Size, Geography, and Multinational Production*

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Abstract

This paper analyzes the cross-country allocation and volume of multinational production (MP), quantifies its costs, and impact on welfare. From the pattern of MP across countries, three facts stand out: a small fraction of country-pairs engages in MP with each other; geography is a significant impediment to these activities; and country size matters. I introduce MP in a competitive, multi-country industry model, close to Eaton-Kortum (2002), in which firms can transfer their technology abroad at a cost. Costs are fixed and country-pair specific, while technologies are country-specific. The model highlights the role of absolute advantages in determining the allocation of MP across countries, predicts zero as well as positive bilateral MP volumes, and delivers a gravity equation. Using new data on bilateral sales of affiliates, I estimate the cost of MP matching simulated and actual moments. Estimates suggest that country-pairs twice as distant have 56% higher costs, and there are large unrealized gains of lowering costs of MP, larger than the ones calculated for trade.

JEL: F2; O33; C5. Key Words: multinational production; bilateral; technology; gravity; welfare; simulated method of moments.

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1 Introduction

One of the most notable features of economic globalization has been the increasing importance of multinational production (MP) around the world. In fact, international firms have become one of the most important mechanisms through which countries exchange goods, capital, ideas, and technologies.[1] By 2001, total sales of foreign affiliates of multinational firms represented almost 60% of world GDP, more than double the share of world exports. Furthermore, over the past two decades, while exports have almost quadrupled, sales of affiliates have increased by a factor of more than seven.[2] Despite the importance of MP as a mechanism through which firms serve foreign buyers, and potentially, technologies diffuse across countries, little work has been done that describes, analyzes, and quantifies the cross-country patterns of such flow as well as its impact on welfare. This paper tries to fill that gap by analyzing the determinants of the cross-country allocation and volumes of multinational activities, and quantifying the welfare effects of changing barriers to such activities.

Three new facts stand out from the observed patterns of MP across countries.[3] First, only around 25% of all possible country-pairs engages in multinational activities with each other. Second, distance seems to be important for the location of such activities; remote country-pairs have substantially less, and mostly non-existent, multinational activities with each other. Third, the size of a country also matters in determining both the allocation and volume of MP; in fact, the bulk of multinational activities takes place between large economies, while the lack of them is mostly observed between small economies.

I introduce MP in a model close to Eaton and Kortum (2002)'s from which I borrow the probabilistic formulation of productivities. I modify their framework in order to incorporate

[1] Multinational activities involve activities of foreign affiliates of multinational plants in a host country, and not always take the form of Foreign Direct Investment (FDI). FDI is a financial category in the Balance of Payment of a country, and one of the mechanisms, among others, through which multinational firms fund their affiliate plants. Throughout this paper, I use indistinctly the terms multinational activities, multinational production, and FDI to refer to the activity of affiliate plants of multinational firms.

[2] See Table 1 in the paper.

[3] I construct these facts using a new data set on bilateral activities of foreign affiliates of multinational firms that I assembled using data from UNCTAD and OECD

plants' rather than goods' mobility, and to capture the facts above. Firms in an industry decide whether to transfer their home productivity and serve consumers in a foreign country by opening a plant. However, this replication is costly because firms face a fixed cost per new plant that depends on variables specific to the pair of trading countries, such as geographical distance, regulations, and cultural factors, some of which are observable while others are not. A plant's technology is then defined by a productivity parameter and the fixed cost. Moreover, all firms in an industry from the same country of origin have the same technology, and countries are also heterogenous in size. Hence, in this model, the sources of heterogeneity are given at the country and country-pair level, not at the firm or plant level.

Once established in a foreign market, affiliate plants produce using local labor, sell output exclusively in the host market, and eventually, repatriate profits to the home economy.

Similarly to the model in Hopenhayn (1992), the model in this paper is one where industries are competitive, with decreasing returns to scale and a fixed cost at the plant level, but constant returns to scale at the industry level. Consequently, firms from the country with the most efficient technology are the only suppliers in a given foreign industry (i.e. firms with the lowest minimum average cost).

One insight of the model is the role of absolute advantages in determining the allocation of MP across countries. While the allocation of trade in goods between countries is driven by comparative advantages, the allocation of trade in technologies or ideas between countries is driven by absolute advantages. The intuition is as follows: since firms are able to transfer their home technology to their affiliates, and theses affiliates carry production in the foreign market by employing local inputs, as long as input prices are uniform across plants of any origin, input costs do not matter in determining which plants produce in that host market, but only how efficient technologies from different origins are. Hence, the link between wages and technologies present in the Ricardian mechanism of comparative advantages disappears. [4]

The model delivers implications regarding the patterns of MP across countries that, in turn,

[4] David Ricardo (1817) first noted that if capital were allowed to freely move instead of goods, absolute rather comparative advantages would regulate such flows.

are used to quantify the model. First, this model is consistent with zero MP flows between some country-pairs as observed in the data. A country j might have inefficient technologies in every single industry and not be able to produce in country i. Second, because of the presence of heterogenous bilateral fixed costs, the model predicts two-way as well as one-way positive MP flows between country-pairs, also observed in the data. Finally, as suggested by the stylized facts, the model generates a gravity equation for sales of affiliate plants of firms from country j in i, according to which positive volumes are proportional to countries' technology and size, dampened by bilateral barriers.

I assemble detailed data on the activity of affiliate plants from country j in i to quantify the magnitude of barriers to MP, and calculate welfare gains from eliminating them. The data set I constructed includes variables such as bilateral sales of affiliate plants, as well as other measures of bilateral multinational activities and FDI, for OECD and non-OECD countries, from 1990 to 2002.

Regarding the empirical strategy, the presence of bilateral fixed costs and zero volumes does not allow one to apply linear regression methods to consistently estimate the model parameters. Hence I estimate them using an indirect inference procedure that deals with biases typically present in linear estimates of gravity equations.

It turns out that distance is the most important impediment to MP: country-pairs twice as distant face a 56% lower share of sales of affiliates from country j on income of country i. Variables such as bilateral corporate tax rates have a small impact on the bilateral cost of multinational activities. Regarding welfare, estimates suggest that the average real income loss of going to autarky for a country would be of more than 4%, ranging from 2% for the United States, to 10% for Sri Lanka. Conversely, average real income gains of lowering barriers to a uniform level across plants of different origins would be more than 30%. Moreover, if the EU further liberalized MP among its members, it would experience an increase in real income of more than 20%, while further liberalization within NAFTA would increase real income among its members by more than 7%. All these numbers are much higher than the ones calculated for trade flows. [5]

[5] Eaton and Kortum (2002) calculate that welfare losses of going to trade autarky are 3.5% for OECD countries

Previous literature has typically examined the determinants of trade volumes across countries using mostly a gravity approach.[6] This approach has been very successful in fitting bilateral trade flows, with increasingly accurate estimates of the size of trade barriers, and their impact on welfare.[7] However, to my knowledge, there is no study that introduces bilateral sales of affiliates of multinational firms into a model that delivers gravity, and is used to quantitatively evaluate gains from openness. This paper shows a way to do so using a framework close to Eaton and Kortum (2002), and Alvarez and Lucas (2004).

