y^i/L^i	L^i	K^i/Y^i	s^i	τ_F^i
	Values as % of net source country			*Values in %*	
Argentina	53.6	3.8	78.4	10.7	43.4
Bolivia	13.7	0.8	45.9	38.3	28.2
Brazil	37.7	15.2	74.8	7.4	21.1
Chile	49.7	1.4	63.3	33.8	23.2
Colombia	23.8	4.7	53.7	11.6	47.3
Costa Rica	28.5	0.4	61.7	18.0	25.6
Dominican R	30.2	0.6	42.5	23.5	10.6
Ecuador	23.5	0.9	81.7	4.8	28.2
Guatemala	26.6	0.8	33.0	18.7	19.2
Honduras	13.4	0.5	60.1	15.1	34.4
Jamaica	15.0	0.3	96.1	18.5	13.9
Mexico	46.1	8.3	73.5	10.0	30.0
Nicaragua	10.8	0.4	70.5	26.1	33.5
Peru	20.6	2.7	92.9	10.7	28.2
Paraguay	22.6	0.6	55.5	11.7	29.0
El Salvador	27.3	0.5	32.1	15.8	33.5
Uruguay	43.7	0.4	54.9	7.7	29.0
Venezuela	37.7	2.1	74.2	14.5	18.9
China	11.2	184.8	55.8	19.2	24.3
Egypt	26.9	4.6	23.9	32.8	44.1
Indonesia	18.3	20.3	62.9	6.5	45.8
India	11.8	96.0	40.1	3.8	56.4
Israel	86.7	0.6	97.3	5.5	21.7
Jordan	33.0	0.3	58.4	10.7	44.1
Malaysia	53.8	2.0	78.1	23.5	26.0
Pakistan	13.9	9.3	41.6	7.7	56.4
Philippines	16.5	7.3	64.5	10.0	22.9
Syria	32.1	1.0	40.3	40.2	44.1
Thailand	25.0	7.9	112.6	7.4	19.5
Botswana	41.5	0.1	52.2	20.4	47.9
Morocco	23.2	2.2	51.3	14.6	47.9
Tunisia	38.1	0.8	53.5	37.7	47.9
Spain	84.9	3.9	108.5	7.9	25.5
Greece	67.6	1.1	110.3	4.0	41.6
Ireland	116.2	0.4	62.9	48.6	8.8
Iceland	86.3	0.0	97.5	2.2	20.9
Portugal	66.5	1.1	88.1	9.5	27.2
Turkey	30.6	7.1	69.0	2.8	52.2
Median	29.3	1.1	62.9	11.7	28.6
Average	37.1	10.4	66.1	16.1	32.2
Max	116.2	184.8	112.6	48.6	56.4
Min	10.8	0.0	23.9	2.2	8.8

Computed on the basis of data from the Bureau of Economic Analysis, Lane and Milesi-Ferretti (2006), and Penn-World Tables.

Table 2: Model inference of country- and firm-embedded productivities (benchmark parametrization, 1997-2000)

