

# Aggregate Consequences of International Firms in Developing Countries\*

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May 2005

## Abstract

We construct a dynamic multicountry version of Lucas' (1978) span of control model to examine the cross-country allocation of managerial skills. Countries differ in three characteristics: their 'pure productivities' (quality of the labor force, infrastructure, etc.), the skills of their domestic managers, and their tax policies. In equilibrium, foreign managers control capital and labor in host countries in magnitudes that are a function of the country's characteristics.

Observing the share of capital controlled by foreign firms, we use the model to separate the pure productivity and the average domestic managerial skills in each country. With aggregate data for 16 developed countries and 39 developing countries we find that, for 1998, differences in domestic managerial skills account for 18% of the average gap in output per capita between developed and developing countries, and 17% of the dispersion within the group of developing countries. Differences in pure country productivities account for 46% and 48%, respectively.

We also examine counterfactuals to assess the impact of policy barriers on international firms. We find that by unilaterally reducing barriers on foreign firms from 100% to zero, the median host country gains 12% in output and 1.6% in welfare (equivalent variation in consumption.) When all host countries simultaneously reduce barriers to zero, the median gains are 6% and 0.4%, respectively. Technology spillovers from foreign to domestic managers greatly amplify these gains.

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\*A previous version of this paper circulated under the title "International Mobility of Entrepreneurs". We thank Manuel Amador, Andy Atkeson, Pete Klenow, and Lyndon Moore, and seminar participants in various places for useful comments and suggestions.

# 1. Introduction

To be productive, a technology must be managed and controlled by appropriately skilled individuals. While technological knowledge is a non-rival resource that can potentially replicate itself without bounds, managerial skills is a rival resource: if used in one activity or region, it cannot be used in others.<sup>1</sup> In recent times, the mobility of managerial skills across countries has been greatly enhanced, as reflected by the fast growing presence of multinational firms worldwide.<sup>2</sup> Managerial skills are allocated internationally in response to costs, productivity, and policies of the entire set of potential host countries. Changes in policy barriers in one country impact the quantity and quality of managers in the country itself and in all other countries competing for foreign managers. Over time, the response of capital accumulation magnifies the impact on output and welfare. Interestingly, even though the importance of cross-country knowledge spillovers has been widely recognized, the world equilibrium allocation of managerial skills has, until very recently, received remarkably little attention.<sup>3</sup>

In this paper we construct and calibrate a dynamic, multicountry version of the span of control model of Lucas (1978) to examine the equilibrium allocation of managerial skills across countries. Managers control production units with decreasing returns to scale in labor and capital services, and earn the unit's profits. A firm is one manager and the inputs under his or her control. Throughout the paper we will use the words 'firm' and 'manager' interchangeably. Countries differ in three characteristics. The first one is the 'pure productivity' of countries which impact all firms, regardless of the skills and country of origin of managers. It includes factors such as the quality of the labor force, infrastructure, and geography. The second characteristic is the skills of the potential domestic managers. These 'managerial skills' capture the ability of individuals to make and implement the critical decisions relevant to a firm.<sup>4</sup> The third characteristic is the 'tax policy' of countries. Managers are internationally mobile in the sense that they can choose to locate their firms in one of many countries. We look at equilibria in which one of the countries is the 'source' and the other

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<sup>1</sup>For a discussion of rival and non-rival factors in the context of growth theory, see Romer (1990) and Klenow (1998).

<sup>2</sup>See chapter one 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.

<sup>3</sup>For a survey on the literature of cross-country knowledge externalities and growth see Klenow and Rodriguez-Clare (2004). We discuss below some recent work on the cross-country allocation of skills.

<sup>4</sup>Those managerial skills that are complementary to other managers are captured in the 'pure productivity' of the country.

countries are the ‘hosts’ of international firms. Host countries tax the profits of foreign firms. The world allocation of managers is determined by the distribution of characteristics across countries.

In equilibrium, a country with a high level of pure productivity relative to its domestic managerial skills attracts more foreign managers. It also attracts more foreign managers the lower are taxes on foreign firms’ profits and the higher is the abundance of capital and labor. These implications of the model enable us to identify and uncouple the pure productivity and average managerial skills of each country from observed aggregate data that includes the share of capital controlled by foreign firms. The key feature of the model that enables us to do this separation is that pure productivity and managerial skills impact this share in opposite directions. For example, consider two host countries A and B with the same taxes, output, capital and labor force. If we observe that foreigners control a higher fraction of the capital in country A, we can infer that country A has lower domestic managerial skills relative to its pure country productivity than country B. Solving for the world-wide equilibrium produces a mapping that pins down the two components for each host country relative to the source country.

In our quantitative analysis we measure the capital controlled by foreigners in each host country using the stock of foreign direct investment (FDI), as constructed by Lane and Milesi-Ferretti (2001). FDI is a good proxy since it represents foreign investment 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. The data on FDI shows two important features (see Table 1). First, developed countries are both the main sources and recipients of FDI. Second, most net recipients of FDI are developing countries, or countries that developed rapidly in the last decades such as Ireland and Spain. In this paper we focus on the flows of developed to less developed economies and abstract from managerial flows within developed countries,<sup>5</sup> and from flows originated from developing countries.<sup>6</sup>

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<sup>5</sup>Our model does not incorporate trade frictions that are essential to understanding the horizontal nature of the FDI within developed countries. Brainard (1993), Markusen and Venables (1998), and Helpman, Melitz, and Yeaple (2004) consider models of horizontal FDI in which firms establish foreign subsidiaries to serve the local market.

<sup>6</sup>We abstract from the flows originated from developing countries since empirically they are significantly less important. For example in 2001, agents from other developed countries owned almost 93% of all the assets controlled by foreign affiliates in the U.S. The analogous ratios for sales, gross product, employment, and total employee compensation expenditures are 89%, 88%, 89% and 89%, respectively. Similar figures apply for other developing countries. For example, for Argentina, Peru, and Costa Rica, approximately 80% of the FDI received in the 1990’s originated from developed countries. In Mexico, that number is

In our model, we take taxes on foreign firms as the policy barrier in each country. We follow Desai, Foley, and Hines (2004) in calculating the effective tax rates on profits paid by multinational firms. We think of these taxes as proxying for other formal or de facto policy barriers to the international firms.<sup>7</sup>

We undertake two types of exercises. First, we assess the relative importance of pure productivities and managerial skills in accounting for cross-country differences in output and productivity. Here we extend the accounting exercises of Klenow and Rodríguez-Clare (1997), Hall and Jones (1999), and Caselli (2004).<sup>8</sup> Second, we examine counterfactuals to assess the impact of reductions in barriers to international mobility of managers on output and welfare. These experiments are similar in nature to the experiments studied by Eaton and Kortum (2002 and 2003), and Alvarez and Lucas (2004) in the context of international trade in goods.

We find that both the pure productivities and managerial skills of developing countries are significantly lower than in developed countries (on average 52% and 20% lower, respectively, in 1998). Pure productivity accounts for 46% of the average output per capita gap between developed and developing countries, and 48% of the output per capita variability within the group of developing countries. On the other hand, differences in managerial skills account for 18% and 17% of developed-developing and within-developing differences of output per capita, respectively.

In our counterfactual exercises, we find that changes in policy barriers to foreign firms have large implications on output and welfare. We consider both unilateral policy changes (one country at a time) and global changes (all developing countries simultaneously). Output and welfare gains are higher under unilateral tax reductions, when other countries keep their barriers constant. However, simultaneous tax reductions are not a race to the bottom as most countries still have welfare gains. We also find that, on average, the welfare gains from a reduction in barriers to foreign firms are significantly higher than those obtained from other experiments that have been widely studied such as a reduction in capital income taxes

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approximately 91% . Barba-Navaretti and Venables (2004) also discuss the predominance of vertical FDI from developed in developing countries.

<sup>7</sup>For example, starting in 1989, Mexico eliminated some restrictions on foreign ownership of firms. For a detailed discussion, see Perez-Gonzales (2004).

<sup>8</sup>Caselli and Gennaioli (2002) also relate cross-country differences in total factor productivity to differences in the pool of active managers. In our framework we consider an exogenous distribution of managerial skills in each country and focus on their allocation across countries. Caselli and Gennaioli (2002) focus on asset market imperfections that affect the distribution of active managers within each country.

or a shift from financial autarky to financial integration.

Much work on the world income distribution is based on international transfers of knowledge.<sup>9</sup> In addition, since the work of Findlay (1978), there has been extensive theoretical and empirical work based on the idea that multinationals have positive technological spillovers to local firms.<sup>10</sup> When we extend our model to allow for productivity spillovers from foreign to domestic firms, we find that the output and welfare gains from a reduction in the barriers to the international mobility of managers can be significantly higher.

In this paper we abstract from other related issues such as the cross-country within-firm allocation of skills and tasks,<sup>11</sup> the within-country inequality implications of cross-border allocation of managerial skills,<sup>12</sup> different strategies of foreign investment,<sup>13</sup> and worker flows from developing to developed economies.<sup>14</sup> Our economy is a one good model that abstracts from intratemporal trade in goods.<sup>15</sup> In this paper we focus on providing a simple framework to quantitatively analyze the effects of mobility of firms from developed to developing economies in a multicountry general equilibrium setting.

The remainder of the paper is organized as follows. Section 2 describes the model and section 3 analyzes its equilibrium implications. Section 4 discusses how to use the model to infer the pure productivity and average managerial skills for each country from aggregate data. Section 5 uses the model to account for cross-country differences in productivity and output. Section 6 assess the impact of reductions in the barriers to international mobility of

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<sup>9</sup>Among others, Ciccione and Matsuyama (1996), Howitt (2000), and Klenow and Rodriguez-Clare (2004) emphasize the innovation in technological knowledge that has taken place mostly in the North and its subsequent adoption in the South.

<sup>10</sup>See Aitken and Harrison (1999), Kugler (2005), and Barba-Navaretti and Venables (2004) for a summary of the empirical evidence of diffusion by multinational firms. Monge-Naranjo (2005) studies a model in which firms are dynamic coalitions and where transfers of knowledge are fully internalized by multinationals.

<sup>11</sup>See for example Helpman (1984), Antras and Helpman (2004), and Grossman and Helpman (2003). In our economy, firms could be composed by one or many different production units controlled by unitary managers. Our model pins down the total mass of those units, and alternative interpretations can be given in terms of the integration of firms within or between countries.