This paper contributes to two strands of the international literature: the one related to multinational firms and FDI; and the one related to technology transfer and diffusion that is also linked to the industrial organization and growth literature.

In fact, MP can be intended as a mechanism through which diffusion of technologies across countries takes place. In particular, diffusion in this paper occurs through immediate but costly replication of technologies. The cost of transmission depends on "gravity" variables such as distance between countries. Estimates of these costs indicate that the incentives to replicate technologies vary significantly across countries, and that geographical distance plays an important role in these decisions.[8] Moreover, since welfare gains from lowering the cost to MP seem to be large, the gains of reallocating production by replicating technologies across countries might also be large.[9]

Regarding the international trade literature, it has typically equated gains from trade with overall gains from openness. But, trade is only one possible channel through which countries interact, and the gains from openness can be much larger than the gains from trade. Rodriguez-

(0.8% for the United States); the comparable number for MP is 4.4%. Analogously, gains from eliminating barriers to trade are 20%, and 30% for MP, for the same group of countries.

[6]See Anderson and Van Wincoop (2003).

[7]See Eaton and Kortum (2002).

[8]This finding on the importance of geography in MP location decisions seems in line with the finding on retail chains, such as Wal-Mart (see Holmes 2006).

[9]In this line, the work of Burstein and Monge (2005) is close to this paper in that they analyze the allocation of multinational activities across countries and derive welfare implications. However, in their paper, a firm is equivalent to a managerial ability, and the scarcity of managers creates a constraint that makes replication of technologies across countries rivalrous.

Clare (2006) shows that once we add diffusion of ideas into an Eaton-Kortum model of trade, the implied gains from trade are lower but the overall gains from openness are much larger.[10] He concludes that the role of diffusion of ideas seems to be much more important than trade in accounting for the gains from openness. MP is surely one mechanism through which diffusion of ideas and technologies between countries takes place. Hence, even though this paper does not allow for competing alternatives to MP such as trade, it can be seen as a first step toward understanding and quantifying the importance of this diffusion mechanism and its impediments in evaluating the gains from openness, as well as an alternative benchmark to models with only trade.[11]

Regarding the empirical framework, studies which incorporate countries that do not trade with each other are rare in the international trade and FDI literature, with the notable exception of Helpman, Melitz and Rubinstein (2004), Silva and Tenreyro (2005), for trade flows, and Razin, Rubinstein and Sadka (2003), for FDI flows. Those papers incorporate zero bilateral trade/FDI flows and correct for biases present in linear estimates of gravity equations. This paper also incorporates MP bilateral zero flows, but it deals with them using a moment-based estimation procedure.

The paper is organized as follows. Section 2 presents the stylized facts on bilateral multinational activities. Section 3 develops the theory and its implications. Section 4 presents the empirical framework. Section 5 shows estimates of the model's parameters, and welfare. Section 6 concludes.

[10] He shows that calibrating Eaton-Kortum model to match observed trade flows delivers very low growth rates for OECD countries. Conversely, calibrating the model to match observed growth rates, delivers much higher trade volumes than the ones observed between OECD countries.

[11] Besides, the MP benchmark is useful to evaluate gains from openness for most service sectors where the only way of serving foreign markets is by setting up local operations through FDI or licensing. In fact, FDI in services sectors has grown more rapidly than FDI in other sectors, representing in some countries, 80% of total FDI stocks. However, international transactions in goods still rely on FDI much more than on trade, and much more so than international transactions in services (World Investment Report, 2004).

2 Cross-Country Facts on Multinational Production

International production has become increasingly important in the last decades of the twentieth century, as the mechanism through which countries exchange goods, capital and technologies.

	Value at Current Prices (billions of dollars)				Growth (per cent)
	1982	*1990*	*1996*	*2001*	*82-01*
World GDP	11,758	22,610	29,024	31,900	5.3
World sales of foreign affiliates	2,765	5,727	9,372	18,517	10.0
as % of world GDP	24	25	32	58	
World exports*	2,247	4,261	6,523	7,430	6.3
as % of world GDP	19	18	22	23	
World exports of foreign affiliates	730	1,498	1,841	2,600	6.7
as % of sales of affiliates	26	26	20	14	

(*): goods and non-factor services.

Table 1: World International Production and Trade. Source: UNCTAD (WIR, 2004).

Table 1 shows world totals for GDP, sales of foreign affiliates of multinational firms, and exports, for the period 1982-2001. While world exports have represented between 19% and 23% of world GDP during these period, total sales of foreign affiliates of multinational firms have increased from 24% of world GDP in 1982, to 58% in 2001. Moreover, over the period 1982-2001, while GDP and exports grew at an average annual rate of around 5% and 6%, respectively, sales of foreign affiliates did it at more than 10% per year. Meanwhile, the share of world exports of affiliates in world sales of affiliates, has been decreasing in the last two decades, reaching 14%, in 2001. These magnitudes suggest that not only multinational production is the most important mode through which firms serve foreign consumers, as opposite to exports, but also that "horizontal FDI" remains much more important than "vertical FDI".

The data set that I introduce in this paper includes six bilateral measures of FDI and international production. In particular, I record FDI stocks and flows from country j in country i, as measured in the balance of payment of countries, and, more importantly, variables related to the activity of affiliates of firms from country j in country i: sales, number of plants, employment, and assets. Additionally, OECD and non-OECD countries with population over one million are included. Observations are averages over the period 1990-2002. The main information source is published and unpublished data from UNCTAD.

(Data details are in Appendix A).

In what follows, let country-pairs be classify according to their MP status: country-pairs with some multinational activity in both directions, country-pairs with activities in only one direction, and country-pairs that do not have any multinational relationship with each other. I consider that country j has MP activities in country i if at least one of the six variables recorded in the database is positive. On the contrary, a country j is considered to have zero production activity in country i, if *all* six measures are missing values or zeros.

Table 2 shows that among the 151 countries in the sample, there are 22,650 possible bilateral country-pairs of which only 3,810 have an FDI relationship. In particular, 77% of all possible country-pairs do not engage in any FDI activity, during the 90s'; the comparable figure for international trade is around 50% for the mid-nineties.[12] Since engaging in a FDI relationship implies a significant participation in the ownership of either a preexistent or new plant abroad, unlike international trade flows, the nature of the FDI relationship makes it implausible to attribute such a high fraction of zeros to a statistical problem, that either bunches small flows in an "other" category, or does not compute them at all.