	1	2	3	4	5	6
Host country	$\tilde{z}^i/\tilde{z}^1$	$\tilde{x}^i/\tilde{x}^1$	z^i/z^1	x^i/x^1	R^i_{static}	R^i_{SS}
Argentina	78.8	35.6	84.1	39.2	0.70	0.60
Bolivia	42.1	8.0	49.1	10.7	0.64	0.42
Brazil	62.6	36.2	67.1	39.1	1.07	0.92
Chile	77.0	33.2	80.1	42.8	0.74	0.58
Colombia	57.2	14.6	65.8	16.1	0.63	0.44
Costa Rica	57.4	22.9	63.1	26.3	0.88	0.68
Dominican R	64.5	27.2	69.3	32.4	1.02	0.66
Ecuador	47.7	21.1	53.6	22.5	0.98	0.88
Guatemala	65.8	23.0	72.3	26.5	0.96	0.53
Honduras	38.9	9.8	46.1	11.1	0.79	0.59
Jamaica	34.6	13.8	39.6	15.9	1.04	1.04
Mexico	71.6	38.2	76.1	41.9	0.90	0.76
Nicaragua	32.9	7.0	39.5	8.5	0.70	0.57
Peru	42.7	17.4	48.5	19.1	0.92	0.89
Paraguay	52.6	18.7	59.3	20.6	0.90	0.65
El Salvador	69.4	20.1	77.3	22.8	0.79	0.42
Uruguay	75.7	37.6	80.8	40.7	0.94	0.68
Venezuela	62.5	34.4	66.6	38.6	1.02	0.88
China	35.3	9.0	42.0	10.4	0.89	0.65
Egypt	77.2	13.3	87.0	17.0	0.52	0.23
Indonesia	47.0	12.2	55.2	13.1	0.69	0.52
India	43.7	6.5	54.3	6.9	0.55	0.32
Israel	91.7	84.4	91.5	90.2	1.08	1.07
Jordan	66.1	21.7	73.6	23.8	0.68	0.50
Malaysia	75.9	40.1	78.9	47.7	0.82	0.72
Pakistan	47.1	7.4	57.8	7.9	0.53	0.31
Philippines	41.8	15.1	48.0	16.5	1.01	0.80
Syria	72.7	14.1	80.5	19.3	0.46	0.27
Thailand	44.0	24.5	48.8	26.4	1.09	1.18
Botswana	78.4	22.7	85.9	26.4	0.56	0.38
Morocco	57.2	13.6	66.0	15.3	0.60	0.41
Tunisia	74.2	16.3	81.5	21.7	0.44	0.30
Spain	88.3	76.7	88.7	83.0	0.99	1.04
Greece	80.5	49.9	84.2	52.9	0.78	0.80
Ireland	119.9	71.7	113.9	107.3	0.70	0.56
Iceland	91.2	87.9	91.2	92.3	1.13	1.13
Portugal	82.5	57.7	84.7	63.0	0.95	0.89
Turkey	61.7	18.7	70.2	19.7	0.62	0.49
Median	63.6	21.4	69.8	23.3	0.81	0.62
Average	63.4	28.5	69.0	32.5	0.81	0.65
Max	119.9	87.9	113.9	107.3	1.13	1.18
Min	32.9	6.5	39.5	6.9	0.44	0.23

Table 3: Accounting for cross-country differences in output per worker

		1	2	3	4	5
			Decomposition (adds up to 100%)			
		$\log\left(\frac{Y^i/L^i}{Y^1/L^1}\right)$	$\frac{1}{1-\alpha\nu}\log\left(\frac{\tilde{z}^i}{\tilde{z}^1}\right)$	$\frac{1-\nu}{1-\alpha\nu}\log\left(\frac{\tilde{x}^i}{\tilde{x}^1}\right)$	$\frac{1-\nu}{1-\alpha\nu}\log\left(\frac{1}{(1-s^i)m^1}\right)$	$\frac{\alpha\nu}{1-\alpha\nu}\log\left(\frac{K^i/Y^i}{K^1/Y^1}\right)$
	Difference between Host and Source Countries, 1997-2000 (average host vs. source)					
1	Benchmark parametrization	-118.4%	60.5%	27.2%	-4.9%	17.2%
2	$\nu = 0.8$	-118.4%	55.2%	35.4%	-6.3%	15.7%
3	$\nu = 0.9$	-118.4%	66.1%	18.6%	-3.3%	18.6%
4	Reduced set of countries (FDI stocks)	-111.3%	63.2%	26.4%	-4.7%	15.0%
5	Reduced set of countries (employment shares)	-111.3%	63.2%	24.9%	-3.1%	15.0%
	Variation within Host Countries, 1997-2000 (variance-covariance decomposition)					
6	Benchmark parametrization	38.5%	67.1%	23.0%	0.3%	9.6%
7	$\nu = 0.8$	38.5%	60.8%	29.9%	0.4%	8.8%
8	$\nu = 0.9$	38.5%	73.6%	15.7%	0.2%	10.5%
9	Reduced set of countries (FDI stocks)	43.9%	67.0%	22.0%	1.2%	9.8%
10	Reduced set of countries (employment shares)	43.9%	67.0%	22.5%	0.8%	9.8%