<sup>12</sup>See for example Antras, Garicano and Rossi-Hansberg (2005). Our model abstracts from worker heterogeneity and so it is silent with respect to the within-country workers inequality. However, our model has similar implications for the inequality between-occupations within a country and within-occupations between countries.

<sup>13</sup>See for example Nocke and Yeaple (2004). In our model, the productivity of the firm is determined by the skills of the managers in control, regardless of how those skills were acquired.

<sup>14</sup>See for example Rauch (2001) and Klein and Ventura (2004). While worker flows are indeed important, managers and capital are arguably easier to move across borders.

<sup>15</sup>Rauch (1991), in a very similar setting to our model, shows that when there are differences in the endowments of managerial skills across countries, factor mobility takes place even if there is trade in multiple goods

managers on output and welfare. Section 7 provides some concluding remarks.

## 2. The Model

Time is discrete and periods are indexed by  $t = 0, 1, 2, 3, \dots, \infty$ . Countries are indexed by  $i = 1, 2, \dots, I$ . Country  $i = 1$  will be referred to as the developed (or source) country, and countries  $i = 2, \dots, I$  as the developing (or host) countries. There is one consumption good which is freely traded across countries. In any time period, each country  $i$  has a population of  $L_t^i$  individuals. Countries may have different population sizes, but we will restrict the analysis to all having the same population growth rate  $l > 0$ . Over time, the population of country  $i$  is  $L_t^i = L_0^i(1 + l)^t$ .

### Households

Individuals in all countries have an endowment of one unit of time, which can be used in two mutually exclusive activities: being a worker or being a manager. We assume perfect capital markets within each country so that 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 agent are:

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

where  $0 < \beta < 1$ .

The representative agent in country  $i$  faces the following budget constraint at time  $t$ :

$$C_t^i + I_t^i + A_{t+1}^i = (1 - \tau_{L,t}^i) w_t^i N_t^i + \tilde{\Pi}_t^i + (1 - \tau_{K,t}^i) r_t^i K_t^i + (1 + r^*) A_t^i + T_t^i.$$

Consumption ( $C_t^i$ ), investment ( $I_t^i$ ) and the purchase of foreign assets ( $A_{t+1}^i$ ) are financed by aggregate returns to workers, managers, and the stock of physical capital and financial assets.  $N_t^i$  denotes the mass of workers in country  $i$ , and  $K_t^i$  denotes the stock of physical capital.  $w_t^i$  and  $r_t^i$  are the wage rate and the rental rate of capital, respectively. Labor and capital income are taxed at rates  $\tau_{L,t}^i$  and  $\tau_{K,t}^i$ , respectively. The variables  $\tilde{\Pi}_t^i$  and  $T_t^i$  denote total after-tax profits and lump-sum transfers from the government, respectively, received by the representative household. The law of motion for aggregate capital in country  $i$  is given by:

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

where  $\delta$  denotes the depreciation rate of capital.

The representative household of each country can borrow or lend at the international risk free rate  $r^*$ . We impose the no-Ponzi game condition:

$$\lim_{t \rightarrow \infty} \frac{A_{t+1}^i / (1+l)^{t+1} / (1+g)^{\frac{t+1}{1-\alpha v}}}{(1+r^*)^t} = 0,$$

where  $g$  is the exogenous growth rate of productivity. The parameters  $\alpha$  and  $v$  are introduced below. We will also consider the case of financial autarky, imposing  $A_t^i = 0$  at all times.

### Production Technology

Production is organized in firms. A firm is a manager and the labor and capital inputs under his control. The productivity of each unit depends on two factors. The first is the ‘pure productivity’ of the country where the firm is located. It includes the average quality of the work force, the infrastructure, the geography, etc. The second factor is the ‘managerial skill’ or know-how of the manager in control.

We let  $z^i$  denote the pure productivity of country  $i$ . The output from a firm operated by a manager with ability  $x$  controlling inputs  $(n, k)$  in country  $i$  is given by:

$$z^i x [k^\alpha n^{1-\alpha}]^v$$

Here,  $0 < v < 1$  determines the degree of diminishing returns to scale to the manager’s control of inputs of production. Following Lucas (1978), we call  $v$  the “span of control” parameter.

We now explain how individuals are allocated between occupations and across countries, and how productivities and skills evolve over time and across countries.

### Occupation and Location Decisions

At any point in time, countries have different pools of potential managers. The average skill of the pool in country  $i$  is denoted by  $x_t^i$ . Each period, individuals of country  $i$  independently draw an ability level  $x_t^i e$ , where  $e$  is a purely idiosyncratic term with mean equal to one. The support of  $e$  is  $[0, \infty)$ , and we use  $F(\cdot)$  to denote its cumulative distribution function.

Upon the realization of their ability as managers, individuals choose to become workers or managers. As workers, all individuals earn the same after-tax wage  $(1 - \tau_L^i) w_t^i$  regardless

of  $e$ . However, earnings as managers are determined by ability. The before-tax returns of a local manager with ability  $x_t^i e$  operating in country  $i$  at time  $t$ , are:

$$\pi_t^i(x_t^i e) = \max_{k,n} [z_t^i x_t^i e (k^\alpha n^{1-\alpha})^\nu - w_t^i n - r_t^i k].$$

Facing proportional taxes  $\tau_{D,t}^i$  on the returns of managing a firm, an agent becomes a manager if:

$$(1 - \tau_{D,t}^i) \pi_t^i(x_t^i e) > (1 - \tau_{L,t}^i) w_t^i.$$

Given that  $\pi_t^i(x_t^i e)$  is strictly increasing in  $e$ , the threshold  $\bar{e}_t^i$  for becoming a manager is defined by the condition:

$$(1 - \tau_{D,t}^i) \pi_t^i(x_t^i \bar{e}_t^i) = (1 - \tau_{L,t}^i) w_t^i. \quad (2.1)$$

The population in each country is split into a mass of  $F(\bar{e}_t^i) L_t^i$  workers and a mass of  $[1 - F(\bar{e}_t^i)] L_t^i$  managers.

Managers from country 1 have the additional decision of where to locate their operations. We assume that the skill of a manager of country 1 is the same in all host countries. Therefore, we are abstracting from considerations of geographical costs of mobility, cultural barriers, or any other factor that may affect the skills of these managers when operating in foreign countries.<sup>16</sup>

For their location choice, managers contemplate the array of profits attainable from locating in each of the host countries. It is straightforward to show that, regardless of the location, the returns of a manager with skill  $e$  to managing a firm are proportional to  $e^{\frac{1}{1-\nu}}$ . So, without loss of generality we will only look at the profits for a manager with  $e = 1$ . Let  $\pi_{F,t}^i$  denote pre-tax returns of a manager from country 1 with  $e = 1$ , operating in country  $i$ :

$$\pi_{F,t}^i = \max_{k,n} [z_t^i x_t^1 (k^\alpha n^{1-\alpha})^\nu - w_t^i n - r_t^i k].$$

We consider a world economy where governments in developing countries impose taxes  $\tau_{F,t}^i$  on the profits of foreign managers (i.e: managers from country 1). These taxes can be seen as a proxy for a variety of barriers faced by firms operating in a foreign country. We model them as taxes on profits, affecting only the location decisions of firms and not their

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<sup>16</sup>In section 6 we discuss some implications of incorporating these factors.

hiring of inputs. The location decisions are based on the vector  $\{(1 - \tau_{F,t}^i)\pi_{F,t}^i\}_{i=2,\dots,I}$  and the domestic option  $(1 - \tau_{D,t}^1)\pi_t^1$ , where  $\pi_t^1 = \pi_t^1(x_t^1)$ .

Given that the profits from managing a firm are proportional to  $e$ , if a manager from country 1 with ability  $x_t^1 e$  weakly prefers to locate in country  $i \neq 1$  over operating in country  $i = 1$ , then all other managers of country 1 would also weakly prefer to do so.<sup>17</sup> Here, without loss of generality, we focus on the equilibrium in which each country receives a representative sample of the cross-section of active managers from country 1. This is to say, we assume that the ability distribution of country 1 managers in every country where they operate is equally distributed according to  $F(e) / [1 - F(\bar{e}_t^1)]$  for  $e \geq \bar{e}_t^1$ .

Let  $\{m_t^i\}_{i=1}^I$  denote the allocation of country 1 managers across countries. That is,  $m_t^i$  is the fraction of country 1 managers operating in country  $i$ . Feasibility requires that  $m_t^i \geq 0$  and  $\sum_{i=1}^I m_t^i = 1$ . In equilibrium, it is always the case that  $m_t^1 > 0$ . Otherwise, a manager staying in country 1 would make arbitrarily large profits. Thus, for an equilibrium we only need to check that, for all  $i > 1$ :

$$m_t^i \geq 0, \quad (1 - \tau_{D,t}^1)\pi_t^1 \leq (1 - \tau_{F,t}^i)\pi_{F,t}^i, \quad \text{and at least one with equality.} \quad (2.2)$$

### Law of motion of managerial skills and countries productivities

We assume that the engine of growth for all countries is the growth of their pure productivities,  $z_t^i$ . We assume that  $z_t^i$  grows at the rate  $g > 0$  for all  $i$ , so that:

$$z_t^i = z_{t-1}^i(1 + g).$$

We allow for the possibility that domestic managers learn from foreign managers operating in their country. We assume that  $x_{t+1}^i$  is a weighted average of the managerial skills of domestic and country 1 managers:

$$x_{t+1}^i = (x_t^1)^{\zeta s_t} (x_t^i)^{1-\zeta s_t}$$

Here  $s_t^i$  denotes the fraction of capital controlled by foreign managers at time  $t$ . The parameter  $\zeta \in [0, 1]$  measures the extent that domestic managers learn from foreign managers.

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<sup>17</sup>Likewise, if managers from country 1 are indifferent between locating in country 1 or country  $i$ , then managers from country  $i$  will also be indifferent between producing in either country if they had the option of doing so. Fixed costs of production would break this symmetry.

If  $\zeta = 1$ , foreign firms fully diffuse their know-how to domestic managers.<sup>18</sup> When  $\zeta = 0$ , there is no diffusion.

### Government Policy and Equilibrium

The government of country 1 collects taxes on labor and capital income, and on the profits of domestic managers. The governments of countries  $i = 2, \dots, I$  also collect taxes on the profits of foreign managers. All governments run a balanced budget every period, fully rebating collected taxes to domestic households.