Table 2 also shows that, on average, the bulk of multinational activities occurs among country-pairs that have positive volumes in both direction; they are much smaller for country-pairs with positive volumes in only one direction, according to any of the measures shown. The gravity approach suggests that bilateral volumes of MP is a multiplicative function of trading partners' sizes in terms of income, dampened by barriers. One widely used variable for barriers

[12]See Helpman, Melitz and Rubinstein (2004).

Country-pairs with:	$X_{ij} > 0$ $X_{ji} > 0$	$X_{ij} > 0$ $X_{ji} = 0$	$X_{ij} = 0$ $X_{ji} = 0$
Sales of foreign affiliates*	8,015	16	0
Assets of foreign affiliates*	18,490	13	0
FDI stocks*	1,531	44	0
Number of foreign affiliates	119	2	0
Number of country-pairs	2,404	2,812	17,434
% of country-pairs	**11**	**12**	**77**

(*): millions of current U$. X_{ij}: sales of firms from country j in country i.

Table 2: Bilateral Multinational Production and FDI. Means.

Country-pairs with:	$X_{ij} > 0$ $X_{ji} > 0$	$X_{ij} > 0$ $X_{ji} = 0$	$X_{ij} = 0$ $X_{ji} = 0$
Mean bilateral distance (in km)	5,862	7,028	7,504
% of country-pairs with common language	14.3	13.3	14.1
% of country-pairs with common border	8	3	2
% of country-pairs ever in colonial relationship	5	2	1
Mean bilateral corporate tax rate	16.8	26.3	34.1

X_{ij}: sales of firms from country j in country i.

Table 3: Bilateral Barriers to Multinational Production.

is geography. Table 3 shows that the average distance among the group of country-pairs with no FDI is much higher than among country-pairs with positive flows. The table also shows that the fraction of country-pairs with a common border and a common colonial past is higher among pairs with positive than for pairs with no FDI. Unexpectedly, sharing a language does not seem to be a factor that promotes international production. Finally, average bilateral corporate tax rates are substantially lower among country-pairs with positive flows than among the ones with zero MP activities (16% against 34%).

Country-pairs with:	$X_{ij} > 0$	$X_{ij} > 0$		$X_{ij} = 0$
	$X_{ji} > 0$	$X_{ij} = 0$		$X_{ji} = 0$
GNP		source j	host i	
Mean (millions of current U$)	728,764	614,778	95,688	82,890
as % of world mean	3.7	3.3	0.5	0.4
Standard Deviation	1,680,175	1,463,616	402,490	345,273
as % of mean	1.6	2.4	4.3	2.9

X_{ij}: sales of firms from country j in country i.

Table 4: Gross National Product (GNP).

Lastly, Table 4 suggests that MP mainly takes place among large countries in terms of GNP, and from large to small countries. The lack of this kind of flows is mainly observed among small economies, and from small to large economies. In fact, country-pairs with positive volumes in both directions involve countries almost four times larger than the world average, and fairly similar in terms of size (the standard deviation of GNP as percentage of the mean is 1.6). Among country-pairs with FDI in only one direction, source countries are more than three times larger than the world average, while host countries are half the size of the world average. Country-pairs with zero FDI in both directions are mostly small countries with an average size less than half the world average.

Indeed, the evidence summarized in the previous tables suggests that size in terms of income and geography are important factors in explaining the existence, allocation and volumes of international production activities across countries. Moreover, a theory that tries to explain the cross-country patterns of such flows has to be able to predict zero flows between some country-pairs.

3 Model

I introduce the decision to replicate production abroad in a competitive, multi-country model with fixed costs to multinational activities, close to Eaton and Kortum (2002). Firms in a given industry decide whether to open affiliates abroad, and where to locate them. Once established in a host market, affiliate plants carry production using local labor, and sell output exclusively there. Regardless of the country of destination, affiliate plants can replicate the productivity levels of their parent firm. However, to transfer such productivity level, firms face a fixed cost. A plant's technology is then defined by both productivity (which are industry-country specific) and a fixed costs (which are country-pair specific). This technology along with decreasing returns to scale delivers U-shaped average cost curves, that, in a given host industry, differ across plants of different origins. With free-entry, the technology with the lowest minimum average cost is used. Hence, at the industry level, the model displays constant returns to scale with flat supply curves. This turns out to be a standard Marshallian industry model where the supply side determines who serves the market and prices, and the demand side determines the size of the industry. Figures 1 and 2 illustrate the basic mechanism of the model for a host country i, and three potential source countries k, i (i.e. local suppliers), and j.

This model highlights the role of absolute advantage in determining the allocation of MP across countries. Since technologies are replicable in foreign industries through MP, and production in affiliate plants is done by employing local inputs, only efficiency matters in determining which technology is used, not wages.

Finally, the model delivers a structural equation for sales of affiliates from country j in country i that relates volumes to the size of country i, technology of of country j, and the cost of access the host market, and allows for zero volumes between some country-pairs.

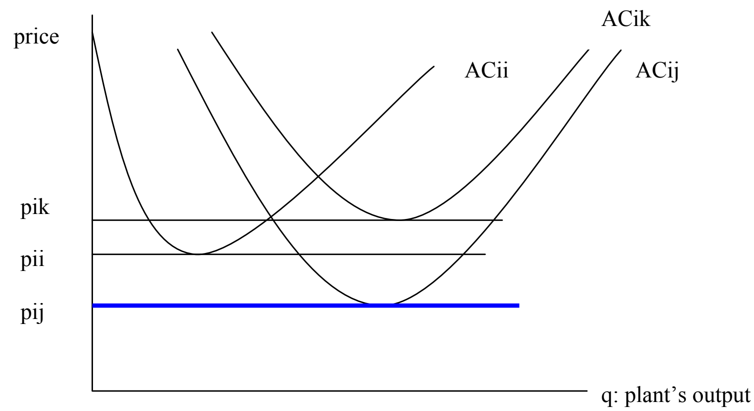

Figure 1: Supply with Multinational Production (MP). i : host, j : source

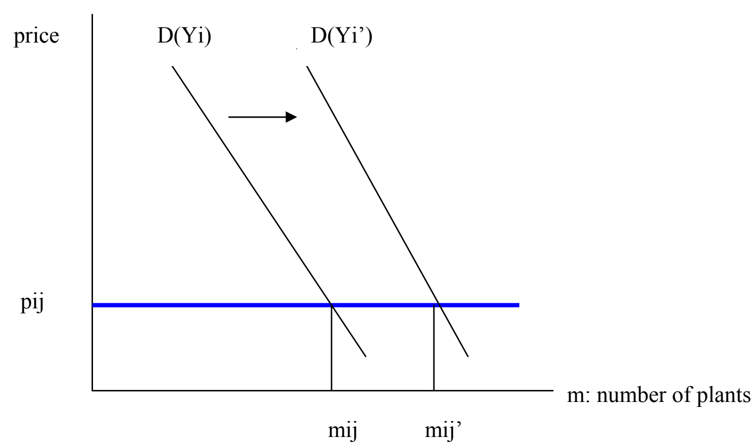

Figure 2: Industry Equilibrium with Multinational Production (MP). i : host, j : source

I present the basic set up, and the equilibrium where multinational activities are allowed.