Table 4: Output and consumption percentage gains for host countries of unilaterally moving from autarky to openness to foreign firms

Host Country	1	2	3	4	5	6
	Initial K and Fixed OC		SS K and Fixed OC		SS K and Endog. OC	
	Y	C	Y	C	Y	C
Argentina	6.8	1.3	13.4	5.0	26.8	9.4
Bolivia	8.3	1.7	22.7	10.1	34.4	13.0
Brazil	0.3	0.0	3.4	0.9	3.6	0.9
Chile	5.9	1.0	14.3	5.5	17.5	5.5
Colombia	8.4	1.8	21.2	9.2	41.2	17.6
Costa Rica	3.2	0.3	10.5	3.7	16.4	5.1
Dominican R	0.9	0.0	11.4	4.1	16.1	4.9
Ecuador	1.5	0.1	4.6	1.3	7.1	1.9
Guatemala	1.8	0.1	16.4	6.6	30.5	11.1
Honduras	4.9	0.7	13.9	5.3	25.9	9.0
Jamaica	0.7	0.0	1.0	0.2	0.0	0.0
Mexico	2.7	0.2	7.6	2.4	12.9	3.8
Nicaragua	6.9	1.3	14.7	5.7	22.7	7.6
Peru	2.5	0.2	4.4	1.3	4.6	1.2
Paraguay	2.9	0.2	11.5	4.1	21.7	7.2
El Salvador	4.8	0.6	22.3	9.8	41.5	17.8
Uruguay	2.2	0.1	10.6	3.7	21.0	6.9
Venezuela	1.0	0.0	4.7	1.3	3.7	0.9
China	2.6	0.2	9.5	3.2	15.2	4.6
Egypt	11.7	3.1	38.6	20.3	55.8	29.4
Indonesia	6.8	1.2	16.2	6.5	35.6	13.6
India	9.8	2.3	26.3	12.2	50.0	24.7
Israel	0.1	0.0	0.2	0.1	0.0	0.0
Jordan	7.1	1.3	18.1	7.4	37.7	14.7
Malaysia	4.3	0.5	9.2	3.1	10.8	3.1
Pakistan	11.3	3.0	30.1	14.6	52.5	26.8
Philippines	1.1	0.0	6.6	2.1	10.4	2.9
Syria	13.8	4.2	34.3	17.3	48.1	23.2
Thailand	0.0	0.0	0.0	0.0	0.0	0.0
Botswana	10.4	2.6	25.0	11.4	43.5	19.4
Morocco	9.2	2.1	23.2	10.4	42.9	19.0
Tunisia	14.5	4.7	31.3	15.4	45.6	21.2
Spain	1.3	0.1	0.8	0.2	0.0	0.0
Greece	5.1	0.8	6.6	2.1	12.6	3.7
Ireland	6.7	1.2	15.2	5.9	9.9	2.8
Iceland	0.0	0.0	0.0	0.0	0.0	0.0
Portugal	2.0	0.1	4.4	1.2	4.9	1.3
Turkey	8.6	1.9	18.3	7.5	39.5	16.2
Median	4.6	0.6	12.5	4.6	19.3	6.2
Average	5.1	1.0	13.7	5.8	22.7	9.2
Max	14.5	4.7	38.6	20.3	55.8	29.4
Min	0.0	0.0	0.0	0.0	0.0	0.0

Table 5: Output and consumption percentage gains for host countries of globally moving from autarky to openness to foreign firms