Equilibrium in the world economy requires that within each country, the local labor and capital markets clear. It also requires that occupational and locational decisions be optimal, and the accumulation and cross-country allocation of capital also be optimal. In this draft, we assume that  $r^*$  is exogenously given. Thus, given an array of policies  $\{\tau_{D,t}^i, \tau_{F,t}^i, \tau_{L,t}^i, \tau_{K,t}^i\}_{i \in I, t \geq 0}$  and a set of initial conditions  $\{A_0^i, K_0^i, L_0^i, z_0^i, x_0^i\}_{i \in I}$ , we look for a price system  $\{w_t^i, r_t^i\}_{i \in I, t \geq 0}$  and an allocation  $\{A_t^i, C_t^i, I_t^i, \bar{e}_t^i, m_t^i\}_{i \in I, t \geq 0}$  that satisfy all the equilibrium conditions.

### 3. Equilibrium Implications

At any point in time, each country has a predetermined state  $(z_t^i, x_t^i, K_t^i, L_t^i)$ . Taking as given the cross-country allocation of managers of country 1, we first analyze the occupation decision  $(\bar{e}^i)$ . Then, for given occupation decisions in each country, we analyze the cross-country allocation of country 1 managers,  $\{m_t^i\}_{i=1}^I$ . Finally, we obtain an expression for the aggregate productivity and output in each country.

To save on notation, we drop the time subindices. We will re-introduce time subscripts when we analyze the dynamics of the model.

#### Occupation Decisions

Given  $\bar{e}^i$  and  $m^i$ , the equilibrium wages in country  $i \neq 1$  is:

$$w^i = (1 - \alpha) \nu z^i \left( (x^i)^{\frac{1}{1-\nu}} \xi^i(\bar{e}^i) + m^i (x^1)^{\frac{1}{1-\nu}} \xi^1(\bar{e}^1) \left( \frac{L^1}{L^i} \right) \right)^{1-\nu} \left( \frac{K^i}{L^i} \right)^{\alpha \nu} [F(\bar{e}^i)]^{\nu(1-\alpha)-1}. \quad (3.1)$$

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<sup>18</sup>Here we are following the common practice of taking diffusion as an externality. Monge-Naranjo (2005) constructs a model in which diffusion is fully internalized.

Here we define  $\xi^i(\bar{e}^i) \equiv \int_{\bar{e}^i}^{\infty} e^{\frac{1}{1-\nu}} dF^i(e)$ , where  $x_i^i \xi^i(\bar{e}^i)$  is the aggregate of active domestic managerial skills in country  $i$ .

Similarly, before-tax profits of the marginal manager in country  $i$  (i.e: with idiosyncratic ability  $\bar{e}^i$ ), for a given  $m^i$ , are:

$$\pi^i(\bar{e}^i) = \frac{(1-\nu) z^i (\bar{e}^i)^{\frac{1}{1-\nu}} (x^i)^{\frac{1}{1-\nu}} \left(\frac{K^i}{L^i}\right)^{\alpha\nu} F(\bar{e}^i)^{(1-\alpha)\nu}}{\left[(x^i)^{\frac{1}{1-\nu}} \xi^i(\bar{e}^i) + m^i (x^1)^{\frac{1}{1-\nu}} \xi^1(\bar{e}^1) \left(\frac{L^1}{L^i}\right)\right]^\nu} \text{ for } i = 2, \dots, I. \quad (3.2)$$

Similar expressions obtain for  $w^1$  and  $\pi^1(\bar{e}^1)$  in country 1.

The equilibrium threshold  $\bar{e}^i$  is determined from equation (2.1). Given  $m^i$ , there is a unique equilibrium  $\bar{e}^i$ . Moreover,  $\bar{e}^i$  is strictly increasing in  $m^i$ . More foreign managers raise the wage, improving the earnings of workers and reducing those of local managers.

### International Allocation of Managers

We now characterize  $m^i$  given the occupation decision  $\bar{e}^i$ . Taking  $\{m^j\}_{j \neq i}$  as given, we now define  $\pi^1(m^i)$  to be the profits attainable in country 1 for a local manager with idiosyncratic ability  $e = 1$ , as a function solely of the mass of managers sent to country  $i$ . It is given by:

$$\pi^1(m^i) = (1-\nu) z^1 x^1 \left(1 - m^i - \sum_{j>1, j \neq i} m^j\right)^{-\nu} [\xi^1(\bar{e}^1)]^{-\nu} (K^1/L^1)^{\alpha\nu} F^1(\bar{e}^1)^{(1-\alpha)\nu}. \quad (3.3)$$

Similarly, the pre-tax profits of a country 1 manager with idiosyncratic ability  $e = 1$  operating in country  $i$  are:

$$\pi_F^i(m^i) = \frac{(1-\nu) z^i (x^1)^{\frac{1}{1-\nu}} \left(\frac{K^i}{L^i}\right)^{\alpha\nu} F(\bar{e}^i)^{(1-\alpha)\nu}}{\left[(x^i)^{\frac{1}{1-\nu}} \xi^i(\bar{e}^i) + m^i (x^1)^{\frac{1}{1-\nu}} \xi^1(\bar{e}^1) \left(\frac{L^1}{L^i}\right)\right]^\nu}. \quad (3.4)$$

This function is decreasing in  $m^i$  since more foreign managers raise the factor prices in country  $i$ . Also,  $\pi^1(m^i)$  is increasing in  $m^i$  because fewer local managers lowers factor prices in country 1. The unique equilibrium  $m^i$  is determined from condition (2.2).  $m^i$  is increasing in  $\bar{e}^i$  because, all else equal, more domestic managers reduce the profits of foreign managers by raising factor prices.

At this point it is convenient to step back and examine the forces that induce a manager from country 1 to set up a firm in another country. Producing in a developing country entails the following trade-off: lower factor prices versus lower pure productivity and possibly higher

taxes. Consider for now a situation in which all managers produce in their own country, including those from country 1 (i.e:  $m^1 = 1$  and  $m^i = 0$  for  $i > 1$ ). Solving for factor prices, a manager from country 1 manager would be better-off moving to country  $i > 1$  iff:

$$\underbrace{\left(\frac{1 - \tau_F^i}{1 - \tau_D^1}\right)^{\frac{1}{\nu}}}_{\text{taxes}} \underbrace{\left[\frac{z^i}{z^1}\right]^{\frac{1}{\nu}}}_{\text{country productivities}} \underbrace{\left[\frac{K^i/L^i}{K^1/L^1}\right]^\alpha}_{\text{capital per capita}} \underbrace{\left[\frac{F(\bar{e}^i)}{F(\bar{e}^1)}\right]^{(1-\alpha)}}_{\text{labor}} \underbrace{\frac{(x^1)^{\frac{1}{1-\nu}} \xi^1(\bar{e}^1)}{(x^i)^{\frac{1}{1-\nu}} \xi^i(\bar{e}^i)}}_{\text{managerial abilities}} > 1 \quad (3.5)$$

Managers from country 1 would move to country  $i$  if in country  $i$ : (i) taxes on foreign firms  $\tau_F^i$  are not too high relative to taxes in country 1, (ii) the relative pure productivity  $z^i/z^1$  is sufficiently high, (iii) capital and labor are relatively abundant, and (iv) competition from other managers is sufficiently low. If the resulting balance among these forces is not favorable, firms from country 1 will not move to country  $i$ .

Those results extend in general. Indeed, in an interior equilibrium ( $m^i > 0$ ),  $m^i$  satisfies:

$$m^i (x^1)^{\frac{1}{1-\nu}} \xi^1(\bar{e}^1) L^1 = \left[ \frac{z^i (1 - \tau_F^i) (1 - \nu) (K^i)^{\alpha\nu} [F(\bar{e}^i) L^i]^{(1-\alpha)\nu}}{(1 - \tau_D^1) \pi^1} \right]^{1/\nu} - (x^i)^{\frac{1}{1-\nu}} \xi^i(\bar{e}^i) L^i. \quad (3.6)$$

Changes in country  $j$ 's allocations or policies have an impact on the number of foreign firms operating in country  $i$  as long as they affect  $\pi^1$ , the profits that country 1 managers earn in their own country.

### Aggregate Output

Aggregate output in country  $i > 1$  is the sum of the output produced by local and foreign firms. Since all firms have the same factor intensities and face the same factor prices, aggregate output is:

$$Y^i = z^i \left( (x^i)^{\frac{1}{1-\nu}} \xi^i(\bar{e}^i) L^i + (x^1)^{\frac{1}{1-\nu}} \xi^1(\bar{e}^1) m^i L^1 \right)^{1-\nu} (K^i)^{\alpha\nu} (F(\bar{e}^i) L^i)^{(1-\alpha)\nu}. \quad (3.7)$$

The share of capital controlled by foreign firms in country  $i$  is:

$$s^i = \frac{(x^1)^{\frac{1}{1-\nu}} \xi^1(\bar{e}^1) m^i L^1}{(x^i)^{\frac{1}{1-\nu}} \xi^i(\bar{e}^i) L^i + (x^1)^{\frac{1}{1-\nu}} \xi^1(\bar{e}^1) m^i L^1}. \quad (3.8)$$

With this expression, aggregate output is:

$$Y^i = z^i x^i \left( \frac{1}{1 - s^i} \xi^i(\bar{e}^i) L^i \right)^{1-\nu} (K^i)^{\alpha\nu} (F(\bar{e}^i) L^i)^{(1-\alpha)\nu}. \quad (3.9)$$

Using equations (3.6) and (3.9), aggregate output in an interior equilibrium (i.e:  $0 < s^i < 1$ ) is:

$$Y^i = (z^i)^{\frac{1}{\nu}} \left( \frac{(1 - \tau_F^i)(1 - \nu)}{(1 - \tau_D^1)\pi^1} \right)^{\frac{1-\nu}{\nu}} (K^i)^\alpha (F(\bar{e}^i)L^i)^{(1-\alpha)}. \quad (3.10)$$

This expression has important implications. First, total factor productivity (TFP) in each country depends on the equilibrium profits in the developed country. Those profits are determined as part of the equilibrium in the global economy and can be affected by developments in other developing countries. For example, suppose that country  $j$  reduces  $\tau_F^j$ .  $m^j$  now increases as managers move to country  $j$ , and therefore in the new equilibrium,  $\pi^1$  is higher. This results in a reduction of output and TFP in all of the other countries  $i$ , both developed and developing.