3.1 Set up

There are N countries which produce goods using only labor. Country i has L_i consumers that supply one unit of labor each. Each country i has two types of goods. One is a homogeneous consumption good, that can be freely traded, produced under a constant returns to scale technology that uses $1/w_i$ units of labor per unit of output. Provided that each country produces it, the homogeneous good is the numeraire, and its price normalized to one, such that the wage rate in country i is w_i.

The other good is a composite good, made of a continuum of goods indexed by $\omega \in [0,1]$, produced with the technology described below, under perfect competition. Multinational production is allowed in this sector so that firms from country j can replicate production of good ω in country i, by opening affiliate plants. In particular, affiliate plants from country j in country i inherit the productivity level of their parent company, carry production hiring local labor, sell output exclusively in the host market, and repatriate (all or part of) their profits to the home economy (in units of the homogenous consumption good).

Technology. There is a continuum of plants in the production of each good ω that behaves competitively. Each plant operates under an only-labor decreasing returns to scale production technology that is assumed to be:

$$q_{ij}(\omega) = z_j(\omega) s_{ij}(\omega)^{\alpha}, \tag{1}$$

where $\alpha < 1$, $q_{ij}(\omega)$ is output of a plant from country j in country i, $s_{ij}(\omega)$ is labor required by a plant from country j to produce good ω in country i, and $z_j(\omega)$ is stochastic, specific to plants from country j that produce good ω. In each country i, the productivity parameter $z_i(\omega)$ is randomly drawn across symmetric goods from a density function $\phi_i(z_i)$ with *bounded* support, $[\underline{z}, \bar{z}]$. In particular, define $z_i \equiv x_i^{-\theta}$ where x_i is distributed exponential:[13]

$$\phi_i^{\mathbf{x}}(x_i) = \frac{\lambda_i e^{-\lambda_i x_i}}{e^{-\lambda_i \underline{x}} - e^{-\lambda_i \bar{x}}}$$

and $x_i \in [\underline{x}, \bar{x}]$. Since productivity is independently distributed across countries, the density function for the vector $z(\omega) = [z_1(\omega), z_2(\omega), ..., z_n(\omega)]$ is:

$$\phi(z) = \prod_{i=1}^{n} \phi_i(z_i). \tag{2}$$

where $z \in \mathbf{Z} = [\underline{z}, \bar{z}]^n$. This stochastic representation of productivity is similar to Eaton-Kortum (2002) and Alvarez and Lucas (2004).

[13] The parameter $\theta > 0$ is necessary for the existence of the integral when $x \in [0, \infty]$.

Preferences. Consumers have preferences given by:

$$u(c_i, Q_i) = c_i^{1-\mu} Q_i^{\mu} \tag{3}$$

where c is the homogenous good, and Q is a symmetric CES aggregate over the continuum of goods ω, given by:

$$Q_i = [\int_{\omega \in [0,1]} q_i(\omega)^{\frac{\eta-1}{\eta}} d\omega]^{\frac{\eta}{\eta-1}} \tag{4}$$

These goods are substitutes, with elasticity of substitution $\eta > 1$. The parameter μ is the exogenous fraction of income spent on the composite good Q. The demand function for good ω, in country i, is:

$$(\frac{p_i(\omega)}{P_i})^{-\eta} Q_i L_i \tag{5}$$

where $p_i(\omega)$ is the price of good ω in country i, and P_i is the price index associated with the aggregate good Q_i, given by:

$$P_i = [\int_{\omega \in [0,1]} p_i(\omega)^{1-\eta} d\omega]^{\frac{1}{1-\eta}} \tag{6}$$

The aggregate demand for Q_i is given by the expenditure condition:

$$L_i P_i Q_i = \mu Y_i. \tag{7}$$

National income in country i, denoted by Y_i, is given by labor income plus profits, and is fixed (in units of the numeraire good).

Since the only parameter that varies across goods is productivity, and goods enter symmetrically the aggregate in equation (4), it is convenient to rename each good ω by its productivity z. From now on, I refer to "good z" instead of "good ω", where z is the vector of productivity draws across countries $(z_1, z_2, ..., z_n)$. The aggregate good in equation (4) and the price index in (6) is rewritten as:

$$Q_i = [\int_{\mathbf{Z}} q_i(z)^{\frac{\eta-1}{\eta}} \phi(z) dz]^{\frac{\eta}{\eta-1}}, \tag{8}$$

$$\tag{9}$$

$$P_i = [\int_{\mathbf{Z}} p_i(z)^{1-\eta} \phi(z) dz]^{\frac{1}{1-\eta}} \tag{10}$$

and the production function in equation (1) as:

$$q_{ij}(z) = z_j s_{ij}(z)^{\alpha} \tag{11}$$

where z_j is the productivity draw specific to plants from country j that produce good z in country i.

Bilateral fixed cost. There is an unbounded pool of potential entrants into the production of good z. A subsidiary plant that enters the production of good z in country i at the same technology level as the one of its parent company in country j, has to pay a fixed cost, t_{ij} (in units of the homogenous consumption good). This cost is specific to the pair of "trading" countries, and can be thought as the costs of forming subsidiaries and distribution networks, adapting the technology to the local environment, as well as any information, transaction, and legal costs related to market access. This fixed cost is also borne by domestic plants, denoted by t_{ii}, and might include any overhead cost of production.

Given the vector $z = [z_1, z_2, ..., z_n]$, potential entrants decide whether to enter the production of good z, in country i, pay the fixed cost, and start production hiring local labor. There is free entry into the industry, and the mass of plants from country j in country i, in sector z, is denoted by $m_{ij}(z)$.

3.2 Equilibrium with Multinational Production

Each country i has the structure described in the set up, with preferences and technology parameters, ρ, η, μ, and α, common across countries. Given the vector of productivities across countries, $z = [z_1, z_2, ..., z_n]$, a producer from country j opens a plant in country i as long as profits are at least as high as the fixed cost:

$$\pi_{ij}(z) \geq t_{ij} \tag{12}$$

where

$$\pi_{ij}(z) = \max_{s_{ij}(z)} p_i(z) z_j s_{ij}(z)^{\alpha} - w_i s_{ij}(z), \tag{13}$$

for all i, j, z_j is the productivity draw for good z specific to firms from country j, and $p_i(z)$ is the price for good z in country i. Since there is an unbounded pool of potential entrants and free entry, in equilibrium, (12) holds with equality. The price for good z at which new plants from country j break even in country i is given by:

$$p_{ij}(z) = \gamma_0 \cdot w_i^{\alpha} \cdot t_{ij}^{1-\alpha} \cdot \frac{1}{z_j} \tag{14}$$

for all i, j, where γ_0 is a constant.[14] There are n source countries of potential suppliers of good z, but consumers buy from the cheapest one. Hence, the prevailing price for good z in country i is the minimum price among all potential sources that satisfies (14):

$$p_i(z) = \gamma_0 \cdot w_i^{\alpha} \cdot \min_j \{t_{ij}^{1-\alpha} \cdot z_j\}. \tag{15}$$

As it can be seem from (15), prices are fully determined by the supply side of the economy; productivity z, costs t, and wages w determine the supply curve (see Figure 1).