Host Country	1	2	3	4	5	6
	Initial K and Fixed OC		SS K and Fixed OC		SS K and Endog. OC	
	Y	C	Y	C	Y	C
Argentina	5.0	0.7	7.4	2.4	16.1	5.0
Bolivia	6.4	1.1	16.0	6.3	23.0	7.7
Brazil	0.0	0.0	0.0	0.0	0.0	0.0
Chile	4.1	0.5	8.1	2.6	6.8	1.8
Colombia	6.5	1.1	14.8	5.7	34.1	12.8
Costa Rica	1.3	0.1	4.4	1.3	5.6	1.5
Dominican R	0.0	0.0	5.3	1.6	5.3	1.4
Ecuador	0.0	0.0	0.0	0.0	0.0	0.0
Guatemala	0.0	0.0	10.1	3.5	19.3	6.2
Honduras	3.1	0.3	7.6	2.4	14.8	4.5
Jamaica	0.0	0.0	0.0	0.0	0.0	0.0
Mexico	1.0	0.0	2.0	0.5	2.7	0.7
Nicaragua	5.0	0.7	8.4	2.8	11.7	3.4
Peru	0.7	0.0	0.0	0.0	0.0	0.0
Paraguay	1.1	0.0	5.4	1.6	10.7	3.0
El Salvador	3.0	0.2	15.6	6.1	34.2	12.9
Uruguay	0.4	0.0	4.5	1.3	10.1	2.8
Venezuela	0.0	0.0	0.0	0.0	0.0	0.0
China	1.3	0.0	5.5	1.6	7.8	2.1
Egypt	9.8	2.3	31.6	15.6	49.9	24.6
Indonesia	5.1	0.7	10.4	3.6	25.4	8.7
India	8.7	1.9	22.8	10.1	46.9	22.2
Israel	0.0	0.0	0.0	0.0	0.0	0.0
Jordan	5.3	0.8	11.6	4.2	26.5	9.3
Malaysia	2.5	0.2	3.2	0.9	0.2	0.0
Pakistan	9.4	2.2	23.3	10.4	46.7	22.1
Philippines	0.0	0.0	0.8	0.2	0.0	0.0
Syria	11.8	3.2	27.0	12.6	42.2	18.4
Thailand	0.0	0.0	0.0	0.0	0.0	0.0
Botswana	8.4	1.8	18.1	7.5	37.7	14.8
Morocco	7.3	1.4	16.6	6.6	37.3	14.4
Tunisia	12.5	3.6	24.1	10.9	39.8	16.5
Spain	0.0	0.0	0.0	0.0	0.0	0.0
Greece	3.3	0.3	0.8	0.2	1.9	0.5
Ireland	4.9	0.7	8.9	3.0	0.0	0.0
Iceland	0.0	0.0	0.0	0.0	0.0	0.0
Portugal	0.2	0.0	0.0	0.0	0.0	0.0
Turkey	6.8	1.3	12.1	4.4	31.0	11.4
Median	2.7	0.2	6.5	2.0	8.9	2.5
Average	3.6	0.7	8.6	3.4	15.5	6.0
Max	12.5	3.6	31.6	15.6	49.9	24.6
Min	0.0	0.0	0.0	0.0	0.0	0.0

Table 6: Sensitivity of counterfactuals to alternative measures of taxes and parameter values

Steady-state percentage gains of unilaterally moving from autarky to openness to foreign firms

	1	2	3	4	5	6
	Benchmark taxes and parameter values		Alternative measure of taxes			
			$\tau_F=\tau^{Max}_F$		$\tau_F=\tau^{Min}_F$	
Host countries	**Y**	**C**	**Y**	**C**	**Y**	**C**
Median	19.3	6.2	23.4	7.9	16.4	5.1
Average	22.7	9.2	25.7	10.3	16.8	5.9
Max	55.8	29.4	55.7	29.3	46.6	21.9
Min	0.0	0.0	0.0	0.0	0.0	0.0

	7	8	9	10	11	12	13	14
	Alternative parameter values							
	$\nu=0.8$		$\nu=0.9$		$\alpha=0.23$		$\gamma=0.05$	
Host countries	**Y**	**C**	**Y**	**C**	**Y**	**C**	**Y**	**C**
Median	23.7	7.3	14.8	4.9	11.0	2.7	15.9	5.3
Average	30.3	11.8	15.4	6.5	14.6	4.8	19.3	7.8
Max	79.5	39.7	34.9	19.4	37.9	16.3	53.0	27.1
Min	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

	15	16	17	18
	Reduced set of Countries			
	FDI Stocks-Based		Employment-Based	
Host countries	**Y**	**C**	**Y**	**C**
Median	12.6	3.7	11.8	3.4
Average	17.8	6.9	16.5	6.4
Max	55.7	29.3	51.2	25.7
Min	0.0	0.0	0.0	0.0