Second, equation (3.10) shows that, everything else constant (including  $\bar{e}^i$ ), a higher tax rate on foreign firms' profits,  $\tau_F^i$ , decreases TFP and output in country  $i$  as foreign managers leave country  $i$ .

Third, everything else constant, in an interior equilibrium ( $0 < s^i < 1$ ) an increase in  $x^i$  leaves aggregate output unchanged. However, this change reduces the share of factors controlled by foreign firms, and therefore increases the income of domestic households.

Fourth, as opposed to a world with no managerial mobility,  $x$  and  $z$  operate in a very different way. For example, suppose that countries  $i$  and  $j$  are such that  $z^i x^i = z^j x^j$ , with  $z^i > z^j$ , and otherwise these countries are identical. Under no international mobility of managers, these two countries will look exactly the same. However, with mobility, country  $i$  will receive a higher number of foreign managers, and will thus have a higher output level. A higher  $x$  reduces the share of factors of production controlled by foreign firms, whereas a higher  $z$  increases this share.

Finally, an increase in  $z$  has a more than proportional effect on TFP. A higher  $z$  attracts more foreign firms, increasing the quantity and possibly the quality of firms operating in the country. This result is even stronger with capital accumulation.

## Dynamics

The equilibrium conditions analyzed thus far take as given the capital stock in each country. Over time, the capital stock depends on the optimal accumulation by the representative

households. After some manipulation, the resource constraints take the form:

$$A_{t+1}^i + C_t^i + I_t^i = [1 - (1 - \tau_{F,t}^i)(1 - \nu) s_t^i] Y_t^i + (1 + r^*) A_t^i, \quad i = 2, \dots, I. \quad (3.11)$$

Of all the output produced in country  $i$ , a fraction  $(1 - \tau_{F,t}^i)(1 - \nu) s_t^i$  is taken by foreigners as net of tax profits. An increase in  $\tau_{F,t}$  reduces  $s_t^i$  so available resources to the domestic households might decrease. Otherwise, this is a standard capital accumulation problem.

For country 1, the resource constraint is:

$$A_{t+1}^1 + C_t^1 + I_t^1 = Y_t^1 + (1 + r^*) A_t^1 + (1 - \nu) \sum_{i=2}^I (1 - \tau_{F,t}^i) s_t^i Y_t^i. \quad (3.12)$$

The last term of this expression is net of tax profits earned by managers operating abroad.

Along a balanced growth path the rental rate of capital (net of taxes) must be equal across countries. For two countries  $i, j > 1$  with  $m^i > 0$  and  $m^j > 0$ , the ratio of their output per capita is:

$$\frac{Y^i/L^i}{Y^j/L^j} = \left( \frac{z^i}{z^j} \right)^{\frac{1}{\nu(1-\alpha)}} \left( \frac{1 - \tau_F^i}{1 - \tau_F^j} \right)^{\frac{1-\nu}{\nu(1-\alpha)}} \left[ \frac{1 - \tau_K^i}{1 - \tau_K^j} \right]^{\frac{\alpha}{(1-\alpha)}} \frac{F^i(\bar{e}^i)}{F^j(\bar{e}^j)}. \quad (3.13)$$

An increase in  $z$  now has an even larger effect on output per capita. First, as discussed above, a higher  $z$  attracts more foreign firms. Second, a higher  $z$  induces more capital accumulation. The two effects reinforce each other. Likewise, a lower  $\tau_F$  attracts more foreign firms and induces more accumulation of capital. Since  $\tau_F$  only distorts the mass of foreign firms and not their hiring of capital and labor, the effect of a change in  $\tau_F$  is smaller than that of a change in  $z$ . The implications of changes in  $\tau_K^i$  are the same as in a standard neoclassical growth model.

At this point it is convenient to illustrate the welfare gains of international mobility of managers in a simplified example with only one host country ( $I = 2$ ). We assume that capital, labor, and corporate taxes are zero, that both countries start in a balanced growth path with no international mobility of firms ( $\tau_F^2 = 1$ ), that there is no technology diffusion from foreign to local managers, and we compute the welfare consequences (equivalent variations of consumptions) for both countries of lowering  $\tau_F^2$  to zero. The parameter values (discussed in detail in Section 5) and results are reported in Table 2 for different configurations of  $z^2/z^1$  and  $x^2/x^1$ . The welfare gains can be significantly large, specially when the quality of managers from country 1 is high relative to managers from country 2, and when the pure productivity of country 2 is close to that of country 1. For example, for  $z^2/z^1 = 0.8$  and

$x^2/x^1 = 0.8$ , the welfare gains for countries 1 and 2 are 0.8% and 3.8%, respectively. Notice that if the pure productivity of country 2 is too low, no managers from country 1 will move to country 2. The lower panel of Table 2 also reveals that welfare gains for the host country are larger the smaller is its population relative to the source country, because the reduction in  $\tau_F^2$  leads to a smaller increase in the profits of managers in country 1.

A full quantitative evaluation of the welfare gains in a multicountry version of the model in the presence of other taxes and different initial conditions is presented in Section 6. We first need to discuss how we obtain values of  $z^i/z^1$  and  $x^i/x^1$  using aggregate data.

#### 4. Identifying $\{z^i, x^i\}$ Using Aggregate Data

Suppose that we observe data on  $\{Y_t^i, L_t^i, K_t^i\}$  for all countries for the time period  $t$ . Assume we also observe positive shares of factors of production controlled by foreigners,  $\{s_t^i\}$ , and taxes  $\{\tau_{D,t}^i, \tau_{F,t}^i, \tau_{L,t}^i, \tau_{K,t}^i\}$ . Then, interpreting the observed data as the equilibrium outcome of the model, we can use the intratemporal equilibrium conditions to separate  $x_t^i$  and  $z_t^i$  for all countries.

We now describe the algorithm. We normalize  $x^1 = 1$ . To simplify the presentation, we omit time subscripts and the determination of  $\bar{e}^i$ , taking it as exogenously given.

Consider an arbitrary value of  $m^1$ . Then, the aggregate output expression for country 1 determines  $z^1$ :

$$z^1 = \frac{Y^1}{(m^1 \xi^1(\bar{e}^1) L^1)^{1-\nu} (K^1)^{\alpha\nu} (F^1(\bar{e}^1) L^1)^{(1-\alpha)\nu}}. \quad (4.1)$$

Pre-tax profits of a local manager with idiosyncratic skill  $e = 1$  operating in country 1 are:

$$\pi^1 = (1 - \nu) z^1 \left( \frac{1}{m^1 \xi^1(\bar{e}^1)} \right)^\nu (K^1/L^1)^{\alpha\nu} (F^1(\bar{e}^1))^{(1-\alpha)\nu}. \quad (4.2)$$

Using (3.6), (3.7), (3.8) we can now solve for  $x^i$ :

$$(x^i)^{\frac{1}{1-\nu}} = (1 - s^i) \frac{(1 - \tau_F^i)(1 - \nu)}{(1 - \tau_D^1) \pi^1} \frac{1}{\xi^i(\bar{e}^i)} \frac{Y^i}{L^i}. \quad (4.3)$$

With this we can solve for  $m^i$ :

$$m^i = \frac{s^i}{1 - s^i} (x^i)^{\frac{1}{1-\nu}} \frac{\xi^i(\bar{e}^i) L^i}{\xi^1(\bar{e}^1) L^i} \quad (4.4)$$

Once we solve for  $x^i$ , we use the aggregate output expression (3.7) to compute  $z^i$ .

The equilibrium value of  $m^1$  is such that  $m^1 + \sum_{i=2}^I m^i = 1$ . This is a very simple algorithm since the search is one-dimensional.

## 5. Accounting for Cross-Country Income Differences

### Data and Parameter Values

We first discuss the choice of parameters for preferences, technology, and the distribution of managerial abilities. We then discuss the information that we use on output, capital, labor, foreign controlled capital, and taxes.

We take a period to be a calendar year. We calibrate  $l$ ,  $g$ , and  $\beta$  to replicate the main long run growth features of the U.S., very much along the lines of Gourinchas and Jeanne (2003). Preferences are logarithmic ( $\sigma = 1$ ). We fix the world interest  $r^*$  to be the asymptotic, balanced growth path interest rate. That interest rate satisfies the following condition:

$$(1 + g)^{\frac{-\sigma}{1-\alpha\nu}} \beta (1 + r^*) = 1$$

The resulting parameter values are  $\beta = 0.96$ ,  $l = 0.74\%$ ,  $g = 0.86\%$ , and  $r^* = 5.4\%$ . Throughout we assume that initial foreign asset holding are zero for all countries.

We assume that the distribution of managerial idiosyncratic skills,  $F$ , is lognormal.<sup>19</sup> We calibrate the two parameters of the distribution so that two conditions are satisfied. First, the expected value of  $e$  is equal to 1. Second, in the absence of foreign managers, in equilibrium all countries would have a fraction of managers equal to 10%. The first condition is simply the normalization required to interpret  $x^i$  as the average managerial skill. The second condition makes the model consistent with the observed fraction of individuals that are self-employed in the U.S.<sup>20</sup> We also consider the case with a fixed fraction of homogenous managers in each country and find no substantial differences in the results.

We set  $\alpha = 1/3$ , a standard value for this parameter. We assume  $\nu = 0.85$  following Atkeson, Kahn, and Ohanian (1996) and Atkeson and Kehoe (2005). To explore the implications of diffusion, we only consider two extremes:  $\zeta = 0$  and  $\zeta = 1$ . Table 3 summarizes the parameter values used in the exercises.

Table 3: Parameter Values

$\beta$	0.96	$\delta$	6%
$l$	0.74%	$\sigma$	1
$g$	0.86%	$\alpha$	0.33
$r^*$	5.4%	$\nu$	0.85
$\log [std(e)]$	0.043	$\zeta$	0 and 1

<sup>19</sup>The results are fairly robust to assuming a Gamma or a Pareto distributions for  $F$ .

<sup>20</sup>This fraction is in the range discussed by Quadrini (2000), Chari, Golosov, and Tsyvinski (2004), and Cagetti and De Nardi (2004).

Data on GDP, physical investment, and the labor force for each country was obtained from The Penn World Tables, Version 6.1. Capital stocks are constructed using the standard permanent inventory scheme on investment, assuming an annual depreciation rate of 6%.