Next, I introduce the conditions under which the model generates zero MP flows. Let B_{ij} be the set of goods z produced in country i by affiliate plants of firms from country j, i.e., goods for which plants from country j are able to charge the minimum price in country i, defined by:

$$B_{ij} = \{z \in \mathbf{Z} : p_{ij}(z) < p_{ik}(z) \text{ for all } k \neq j\}, \tag{16}$$

Equivalently, B_{ij} can be defined in terms of technologies:

$$B_{ij} = \{z \in \mathbf{Z} : \frac{z_j}{t_{ij}^{1-\alpha}} > \frac{z_k}{t_{ik}^{1-\alpha}} \text{ for all } k \neq j\}. \tag{17}$$

However, B_{ij} might be empty because there could be no good z for which (i) $z_j \in [\underline{z}, \bar{z}]$, and (ii) $p_{ij}(z) < p_{ik}(z)$ for all k, simultaneously. The following condition is needed for B_{ij} to be non-empty:

$$\frac{\overline{z}}{t_{ij}^{1-\alpha}} > \frac{\underline{z}}{t_{ik}^{1-\alpha}} \tag{18}$$

for *all* $k \neq j$. When the support condition in (18) is not satisfied, no firm from country j produces in i. The following assumption assures that there is always some production done by domestic plants (i.e., B_{ii} is never empty).

[14]

$$\gamma_0 \equiv (\frac{\alpha}{1-\alpha})^{1-\alpha} \frac{1}{\alpha}.$$

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Assumption 1. *For all $k \neq i$,*

$$\frac{\overline{z}}{t_{ii}^{1-\alpha}} > \frac{\underline{z}}{t_{ik}^{1-\alpha}}.$$

In each country i, goods are supplied by either foreign or domestic plants, but not both, and all available goods are produced (i.e. $\cup_j B_{ij} = \mathbf{Z}$). However, due to country-pair specific costs, goods are not necessarily produced by plants from the country with the best productivity draw; plants from more than one country might produce the same good in different parts of the world. Moreover, some countries might not produce any good in some other countries, generating zero bilateral multinational activities.

Note that the condition in (17) does not involve the cost of inputs, as standard trade models do. Since country-specific technologies are replicable in foreign host industries through MP, and production in affiliates is done by employing local inputs, only efficiency matters in determining which technology is used in country i, not wages. In this sense, while the allocation of trade in goods is driven by comparative advantage, the allocation of trade in technologies, or ideas, is driven by absolute advantage; the link between wages and technologies is broken.

Bilateral sales of affiliate plants. The total value of sales of affiliate plants of firms from country j in country i, is given, in equilibrium, by:

$$X_{ij} = \begin{cases} \mu \cdot \int_{B_{ij}} (\frac{p_i(z)}{P_i})^{1-\eta} \cdot Y_i \cdot \phi(z) \cdot dz \text{ if } B_{ij} \neq \varnothing \\ \\ 0 \text{ if } B_{ij} = \varnothing \end{cases} \tag{19}$$

where P_i is the price index for the composite good Q_i, given by:

$$P_i^{1-\eta} = (\gamma_0 w_i^{\alpha})^{1-\eta} \sum_j \int_{B_{ij}} t_{ij}^{(1-\alpha)(1-\eta)} \cdot z_j^{\eta-1} \cdot \phi(z) \cdot dz \tag{20}$$

Plugging $p_i(z)$ from (15) and P_i from (20) in (19), yields:

$$X_{ij} = \mu \cdot \frac{t_{ij}^{(1-\alpha)(1-\eta)} \lambda_j \Gamma_{ij}}{\sum_k t_{ik}^{(1-\alpha)(1-\eta)} \lambda_k \Gamma_{ik}} \cdot Y_i, \tag{21}$$

and $X_{ij} = 0$ for $B_{ij} = \varnothing$. The expression $\lambda_j \Gamma_{ij}$ is defined by:

$$\lambda_j \Gamma_{ij} \equiv \int_{B_{ij}} z_j^{\eta-1} \phi(z) dz.$$

The variable Γ_{ij} mirrors the one in Helpman, Melitz and Rubinstein (2004). The main difference is that Γ_{ij} depends on the whole vector of (relative) bilateral fixed costs in country i, $\{t_{ij}/t_{ik}\}_{k\neq j}$, as well as the vector of country average productivities, $(\lambda_1, ..., \lambda_n)$, and the support bounds, $\underline{z}$ and $\bar{z}$. All these parameters determine the cross-country *allocation* of multinational production. First, the set B_{ij} may be empty for some (or all) $j \neq i$, so that Γ_{ij} equals zero, and sales from country j into i are zero. Hence, the model is able to generate zero volumes between some country-pairs, $X_{ij} = 0$. However, firms from country j may have affiliate plants in other destinations, and country i may host plants from other sources. Since Γ_{ij} is different from Γ_{ji}, even with symmetric costs (i.e. $t_{ij} = t_{ji}$), the theory allows for asymmetric bilateral flows, which may be zero in one direction, with $X_{ij} = 0$ and $X_{ji} > 0$, or $X_{ij} > 0$ and $X_{ji} = 0$, zero in both directions, $X_{ij} = X_{ji} = 0$, or positive in both directions but of different magnitude, $X_{ij} \neq X_{ji} > 0$. Such asymmetric FDI relationships are widely spread in the data, as shown in Section 2. Second, for the group of country-pairs with positive flows, gravity regulates their magnitude. In fact, Equation (21) relates the bilateral volume of sales of plants from country j in i to the "importer" size, Y_i, "exporter" technology, λ_j, and bilateral costs to access the importer's market, t_{ij}. The higher Y_i or λ_j, the larger X_{ij}, and the higher t_{ij}, the lower X_{ij}.

Since in the next section, the MP cost t_{ij} will be related to geography and other (observable and unobservable) bilateral variables, Equation 21 *qualitatively* captures the facts about the cross-country patterns of MP presented in Section 2.