We use the stock of FDI to proxy for the capital controlled by foreigners in each developing country. FDI is defined by the International Monetary Fund as investment in a foreign company where the foreign investor owns at least 10% of the ordinary shares, 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.<sup>21</sup> We use the stocks of direct investment liabilities constructed by Lane and Milesi-Ferretti (2001) on the basis of cumulative FDI flows and reinvested profits. A country is a net recipient of FDI when the stock of direct investment liabilities (inward FDI) is larger than the stock of direct investment assets (outward FDI). As we argued in the introduction, Table 1 shows that there is a clear split in the sample. On the one hand, the sources of FDI are highly concentrated in a group of developed countries. On the other hand, less developed countries tend to be net recipients of FDI.

Consistent with these findings, we define country 1 as an aggregate of 16 developed countries that are the major net sources of FDI. They are Austria, Belgium, Canada, Switzerland, Denmark, Finland, France, Germany, Great Britain, Italy, Japan, South Korea, Netherlands, Norway, Sweden, and US. The 39 net recipients of FDI (countries  $i = 2, \dots, I$ ) are 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, Singapore, Syria, Thailand, Botswana, Morocco, Tunisia, Spain, Greece, Ireland, Iceland, Portugal, Turkey.<sup>22</sup>

We choose the tax on capital income,  $\tau_{K,t}^i$ , so that the steady state investment/GDP ratio for each country is equal to the average observed in the data between 1990 and 1998.<sup>23</sup> We use corporate taxes,  $\tau_D^i$ , reported in Ernst and Young’s *Worldwide Corporate Tax Guide*

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<sup>21</sup>We are aware of important problems with this proxy because some FDI items may not carry any effective control by foreigners or some capital controlled by foreigners may not be registered as FDI. The bias can go in both directions.

<sup>22</sup>Countries such as Greece, Ireland, Portugal, Singapore, 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. We believe that geography, which is not incorporated in our model, is the main force of FDI for those two countries.

<sup>23</sup>This tax measure also captures many other distortions that are reflected in cross-country differences in investment rates.

for the year 2001. For country 1, we set  $\tau_D^1 = 0.3$ . Given the lack of accurate information on the effective tax rates paid by different occupations in the sample of developing countries, we assume that  $\tau_{L,t}^i = \tau_{D,t}^i$ . With this assumption we also abstract from the distortion on the occupation choice, which is not the focus of this paper.

To estimate taxes on foreign firms' profits,  $\tau_F^i$ , we follow Desai, Foley, and Hines (2004). Using the surveys of U.S. Direct Investment between 1982 and 2001, from the Bureau of Economic Analysis (BEA), we obtain effective foreign income tax rates paid by affiliates of US Multinationals operating abroad:<sup>24</sup>

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

Desai, Foley, and Hines (2004) extensively discuss why this is an imperfect yet informative measure of the barriers on international firms.<sup>25</sup> In our benchmark parametrization we use an average of the effective foreign income tax rates between the years 1997 and 2000. As a robustness check, we redo our exercises using alternative measures of effective taxes denoted by  $\tau_F^{E,i}$ : (i)  $\tau_F^{E,i} = \max\{\tau_{D,t}^1, \tau_{F,t}^i\}$ , (ii)  $\tau_F^{E,i} = \min\{\tau_{D,t}^1, \tau_{F,t}^i\}$ , and (iii)  $\tau_F^{E,i} = \tau_D^1$ .

With this data, we use the algorithm from the model to compute  $x^i$  and  $z^i$ . Table 4 reports the resulting values of  $x^i/x^1$  and  $z^i/z^1$  for 1998, as well as tax rates, and shares of foreign controlled capital.

## Results

Figure 1 displays  $z^i/z^1$  (horizontal axis) and  $x^i/x^1$  (vertical axis) in 1998, as well as the relative size of each country's population. With the exception of Ireland, country pure productivity and average managerial skills are uniformly lower in developing countries (the median values of  $z^i/z^1$  and  $x^i/x^1$  are 0.63 and 0.80, respectively). Notice also that the host countries in our sample that are relatively more developed than the others (Iceland, Ireland, Israel, Portugal, and Spain), have a high  $z^i/z^1$  and  $x^i/x^1$ .

With the resulting  $z^i/z^1$  and  $x^i/x^1$  we first quantify the sources of the income difference between the developed aggregate and the average of the developing countries in the sample.

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<sup>24</sup>The BEA does not report affiliates information at least for some 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 an average of the countries in the geographic regions for which the BEA does report such information.

<sup>25</sup>For example, Desai, Foley, and Hines (2004) argue that all else equal, U.S. multinational firms invest more in low tax countries than in high tax countries. See also Gordon and Hines (2002) for a discussion of the effects of taxes on multinationals.

Using (3.9), average differences in output per capita between developed and developing countries can be decomposed as:

$$\mu_{\log[(Y^1/L^1)/(Y^i/L^i)]} = \mu_{\log[z^1/z^i]} + \mu_{\log[x^1/x^i]} + \mu_{\log[\chi^1/\chi^i]} + \mu_{(1-\nu)\log(1-s^i)} + \mu_{\alpha\nu\log[(K^1/L^1)/(K^i/L^i)]} ,$$

where  $\chi^i \equiv \xi^i(\bar{e}^i)^{1-\nu} F(\bar{e}^i)^{(1-\alpha)\nu}$  and  $\chi^1 \equiv [m^1\xi^1(\bar{e}^1)]^{1-\nu} F(\bar{e}^1)^{(1-\alpha)\nu}$ . We use  $\mu$  to indicate the average of the statistic in the subscript across the developing countries in our sample. We report the results for 1988, 1998, and for the cumulative growth between those two years in the top panel of Table 5. Also, for 1998 we report the results under our four alternative assumptions on effective taxes, as well as the results from assuming a fixed proportion of homogeneous managers in the population of each country.

Two conclusions arise from these results. First, developed countries have a higher country pure productivity, better managers, and more capital per capita than developing countries. In 1998, the fraction of the higher output per capita in developed countries relative to developing countries accounted for by higher country pure productivities, higher managerial ability, and higher capital per person, is 46%, 18%, and 40%, respectively. Table 5 shows that these conclusions are similar in our two sample years, and are also quite robust to assumptions on the distribution of managerial idiosyncratic skills, and to our alternative assumptions on the effective taxes faced by multinational firms. This is reassuring, given the difficulty to precisely assess the relevant taxes for our experiments.

A second conclusion relates to the growth differences between developed and developing countries between 1988 and 1998. Table 5 shows that developed countries grew 2.4% faster than developing countries during this period. The main force driving the higher growth rates in developed countries is a faster pure productivity growth. On the other hand, developing countries caught up in terms of the quality of their managers and also in terms of their capital per capita. The latter might be associated with technological spillovers from a higher presence of multinational firms in developing countries during the period. Moreover, the increased presence of multinationals from developed countries had the direct impact of reducing the gap in the growth rates by 39%.

Differences in output, productivity, and capital levels are large between developed and developing countries (an average of 114%). But, even within the group of developing countries, there is significant variation in output per capita (the standard deviation of the log of this variable is 63%). We now turn to examining those differences.

Figure 1 shows that country pure productivities  $z^i/z^1$  vary much more than average

managerial skills,  $x^i/x^1$ . The standard deviations of the logarithm of  $z^i/z^1$  and  $x^i/x^1$  are 32% and 11%, respectively. These two components of observed productivity have a high correlation, equal to 0.88. In terms of the components in expression (4.3),  $\rho(x^i, \tau_F^i) = -0.53$  and  $\rho(x^i, s^i) = -0.17$ .

To decompose variation in output per person differences, we follow Klenow and Rodríguez-Clare (1997). Using expression (3.9), the variance of the logarithm of output per person is:

$$\begin{aligned} \text{var}(\log Y^i/L^i) &= \text{cov}[\log Y^i/L^i, \log z^i] + \text{cov}[\log Y^i/L^i, \log x^i] + \text{cov}[\log Y^i/L^i, \log \chi^i] \\ &\quad + \text{cov}[\log Y^i/L^i, \log (1/(1-s^i))^{1-\nu}] + \text{cov}[\log Y^i/L^i, \log (K^i/L^i)^{\alpha\nu}] \end{aligned}$$

The bottom panel of Table 5 displays the results. Consistent with Klenow and Rodríguez-Clare (1997), we find that capital per person is important but not the leading factor underlying the variation in output per person. It accounts for 39% of output per capita variation in 1988, 36% in 1998, and only explains 27% of the growth between 1988 to 1998. Not surprisingly, productivity is the leading factor behind output per person cross-country differences. Variation in  $\log(x)$  and  $\log(z)$  jointly account for 65% of the within-developing countries variation in the logarithm of output per capita in 1998. Pure productivity is the main factor, accounting for 74% of the variation in  $\log(zx)$ . Nevertheless, differences in managerial ability still account for a sizable 26% of productivity differences. Again, the results are quite robust to alternative ways of measuring  $\tau_F^i$  and assumptions on the within-country distribution of skills.

We now use the model to analyze the output and welfare implications of various policy changes.

## 6. Policy Experiments

In this section we quantitatively assess the output and welfare implications of changes in the barriers to the international mobility of managers. We consider two types of experiments: (i) *unilateral*: one country changes its tax rate  $\tau_F^i$ , and all other countries' tax rates remain unchanged, and (ii) *global*: all countries change their tax rates simultaneously.

We examine the implications of these experiments in two different starting points. In the first scenario, there are no foreign managers ( $\tau_F^i = 100\%$ ), capital, labor, and corporate tax rates are equal to zero, and each country starts on its balanced growth path. We then reduce  $\tau_F^i$  to zero. These experiments serve to quantify the effects of removing barriers to foreign

managers abstracting from the role of the initial capital stock, the initial level of  $\tau_F^i$ , and other distortionary taxes. In the second scenario, each country starts with the benchmark tax rates (capital, labor, corporate, and those on foreign managers' profits). All countries start with their 1998 actual capital stock, as measured by the perpetual inventory method. The initial share of capital controlled by foreign managers is equal to the actual 1998 share for each country. We then reduce  $\tau_F^i$  to zero.

In all the experiments we use the same values of  $x^i$  and  $z^i$ . They are those values obtained from the mapping induced by the model, as described above, using actual 1998 capital stocks and shares of capital controlled by foreign firms, and the benchmark tax rates.

We compute the steady state output gains and the equivalent variation in consumption of these policy changes. The equivalent variation measures the percentage change in the initial consumption path that makes consumers indifferent between the old and new policies. In the experiments we account for transitional dynamics and world general equilibrium effects on  $\pi^1$ .

**From  $\tau_F^i = 100\%$  to  $\tau_F^i = 0\%$**

### Unilateral

Columns 1-4 in Table 6 report the results. Under no technology diffusion ( $\zeta = 0$ ), the median output and welfare gains are 12.3% and 1.6%, respectively. The means are 13.4% and 3.1%.<sup>26</sup> There is also significant variation in the response across countries, which is driven by the dispersion in  $x^i$  and  $z^i$  in the countries of the sample. This can be understood as follows. Using expressions (3.7) and (3.9), and holding constant  $\bar{e}^i$  and  $\pi^1$ , the gain in output across the balanced growth paths for host countries that receive foreign managers is proportional to  $(z^i)^{\frac{1-v}{\nu(1-\alpha)(1-\alpha\nu)}} / (x^i)^{\frac{1}{1-\alpha\nu}}$ . Countries with higher pure productivity  $z^i$  and lower ability managers  $x^i$  gain more by attracting more foreign managers, as already illustrated in our two country example in Section 3. Interestingly, even after the reduction in  $\tau_F^i$  from 100% to 0%, six countries in our sample do not receive foreign firms. They are unattractive to foreign managers because of their high  $x^i$  (Iceland, Israel, Singapore, and Spain), because of their low  $z^i$  (Jamaica) or a combination of both (Thailand).

The welfare gains are much higher (the median is 9.7%) and dispersed (the standard

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<sup>26</sup>As a robustness check, we recompute the welfare gains using  $x^i$  and  $z^i$  inferred under the assumption that  $\tau_F^i = \tau_D^1$ . We find that the median welfare gain is remarkably stable, and that the mean welfare gain falls from 3.1% to 1.9%.

deviation is 13.5%) when there is full technology diffusion from foreign to domestic managers ( $\zeta = 1$ ).

### Global

We now consider the case where all developing countries simultaneously reduce  $\tau_F^i$  from 100% to 0%. Results are reported in columns 5-8 in Table 6. Under no technology diffusion the median output and welfare gains are 5.9% and 0.4% respectively. With technology diffusion the gains are much higher (medians of 10% and 8.8% and means of 12.3% and 11.8% for output and welfare respectively).

The gains are considerably smaller than under unilateral reductions in  $\tau_F^i$ . With global tax changes, developing countries compete with each other, increasing  $\pi^1$  by more than under unilateral tax changes. As in the previous case, countries with lower  $x^i$  and higher  $z^i$  gain more from the policy change.

Output in country 1 falls by 7.5% with no diffusion. This results from managers being exported and from a reduction of the capital stock. Still, higher earnings from managers operating abroad implies that welfare increases by 0.5%. With diffusion, the welfare and output gains for country 1 are negligible.

Finally, world output (developed+developing countries) increases by 1.7% under no technology diffusion and 8.9% under technology diffusion.

Note that  $\tau_F^i = 0$  is not necessarily optimal for the developed country. The individual location decisions of its managers do not internalize their effects on the profits of other managers. Then,  $\tau_F^i > 0$  might be preferred to  $\tau_F^i = 0$ .<sup>27</sup> We will then see that this effect, together with interactions with capital and corporate taxes, might imply that welfare falls in the developed country after a reduction in  $\tau_F^i$  by all countries.

**From actual  $\tau_F^i$  to  $\tau_F^i = 0\%$**

### Unilateral

Columns 1-4 in Table 7 report the results. Median output and welfare gains are 12.5% and 2.3% under no technology diffusion (they are 13.5% and 13.1% under technology diffusion).

As in the previous experiments, there is a large dispersion in the magnitude of the gains. In this case there are two additional factors beyond the dispersion in  $x^i$  and  $z^i$ . First,

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<sup>27</sup>The government in country 1 would like to restrict export of its managers. This can be achieved by either taxing the profits of its managers leaving the country (an instrument not considered here) or by subsidizing those remaining ( $\tau_1^D < 0$ ).

countries with a higher initial level of  $\tau_F^i$  gain more by reducing  $\tau_F^i$  to zero. Second, countries with a higher  $\tau_K^i$  gain more from reducing  $\tau_F^i$  which increases the return on capital. Overall, all but four countries gain from reducing  $\tau_F^i$ .<sup>28</sup>

### Global

Gains for developing countries are smaller than in the unilateral case because of increasing competition to attract foreign managers (columns 5-8 of Table 7). The median output growth is 5.7% and the median welfare gain is 0.5% without technology diffusion (9% and 7.6%, under full technology diffusion). Under no technology diffusion, output and welfare in the developed country fall by 8.7% and 0.7%, respectively, due in part to the interaction with other distortions that are present in the model.

### Comparison with Other Experiments

Technology developments (e.g: improvements in communications, transportation, and information) may foster the presence of multinational firms. We can extend our model to analyze those changes. Consider that the output of a manager with skill  $x$  from country 1 operating in country  $i \neq 1$  is:

$$\theta z^i x [k^\alpha n^{1-\alpha}]^v,$$

where  $\theta \leq 1$ , represents the loss of efficiency suffered by a firm operating in a foreign country. It captures geographical, linguistic, regulatory, and cultural barriers not faced by domestic firms, which may be reduced by technology advances. Without a doubt, these barriers vary across countries and their measurement remains an open empirical question.<sup>29</sup> Here we aim to assess the output and welfare implications of such technological advances.

We recompute  $x^i$  and  $z^i$  for each country in 1998 assuming that  $\theta = 0.95$ , with the 1998 capital stocks and benchmark tax rates. When we increase  $\theta$  to 1 for all countries simultaneously, the median output and welfare gains for developing countries are 9.3% and 4.1%, respectively. Clearly, output and welfare are more sensitive to changes in these technology developments than to taxes on multinational profits.

It is also useful to compare the welfare gains from changes in  $\tau_F^i$  with other experiments that have been studied in the literature. We first consider an individual reduction in capital

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<sup>28</sup>Thailand is the country with the biggest welfare loss. This result from the large subsidy to capital we obtain from the very high investment rates between 1990 and 1997.

<sup>29</sup>In reality,  $\theta$  also depends on the source country of foreign managers, leading to regional concentration of FDI (i.e.: U.S. being the main source country of foreign firms in South and Central America, Western Europe in Eastern Europe, etc.). A full parametrization of source/host specific  $\theta$ 's using bilateral FDI data is left open for future work.

tax rates from their actual levels to 0, starting from a balanced growth path with no foreign managers in developing countries ( $\tau_F^i = 100\%$ ). The median welfare gain for developing countries is of 1.6% .

Finally, consider the gains of financial integration. As Gourinchas and Jeanne (2003), we consider the gains of unilaterally moving from financial autarky (no borrowing or lending) to full financial integration. We take taxes and capital stocks in 1998 as the starting point. The median welfare gain for developing countries is 0.46%, a number comparable to that of Gourinchas and Jeanne. If in addition each country reduces  $\tau_F^i$  to zero, then the incremental value of financial integration rises to 0.79%. The gains are higher because countries require more capital and borrowing allows countries to adjust faster to the new balanced growth path.

Clearly, even if there is no technology diffusion from foreign to domestic managers, the gains of allowing foreign firms (reducing  $\tau_F^i$  from 100% to 0%) are larger than the latter two policies which have been studied more extensively in the literature.<sup>30</sup>

## 7. Concluding remarks

In this paper we construct a multicountry span of control model with international mobility of managers 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 (managerial skills) and components that are fixed in each country (pure productivities). Based on this decomposition, we found significant output and welfare gains of policies that enhance the international mobility of firms.

Our analysis highlights the importance of spillovers from foreign firms for the gains of international mobility of firms. Other spillover mechanisms can be analyzed within our framework. For instance, foreign firms could foster the formation of worker skills or improve the infrastructure and regulation of host countries. Then the spillovers would be on the country's pure productivity, potentially generating even larger output and welfare gains. Another possibility is to consider a case where the engine of global growth is the exogenous innovation in the skills of developed countries. Here, the international mobility of firms will have growth effects that generate even larger welfare gains.

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<sup>30</sup>Other studies that compute welfare gains from related policy experiments include Backus, Kydland, and Kehoe (1992) who obtain benefits of financial integration stemming from risk sharing equal to 0.5%, and Mendoza and Tesar (1998) who calculate the benefit of reducing capital income taxes to less than 1%.

In future work we will go beyond a mechanic formulation of spillovers and construct a theory that explicitly considers the endogenous transfers of managerial skills across countries. Along the lines of Monge-Naranjo (2005), we will examine the accumulation of skills in a world economy where these skills are internationally mobile.

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**Figure 1: Pure Productivities and Average Managerial Skills Relative to Country 1, 1998**