Besides sales, employment, assets, and the number of affiliate plants of firms from country j in i, could be considered as measures for MP. In particular, the assumption of decreasing returns to scale gives additional implications on the number of affiliates, employment, and assets from country j in i.[15]

[15] Bilateral employment from country j in i is:

$$S_{ij} = \frac{\alpha}{w_i} X_{ij};$$

the bilateral number of affiliate plants is:

$$m_{ij} = \frac{1-\alpha}{t_{ij}} X_{ij};$$

and the bilateral value of assets is given by the value of installed plants from country j in i:

$$a_{ij} = t_{ij} m_{ij} = (1-\alpha) X_{ij}.$$

4 Empirical framework

Equation (21) relates the volume of bilateral sales of foreign affiliates to characteristics of the source country, host country, and the cost of accessing the host country from a given source country. When condition (18) is not satisfied, no firm from country j is productive enough to open an affiliate in country i, inducing zero FDI from j to i. For positive FDI, equation (21) governs the volume of bilateral sales of affiliates from country j in i. Define $T_{ij} \equiv t_{ij}^{(1-\alpha)(\eta-1)}$. Rearranging terms, equation (21) can be expressed in log-linear form as

$$\ln \frac{X_{ij}}{Y_i} = \ln \mu + \ln \lambda_j - \ln[\sum_k \lambda_k \Gamma_{ik}/T_{ik}] - \ln T_{ij} + \ln \Gamma_{ij} \tag{22}$$

if $\Gamma_{ij} > 0$. The parameter capturing the cost of accessing country i for plants from country j, t_{ij}, has observable and unobservable components. Following the gravity literature on international trade, I relate it to observable variables such as geography, language, colonial past, and policy variables related to corporate taxation. I further assume that these costs are stochastic due to unobservable frictions that are country-pair specific, and denoted by ϵ_{ij}, and have the following functional form:

$$\ln T_{ij} = \delta_d \ln d_{ij} - \epsilon_{ij} \tag{23}$$

for $i \neq j$, where d_{ij} is an observable measure of the bilateral cost, and it is easily extended to be a vector, and ϵ_{ij} is unobservable, i.i.d. across country-pairs, and normally distributed with mean zero and variance σ^2. Notice that T_{ii} cannot be approximated by the observable variables used for T_{ij}. Hence, I set T_{ii} to be a fraction τ of the minimum fixed cost faced by firms from any other country j in i:

$$T_{ii} = \tau \cdot \min_{j \neq i}\{T_{ij}\}. \tag{24}$$

. Replacing (23) in (22), for $j \neq i$, yields:

$$\ln \frac{X_{ij}}{Y_i} = \ln \mu + S_j - H_i - \delta_d \ln d_{ij} + \ln \Gamma_{ij} - \epsilon_{ij} \tag{25}$$

if $\Gamma_{ij} > 0$, where $S_j \equiv \ln \lambda_j$, and $H_i \equiv \ln[\sum_k \lambda_k T_{ik}^{-1} \Gamma_{ik}]$. Equation (25) looks much as the gravity equation that is traditionally estimated through OLS using only positive bilateral flows,

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and two sets of country fixed effects. The first important difference that equation (25) bears with traditional gravity equations is the new variable $\ln \Gamma_{ij}$. This variable mirrors the one in Helpman, Melitz and Rubinstein (2004), and depends on the vector of (relative) barriers in country i, $\{T_{ij}/T_{ik}\}_{k\neq j}$,, among other parameters, transforming equation (25) in a non-linear function of the coefficient δ_d and the error terms ϵ_{ij}. When $\ln \Gamma_{ij}$ is not included as a regressor, there is an omitted variable bias, and the OLS estimate of the coefficient on d_{ij}, can no longer be interpreted as an estimate of δ_d. The second important difference is the bias arising from the fact that, considering positive flows only, the error term of the OLS regression is no longer independent of the regressors. This selection effect induces a positive correlation between the unobservable term ϵ_{ij}, and the observable barriers d_{ij}: country-pairs with large observable barriers (high d_{ij}) that have positive MP are likely to have low unobservable barriers (high ϵ_{ij}), inducing a downward bias in the OLS coefficient on d_{ij}. I evaluate the OLS bias below.

4.1 Estimation procedure

The goal is to quantify the model in order to explore welfare gains of changing the cost of MP. As shown in the previous subsection, when information on zero volumes is disregarded, and there is a fixed cost of MP along with a bounded productivity support, OLS estimates of the gravity equation are biased because of a selection and omitted variable bias, respectively.

I then use an indirect inference procedure to estimate the parameters of the model. The indirect inference estimator is the one that minimizes the distance between a vector of moments (so called "auxiliary" parameters) computed from the actual and simulated data. These moments are chosen to properly capture the empirical patterns of the allocation and volume of MP across countries.

The estimation procedure works as follows. Let Δ be the $(qx1)$ vector of parameters of the model. Let ρ denote the $(px1)$ vector of moments. I first calculate ρ with the actual data. I then simulate the model for H realizations of the matrix $\{\epsilon^h_{ij}\}_{i,j}$, for each vector Δ. With the simulated data, for each h and Δ, I calculate again the vector of moments ρ. The indirect inference estimator Δ^* is the solution to the following minimization problem:[16]

$$\Delta^* = \arg\min_{\Delta} [\rho_d - \frac{1}{H}\sum_{h=1}^{H} \rho_s^h(\Delta)]'\hat{\Omega}[\rho_d - \frac{1}{H}\sum_{h=1}^{H} \rho_s^h(\Delta)] \tag{26}$$

where ρ_d is the vector of moments from the actual data, and $\rho_s^h(\Delta)$ is the vector of moments from simulation h of the model evaluated at the set of parameters Δ. The (pxp) matrix $\hat{\Omega}$ is the optimal weighting matrix. The vector Δ is a subset of the structural parameters of the model:

$$\Delta = [\delta_d, \sigma^2, \tau, \underline{z}, \kappa]$$

where δ_d is the coefficient of the observable component of costs in equation (23); σ^2 is the variance of ϵ_{ij} in equation (25); τ is defined by equation (24); and $\underline{z}$ is the lower bound of the productivity support. The vector of technology parameters across countries $(\lambda_1, ..., \lambda_n)$ is not observable. I calibrate it to countries' TFPs, relative to the United States.[17] The parameter κ is a scale parameter:

$$\lambda_i = \kappa \frac{TFP_i}{TFP_{us}}$$

Besides dimensionality problems in the numerical computations, I choose these parameters to be in Δ because they are the ones that govern the magnitude of MP costs, as well as the allocation and volume of MP across countries in the model.

I set the remaining model parameters at the values summarized in Table 5.[18] The parameter μ is the expenditure share of goods in the CES sector. Since I calibrate it to the observed average sales of foreign affiliates (as share of host country's GNP), for selected developed economies, it can be thought as a lower bound.[19]

[16]The indirect inference estimator Δ^* is consistent under the assumptions in Gourieroux, Monfort and Renault (1993). The minimized value of (26) is distributed $\chi^2(p-q)$.

[17]I am very grateful to Torsten Persson that provided me these data.

[18]Notice that the parameter α, i.e. the degree of returns to scale, is not identified using only sales data; data on bilateral number of plants, employment, or assets are needed.

[19]The parameter μ could be estimated assuming that it is host-country specific rather than common across countries. In particular, it could be a function of observable (and unobservable) variables, such as governance and human capital levels in the host country. This is also the way of incorporating host-country fixed effects into the estimation.

Parameter	Value	Definition	Source
η	3.1	elasticity of substitution	Broda-Weinstein
μ	0.5	share of CES sector in total expenditure*	UNCTAD
$1/\theta$	4	volatility of productivity draws	Eaton-Kortum
$\overline{z}$	1.778	upper bound of productivity support	normalization
Y_i	GNP_i	GNP for country i	WDI
H	1	number of simulations	

(*): average sales of foreign affiliates in a host economy, as share of GDP: United States, Ireland,Czech Rep., Finland, Germany, Hungary, Sweden, Netherlands, Poland, Slovenia, Canada.

Table 5: Calibrated parameters of the model.

The data I use to compute the vector of moments from the data, ρ_d, are aggregate sales of affiliates from country j in i, measures of observable barriers between country-pairs, and GNPs, for the 151 countries in the sample. I divide the sample of country-pairs in three groups: pairs with $X_{ij} > 0$ and $X_{ji} > 0$; pairs with $X_{ij} = 0$ and $X_{ji} > 0$; and pairs with $X_{ij} = 0$ and $X_{ji} = 0$. The vector ρ_d contains the following statistics for each group of country-pairs: fraction of country-pairs in each group; mean value of bilateral barriers (distance, common border, common language, common colonial ties, and bilateral corporate tax rates for foreign firms); mean GNP; mean bilateral sales of foreign affiliates; mean GNP for source and host countries, respectively, for country-pairs with $X_{ij} > 0$ and $X_{ji} = 0$; and mean TFP. (See Table 14 in the Appendix). Additionally, I include the OLS coefficients of the following regression:

$$\ln \frac{X_{ij}}{Y_i} = a + a_d \ln d_{ij} + \tilde{H}_i + \tilde{S}_j + e_{ij}, \tag{27}$$

for country-pairs with $X_{ij} > 0$, where $\tilde{H}_i$ and $\tilde{S}_j$ are host and source country fixed effects, respectively, and the error term e_{ij} has variance σ_e^2. The regression in (27) is the OLS estimate of the gravity equation using data on positive bilateral sales of affiliate plants.

The vector ρ_s has the same moments as ρ_d, except that it is computed with simulated data. In particular, the outcome of each simulation h, for a given set of model parameters, Δ, is the matrix of sales of affiliate plants from country j in i, $\{\tilde{X}^h_{ij}(\Delta)\}_{i,j}$. Creating this simulated data set requires data on observable bilateral barriers, $\{d_{ij}\}_{j \neq i}$, data on GNPs to calibrate the vector of countries' income, $(Y_1, ..., Y_n)$, and data on TFPs measures to calibrate the technology parameters $(\lambda_1, ..., \lambda_n)$, for the 151 countries in the sample.

(Table 14 in the Appendix summarizes the moments calculated from the actual data, ρ_d, and simulated data at the optimal model parameters' value, $\rho_s(\Delta^*)$; a description of each parameter is included).

The indirect inference method focuses on some moments of the data, rather than the whole joint distribution. In particular, I focus on the moments highlighted by the stylized facts in Section 2, that are informative about the parameters of the model.

Since (25) is non-linear in the parameters of interest, an alternative to indirect inference is a maximum likelihood procedure that requires one to write down the likelihood function from the set of conditional probabilities that the model dictates. Alternatively, a two-step procedure that corrects for the selection of country-pairs into MP partners could be derived, similarly to Helpman, Melitz, and Yeaple for trade flows.[20] However, a two-step procedure would recover the parameters of the "gravity" equation, δ_d, but not the other parameters of the model necessary to perform welfare analysis; that is why the structural approach is needed.

5 Estimates

I use the following variables as the observable components of the cost of accessing country i for firms from country j: bilateral distance d_{ij}, common border δ^c_{ij}, common language δ^l_{ij}, colonial

[20]The complex structure of the variable Γ_{ij}, a multivariate truncated distribution that depends on the entire vector of bilateral barriers in country i, $\{T_{ij}\}_{\forall j}$, that includes both $\{d_{ij}\}_{\forall j \neq i}$ and $\{\epsilon_{ij}\}_{\forall j \neq i}$, makes both maximum likelihood and two-step methods hard to apply.

ties δ_{ij}^{col}, and corporate tax rates applied to firms from country j in i, τ_{ij}.[21] Equation (23) ends up being:

$$\ln T_{ij} = \delta_d \ln d_{ij} - \delta_\tau \ln(1-\tau_{ij}) - \sum_{s=c,l,\text{col}} \delta_{ij}^s \ln b_s - \epsilon_{ij}.$$

where $\delta_{ij}^{'}$s are dummy variables. (Details on variables are provided in the Appendix).

Table 6 shows OLS estimates of equation (27), for country-pairs with $X_{ij} > 0$, for all countries in the sample and OECD countries, respectively. Each observation is an average over the period 1990-2002.

It clearly emerges that affiliates from country j have more sales in country i, as share of country i's GNP, when the two countries are closer to each other, while lower bilateral tax rates seem to have an insignificant effect on bilateral multinational production. Additionally, sharing a language and a colonial past seem to have a significant impact on bilateral sales, when all countries in the sample are considered. Conversely, these variables have insignificant effects when OECD countries only are considered. Coefficients in columns (I) and (III) are the ones considered as auxiliary statistics in the indirect inference procedure.[22]

Among the 151 countries in the sample, there are 22,801 possible pairs; only 3,810 of these pairs have non-zero MP relationships, suggesting that, potentially, biases in OLS results can be severe.[23] Conversely, for OECD countries, the presence of zero bilateral MP is very small.

Table 7 summarizes the vector of model parameters' estimates, Δ^*. Results for the 151 countries in the sample, and only OECD countries are shown. According to these estimates, bilateral distance is the most important barrier to international production: country-pairs twice as distant have a 56% higher fixed cost, T_{ij}, equivalent to a tax rate of 66%.[24] Sharing a border or a language decreases the bilateral cost by 16% and 18%, respectively, while sharing a colonial past does it by 56%; tax equivalents are 17%, 20%, and 75%, respectively. Bilateral corporate tax rates have a small effect on total costs: doubling them increases the fixed cost by 0.8%.

[21] I am very grateful to Ernesto Stein and Christian Daude for providing me with data on corporate tax rates.

[22] OLS estimates using bilateral FDI stocks and number of plants give similar results.

[23] A country j has no MP relationships with country i, for the period 1990-2002, if *all the six measures* of international production and FDI recorded in the data base are missing values or zeros.