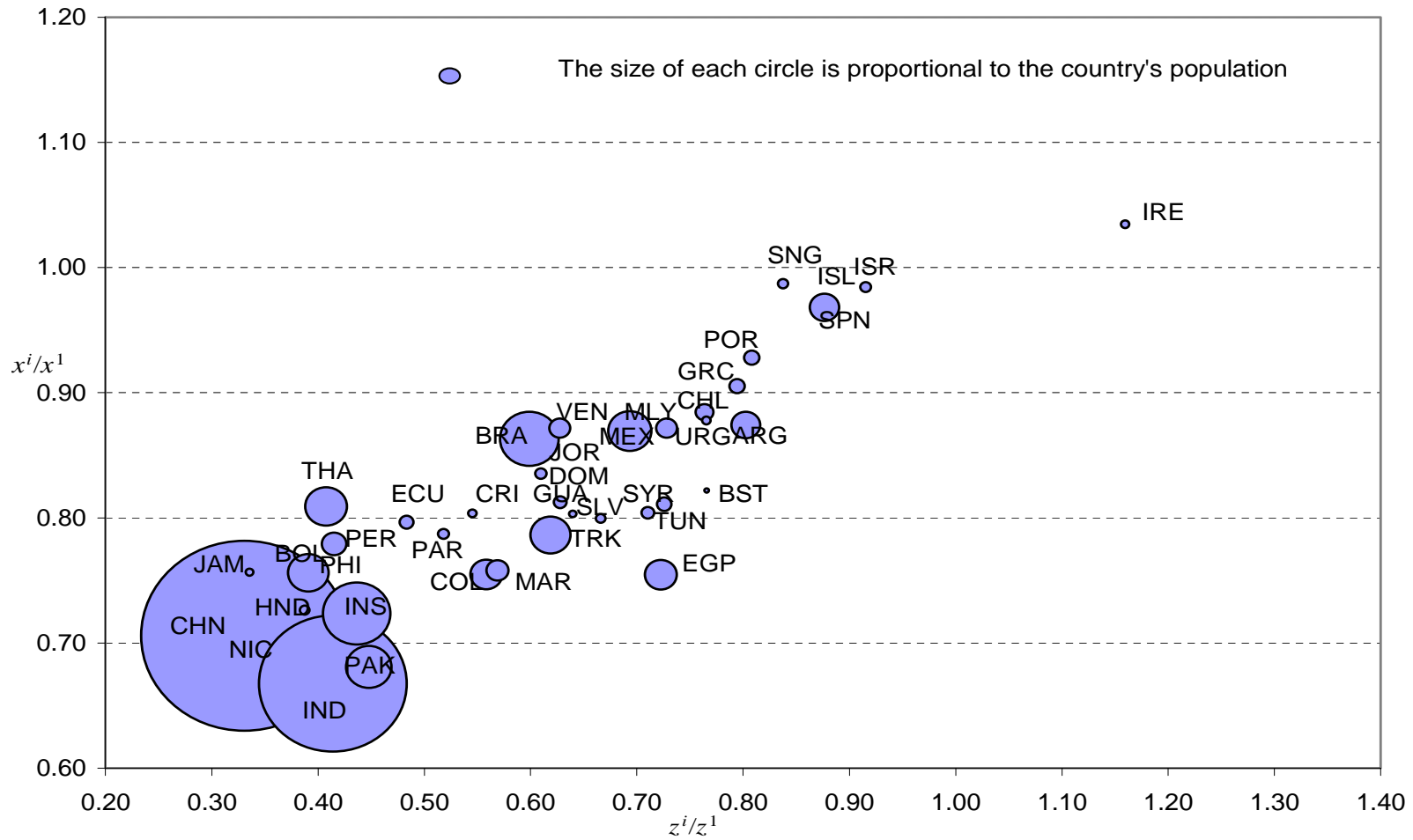


Table 1: Sources and Hosts of the World Stock of Foreign Direct Investment, Average 1995-98

COUNTRY	% of World FDI Stocks		Ratio Own Assets/Liabilities
	Assets (inward FDI)	Liabilities (outward FDI)	
Japan	10.20%	0.43%	26.59
Germany	9.10%	2.38%	4.30
Switzerland	3.52%	1.44%	2.76
Finland	0.79%	0.36%	2.55
South Africa	0.33%	0.20%	1.96
Netherlands	6.94%	4.06%	1.93
Sweden	2.76%	1.77%	1.76
United Kingdom	14.09%	10.16%	1.56
Korea	0.62%	0.48%	1.48
France	8.24%	6.53%	1.42
Italy	2.25%	1.85%	1.38
Norway	0.71%	0.58%	1.37
United States	26.26%	25.62%	1.16
Denmark	0.72%	0.72%	1.14
Canada	3.77%	4.84%	0.88
Austria	0.41%	0.60%	0.79
Israel	0.16%	0.25%	0.72
Belgium - Luxembourg	2.26%	3.64%	0.70
Iceland	0.01%	0.01%	0.52
Australia	1.45%	3.30%	0.50
Singapore	0.78%	2.20%	0.40
Spain	1.13%	3.76%	0.35
New Zealand	0.23%	0.93%	0.28
Portugal	0.14%	0.59%	0.27
Venezuela	0.10%	0.46%	0.26
Ireland	0.10%	0.44%	0.25
Chile	0.14%	0.70%	0.23
Argentina	0.22%	1.26%	0.19
Malaysia	0.23%	1.52%	0.17
Thailand	0.09%	0.75%	0.14
Brazil	0.25%	2.34%	0.12
Colombia	0.06%	0.54%	0.12
Philippines	0.04%	0.36%	0.12
China	0.61%	6.16%	0.11
Botswana	0.00%	0.03%	0.11
Jamaica	0.01%	0.08%	0.09
Indonesia	0.06%	0.81%	0.08
Turkey	0.02%	0.27%	0.07
India	0.01%	0.35%	0.04
Morocco	0.00%	0.13%	0.04
Egypt	0.01%	0.50%	0.03
Costa Rica	0.00%	0.11%	0.02
Sri Lanka	0.00%	0.05%	0.02
Bolivia	0.00%	0.07%	0.01
Tunisia	0.00%	0.16%	0.00
Dominican Republic	n.a.	0.10%	n.a.
Ecuador	n.a.	0.15%	n.a.
El Salvador	n.a.	0.02%	n.a.
Guatemala	n.a.	0.09%	n.a.
Mexico	n.a.	2.74%	n.a.
Paraguay	n.a.	0.04%	n.a.
Peru	n.a.	0.36%	n.a.
Syria	n.a.	0.02%	n.a.
Uruguay	n.a.	0.05%	n.a.

Source: Lane and Milesi-Ferretti (2001)

**Table 2: Welfare gains from managerial international mobility in two country model**

CASE A:  $L^1 = L^2$

COUNTRY 1				COUNTRY 2					
$z^2/z^1$				$z^2/z^1$					
0.6    0.8    1				0.6    0.8    1					
$x^2/x^1$	0.7	0.5	1.5	3.0	$x^2/x^1$	0.7	9.0	13.9	17.6
	0.8	0.1	0.8	1.9		0.8	1.4	3.9	6.2
	0.9	0.0	0.1	0.7		0.9	0.0	0.3	1.2

CASE B:  $L^1 = 100L^2$

COUNTRY 1				COUNTRY 2					
$z^2/z^1$				$z^2/z^1$					
0.6    0.8    1				0.6    0.8    1					
$x^2/x^1$	0.7	0.0	0.0	0.0	$x^2/x^1$	0.7	12.6	21.3	29.4
	0.8	0.0	0.0	0.0		0.8	2.3	7.3	12.7
	0.9	0.0	0.0	0.0		0.9	0.0	0.7	3.2

The experiment is a reduction in  $\tau_F^2$  from 100% to 0%, with both countries starting in a balanced growth path.

Parameter values:  $\alpha = 1/3$ ,  $\nu = 0.85$ ,  $\delta = 0.06$ ,  $\beta = 0.96$ ,  $\zeta = 0$

The fraction of workers in each country is kept constant.

Welfare gains are computed as the equivalent variation in consumption

**Table 4: Shares, taxes, and productivities, 1998**  
(percentages)

	$s^i$	$\tau_K^i$	$\tau_F^i$	$\tau_D^i$	$z^i/z^1$	$x^i/x^1$
Argentina	7.6	19.0	43.4	35.0	0.80	0.87
Bolivia	35.6	47.3	28.2	31.4	0.40	0.71
Brazil	7.2	15.8	21.1	34.0	0.60	0.86
Chile	24.0	-7.6	23.2	16.0	0.76	0.88
Colombia	18.4	38.1	47.3	35.0	0.56	0.75
Costa Rica	25.9	16.7	25.6	30.0	0.55	0.80
Dominican R.	23.3	31.8	10.6	25.0	0.61	0.84
Ecuador	14.3	24.1	28.2	25.0	0.48	0.80
Guatemala	20.0	58.9	19.2	31.0	0.63	0.81
Honduras	7.3	14.6	34.4	30.5	0.39	0.73
Jamaica	18.4	0.4	13.9	33.3	0.34	0.76
Mexico	13.6	-0.2	30.0	35.0	0.69	0.87
Nicaragua	12.0	32.4	33.5	25.0	0.32	0.70
Peru	9.5	2.0	28.2	30.0	0.42	0.78
Paraguay	15.0	40.6	29.0	30.0	0.52	0.79
El Salvador	13.0	55.5	33.5	28.8	0.67	0.80
Uruguay	6.6	41.5	29.0	30.0	0.77	0.88
Venezuela	10.8	30.7	18.9	51.0	0.63	0.87
China	18.9	-7.7	24.3	30.0	0.33	0.71
Egypt	35.0	74.1	44.1	40.0	0.72	0.75
Indonesia	17.7	9.5	45.8	30.0	0.44	0.72
India	4.0	37.0	56.4	35.0	0.41	0.67
Israel	4.1	-46.0	21.7	36.0	0.92	0.98
Jordan	11.9	15.9	44.1	35.0	0.64	0.80
Malaysia	36.3	-38.2	26.0	28.0	0.73	0.87
Pakistan	9.2	45.7	56.4	45.0	0.45	0.68
Philippines	12.1	24.3	22.9	32.0	0.39	0.76
Singapore	22.3	-28.2	8.6	24.5	0.84	0.99
Syria	4.1	53.4	44.1	35.0	0.73	0.81
Thailand	8.9	-68.6	19.5	30.0	0.41	0.81
Botswana	13.1	27.0	47.9	25.0	0.77	0.82
Morocco	11.1	40.2	47.9	35.0	0.57	0.76
Tunisia	17.9	31.6	47.9	35.0	0.71	0.80
Spain	8.4	-21.4	25.5	35.0	0.88	0.97
Greece	4.9	-6.1	41.6	35.0	0.79	0.91
Ireland	13.8	-1.3	8.8	16.0	1.16	1.03
Iceland	3.1	-18.2	20.9	18.0	0.91	0.99
Portugal	8.9	-23.6	27.2	40.0	0.81	0.93
Turkey	2.8	-3.5	52.2	40.0	0.62	0.79
Median	12.1	16.7	28.2	31.4	0.63	0.80
Average	14.1	14.3	31.6	31.7	0.62	0.82

Table 5: Accounting for Cross-Country Differences in Output per Worker

<i>Difference between Developed vs. Developing Countries</i>								
		$\mu_{\log}[(Y^1/L^1)/(Y^i/L^i)]$	Country 1- Mean Country i /			$\mu_{\log}[(Y^1/L^1)/(Y^i/L^i)]$		
			$\log(Y/L)$	$\log(z)$	$\log(x)$	$\log(1-s)^{1-\nu}$	$\log \chi$	$\log(K/L)^{\nu\alpha}$
1998	$\tau_i^E = \tau_i^F$	114.4%	100.0%	45.6%	17.7%	-2.1%	-1.0%	39.9%
	$\tau_i^E = \max\{\tau_i^F, \tau_i^D\}$	114.4%	100.0%	44.8%	18.4%	-2.1%	-1.0%	39.9%
	$\tau_i^E = \min\{\tau_i^F, \tau_i^D\}$	114.4%	100.0%	46.9%	16.4%	-2.1%	-1.1%	39.9%
	$\tau_i^E = \tau_i^D$	114.4%	100.0%	46.1%	17.1%	-2.1%	-1.0%	39.9%
	Fixed fraction of homogeneous managers	114.4%	100.0%	44.6%	18.7%	-2.1%	-1.1%	39.9%
1988		112.0%	100.0%	43.0%	19.6%	-1.3%	-0.2%	38.9%
Growth 88-98		2.4%	100.0%	166.6%	-72.5%	-38.5%	-40.7%	85.1%
<i>Variation Within Developing Countries</i>								
		$var(\log Y^i/L^i)$	$cov[\log Y^i/L^i, w]/var(\log Y^i/L^i)$					
			$\log Y^i/L^i$	$\log z^i$	$\log x^i$	$w = \log(1/(1-s^i))^{1-\nu}$	$\log \chi^i$	$\log(K^i/L^i)^{\nu\alpha}$
1998	$\tau_i^E = \tau_i^F$	0.40	100.0%	48.1%	16.7%	-0.3%	0.0%	35.5%
	$\tau_i^E = \max\{\tau_i^F, \tau_i^D\}$	0.40	100.0%	48.7%	16.1%	-0.3%	0.0%	35.5%
	$\tau_i^E = \min\{\tau_i^F, \tau_i^D\}$	0.40	100.0%	49.0%	15.9%	-0.3%	0.0%	35.5%
	$\tau_i^E = \tau_i^D$	0.40	100.0%	49.6%	15.2%	-0.3%	0.0%	35.5%
	Fixed fraction of homogeneous managers	0.40	100.0%	48.0%	16.8%	-0.3%	0.0%	35.5%
1988		0.37	100.0%	41.6%	19.7%	0.0%	0.0%	38.6%
Growth 88-98		0.06	100.0%	60.3%	12.6%	0.3%	0.0%	26.9%

Table 6: From  $\tau_i^i = 100\%$  to  $\tau_i^i = 0$   
 Percentage change in output and welfare under various experiments

	1	2	3	4	5	6	7	8
	UNILATERAL				GLOBAL			
	No diffusion		With diffusion		No diffusion		With diffusion	
	Output	Welfare	Output	Welfare	Output	Welfare	Output	Welfare
Argentina	15.8	2.7	10.6	9.7	10.1	1.1	10.6	9.6
Bolivia	20.7	4.6	31.4	31.9	15.0	2.4	24.9	24.5
Brazil	2.5	0.1	2.1	1.8	0.0	0.0	1.8	1.5
Chile	11.2	1.3	7.2	6.5	4.8	0.2	7.2	6.3
Colombia	25.1	6.9	28.9	29.1	19.9	4.3	25.0	24.6
Costa Rica	12.6	1.7	13.7	12.7	6.2	0.4	8.3	7.4
Dominican Republic	10.7	1.2	9.9	9.0	4.2	0.2	7.5	6.7
Ecuador	7.8	0.6	9.4	8.6	1.1	0.0	7.9	6.9
Guatemala	17.6	3.3	16.8	15.9	11.7	1.4	12.3	11.3
Honduras	14.7	2.3	22.6	21.9	8.5	0.7	14.4	13.4
Jamaica	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Mexico	9.2	0.9	6.8	6.1	2.9	0.1	6.3	5.5
Nicaragua	12.3	1.6	22.0	21.3	5.9	0.4	11.7	10.8
Peru	3.9	0.2	5.4	4.8	0.0	0.0	5.0	4.3
Paraguay	13.9	2.1	16.2	15.3	7.7	0.6	10.0	9.1
El Salvador	23.4	6.0	22.0	21.4	17.9	3.4	18.4	17.6
Uruguay	12.8	1.7	8.3	7.5	6.5	0.4	8.3	7.4
Venezuela	3.2	0.1	2.5	2.2	0.0	0.0	2.2	1.9
China	10.1	1.1	18.2	17.2	5.7	0.3	11.0	10.0
Egypt	36.2	14.6	34.6	36.2	31.7	11.1	32.8	33.8
Indonesia	20.8	4.7	29.5	29.7	15.6	2.6	24.1	23.6
India	30.1	10.0	45.8	50.4	27.6	8.3	43.8	47.7
Israel	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Jordan	20.7	4.6	19.9	19.2	15.0	2.4	15.8	14.9
Malaysia	11.5	1.4	8.0	7.2	5.2	0.3	7.4	6.6
Pakistan	32.5	11.7	45.2	49.6	27.8	8.5	41.8	45.1
Philippines	6.9	0.5	10.3	9.4	0.1	0.0	10.0	8.8
Singapore	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Syria	24.9	6.7	21.4	20.8	19.5	4.1	18.3	17.5
Thailand	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Botswana	25.0	6.8	20.1	19.4	19.6	4.1	17.5	16.6
Morocco	25.3	7.0	28.6	28.8	20.0	4.3	24.7	24.3
Tunisia	25.3	7.0	22.5	22.0	20.0	4.3	19.4	18.6
Spain	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Greece	8.6	0.8	5.4	4.8	1.9	0.0	5.4	4.7
Ireland	1.2	0.0	3.9	-2.8	0.0	0.0	3.9	-2.6
Iceland	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Portugal	4.2	0.2	2.6	2.2	0.0	0.0	2.6	2.1
Turkey	22.6	5.5	23.1	22.6	17.4	3.2	19.4	18.5
Developed aggregate					-7.5	0.5	0.0	0.0
Total (developed + devoping)					1.7		8.9	
Median developing	12.3	1.6	10.6	9.7	5.9	0.4	10.0	8.8
Average developing	13.4	3.1	14.7	14.4	9.0	1.8	12.3	11.8
Standard deviation developing	10.3	3.6	12.5	13.5	9.3	2.7	11.1	11.9

Table 7: From Actual  $\tau_F^i$  to  $\tau_F^i = 0$   
 Percentage change in output and welfare under various experiments

	1	2	3	4	5	6	7	8
	UNILATERAL				GLOBAL			
	No diffusion		With diffusion		No diffusion		With diffusion	
	Output	Welfare	Output	Welfare	Output	Welfare	Output	Welfare
Argentina	20.1	5.6	14.3	13.6	13.9	2.9	14.0	13.1
Bolivia	12.5	3.7	15.2	15.3	6.0	0.6	8.3	8.1
Brazil	7.8	1.0	6.8	6.3	0.7	0.0	5.3	4.7
Chile	9.7	1.0	7.0	6.3	3.3	-1.2	6.7	5.9
Colombia	23.8	9.0	23.3	24.3	17.9	5.5	19.5	19.9
Costa Rica	11.3	2.2	10.1	9.7	4.7	-0.2	5.3	4.9
Dominican Republic	4.3	0.7	2.8	2.7	-2.7	-1.3	3.9	3.6
Ecuador	11.5	2.2	13.0	12.4	4.3	0.5	7.1	6.6
Guatemala	8.6	2.3	7.9	7.8	1.5	-0.1	3.7	3.4
Honduras	16.2	3.8	21.9	22.5	9.7	1.2	14.3	14.2
Jamaica	6.3	0.4	8.0	7.3	0.0	0.0	-1.5	-1.3
Mexico	13.5	2.1	9.4	8.8	7.2	0.2	9.2	8.3
Nicaragua	14.0	3.5	24.5	25.1	7.1	1.2	16.2	15.8
Peru	11.6	1.5	15.0	14.1	4.5	0.2	8.2	7.5
Paraguay	13.8	3.7	14.0	13.8	6.8	1.3	7.9	7.6
El Salvador	15.6	5.4	14.9	15.2	9.2	2.1	10.5	10.4
Uruguay	12.5	3.2	8.8	8.4	5.4	1.0	8.5	8.0
Venezuela	5.6	0.9	5.7	5.2	0.0	0.0	3.1	2.7
China	8.5	0.4	14.7	14.6	3.8	-1.2	7.2	6.9
Egypt	21.1	9.5	17.9	18.7	15.3	5.5	14.5	14.8
Indonesia	21.9	6.3	26.2	27.3	16.4	3.3	21.7	22.1
India	27.5	11.9	36.2	41.4	23.8	9.1	32.8	36.9
Israel	9.8	-0.7	9.8	-0.6	2.8	-0.9	9.5	-0.7
Jordan	21.6	6.6	18.1	18.3	15.5	3.3	15.1	14.9
Malaysia	10.6	-0.2	8.0	6.7	4.5	-2.2	7.7	6.3
Pakistan	29.8	14.0	39.8	45.9	24.3	9.8	35.8	40.4
Philippines	10.5	2.0	13.5	13.1	3.3	0.4	5.2	4.8
Singapore	3.8	-0.2	3.7	-0.1	-1.4	0.0	3.4	-0.2
Syria	21.5	8.4	19.2	19.9	15.3	4.9	15.4	15.6
Thailand	8.7	-1.8	8.2	7.0	1.6	-0.9	6.8	5.6
Botswana	23.8	8.7	17.3	17.5	17.9	5.0	17.0	17.0
Morocco	24.5	9.6	25.2	26.6	18.5	5.9	21.1	21.8
Tunisia	23.9	8.9	18.4	18.7	18.1	5.2	15.4	15.4
Spain	10.7	0.4	10.2	2.8	3.8	-0.1	10.0	2.7
Greece	17.1	2.8	12.7	10.9	10.5	0.9	12.4	10.5
Ireland	3.7	0.1	3.3	0.1	-3.6	-0.8	3.0	0.0
Iceland	9.1	0.3	9.4	1.0	1.7	-0.1	9.0	0.8
Portugal	12.5	0.7	9.4	5.6	5.7	-0.5	9.0	5.4
Turkey	26.3	8.0	18.9	19.3	20.9	4.7	16.0	16.0
Developed aggregate					-8.7	-0.7	-0.4	-0.1
Total (developed + devoping)					-0.2		6.3	
Median developing	12.5	2.3	13.5	13.1	5.7	0.5	9.0	7.6
Average developing	14.5	3.8	14.4	13.7	8.2	1.7	11.2	10.3
Standard deviation developing	7.1	3.9	8.3	10.4	7.6	2.9	7.6	9.2