[24] Assuming $\eta = 3.1$ and $\alpha = 0.55$, the impact on t_{ij} of doubling distance is 59%.

Dependent Variable:	Bilateral sales of affiliates			
	All countries		OECD countries	
	I	*II*	*III*	*IV*
log of bilateral distance	-1.13	-1.15	-0.85	-0.84
	[0.09]**	[0.11]***	[0.13]**	[0.13]**
1 for pairs with common official language	0.48	0.49		0.25
or $>$ 20% pop. same language	[0.22]*	[0.24]**		[0.27]
1 for pairs ever in colonial relationship	0.83	0.85		0.47
	[0.28]**	[0.27]***		[0.31]
1 for pairs with a common border		-0.1	0.81	0.62
		[0.34]	[0.26]**	[0.27]*
log of (1- bilateral corporate tax rates)		-0.10		-1.12
		[0.53]		[0.79]
Observations	846	846	396	396
R-squared	0.86	0.86	0.82	0.82

Standard errors in brackets. * significant at 5%; ** significant at 1%. All specifications with constant, source, and host country fixed effects. Dependent variable is sales of affiliates from country j in i, in logs, as share of country i's GNP.

Table 6: Gravity for Bilateral Multinational Production. All and OECD countries. OLS.

Regarding the remaining estimates of the model's parameters, results in Table 7 suggest that domestic plants face barriers to entry T_{ij} that are almost half as high as the ones faced by the most favored foreign plants, i.e., $\tau = 0.59$ in equation (24)).

Which are the differences between the indirect inference and OLS estimates of barriers to MP? OLS estimates in Table 6 (column I) suggest that doubling distance between country-pairs increases the fixed cost by 115%, while sharing a language decreases it by 48%, and sharing colonial past by 83%. The comparison with the indirect inference estimator suggests that OLS

Parameters	Estimates				Variable
	All countries		OECD countries		
	IIE	OLS	IIE	OLS	
δ_d	0.56**	1.13**	0.61	0.84**	bilateral distance
$\ln b_c$	0.16	-0.1	0.21	0.62*	common border
$\ln b_l$	0.18	0.48*	0.26	0.25	common language
$\ln b_{col}$	0.56	0.84**	0.13	0.47	common colonial ties
δ_t	0.02	-0.1	0.02	-1.12	1- bilateral corporate tax rate
σ_ε^2	0.26		0.21		standard error of ε_{ij}
τ	0.59*		0.20		barriers for domestic plants
κ	0.024*		0.02		scale parameter
$\underline{z}$	0.60*		0.42		productivity support lower bound

** significant at 10%; * significant at 1%.

Table 7: Parameters' Estimates.

estimates are upward biased, similarly to the findings for bilateral trade flows in Helpman, Melitz, and Rubinstein; the omitted variable bias seems then to dominate. Moreover, for the sample of OECD countries where there is no zero flows, the OLS estimate is systematically larger.

	All countries	OECD countries
Correlation actual and simulated data:		
bilateral sales of affiliates:	0.21	0.19
total sales of foreign affiliates *in* country i:	0.80	0.10
total sales of affiliates *from* country i abroad:	0.16	0.05

Table 8: Goodness of fit: model and data.

How well does the model fit the data? Table 8 shows some correlation coefficients between actual and simulated data. The correlation between simulated and actual data on bilateral sales of affiliates from country j in i is 0.21, while the one for *total* sales of foreign affiliates *into* country i is 0.81. The model does not perform that well on the outward side: correlation between simulated and actual data for *total* sales of affiliates abroad *from* country i is 0.16. [25] In fact, Table 9 shows sales of foreign affiliates for selected economies, model and data: while for individual countries simulated inward flows match fairly well the data, outward flows are systematically underestimated, particularly, for the United States.

	Fixed Costs^a		Sales of foreign affiliates (*in billions of US$*)			
	% of host country's GNP^b	ratio foreign to domestic^c	Model inward	Model outward	Data inward	Data outward
World	10	17	35.9	35.9	40.47	54.8
United States	5.6	16	988.2	59.34	1,526	1,519
Japan	10.4	9.8	987.5	10.3	245.6	671.1
Germany	7	27	331.9	90.71	676.9	694.9
Australia	13	7	104.7	4.09	103.6	34.9
Brazil	16	6	194.7	2.28	107.9	5.26
Congo	4	112	0.17	2.19	0.69	n/a

$(^a)$: $t_{ij} \equiv T_{ij}^{\frac{1}{(1-\alpha)(\eta-1)}}$ where $\alpha = 0.55$. $(^b)$: $\sum_{j \neq i} t_{ij} m_{ij} / Y_i$. $(^c)$: $\overline{t_{ij}} / t_{ii}$.

Table 9: Fixed costs and total sales of foreign affiliates, world average and selected economies.

Table 9 also shows, for some selected countries, estimates of the fixed costs and sales of foreign affiliates. The cost of installing foreign affiliates as percentage of host country's GNP is

[25] These two correlation are illustrated in Figure **??** and **??** in the Appendix. They show total sales of foreign affiliates in country i (total sales of affiliates from country i abroad) as a function of (estimated) fixed costs; the size of the bubble is proportional to the host (source) country 's GNP.

0.45% for the average country, ranging from 0.28% for Australia to 9.2% for Zaire. On average, foreign plants face 16 times higher costs than domestic plants, ranging from 7 times for Australia to 78 times for Zaire!

Table 14 in the Appendix shows the moments calculated with the actual and simulated data for estimates in Table 7. Even though the model captures fairly well the fraction of country-pairs with zero and positive MP, as well as the mean values of barriers, for country-pairs with positive, zero, and one-way MP, and the mean value of sales for country-pairs with positive volumes in both directions, it fails to pick features related to size.

5.1 Welfare gains of Multinational Production (MP)

The estimation above provides parameters' values to quantify the model, and pursue the analysis of counterfactuals, in the same spirit as the experiments in Eaton and Kortum (2002), and Alvarez and Lucas (2004), for international trade, and Burstein and Monge (2005) for international production. Welfare in country i is measured by real income:[26]

$$W_i = Y_i / P_i^{\mu}$$

Since total labor supply L_i and wages w_i are fixed in country i, total income Y_i, in terms of the numeraire good, is also fixed. Therefore, changes in welfare are only due to changes in the price index P_i, given by (20):

$$\ln \frac{W_i'}{W_i} = -\mu \ln \frac{P_i'}{P_i} \tag{28}$$

where P_i' denotes the counterfactual value.

Proposition 1. *For each country i, the aggregate price index for the open economy, P_i^{fdi}, is lower than (or equal to) the aggregate price index for the closed economy, P_i^c.*

Proof. [27] Let P_i^{fdi} be given by (20), and rewritten as:

$$(P_i^{fdi})^{1-\eta} = (\gamma_0 w_i^{\alpha})^{1-\eta} \int_{\mathbf{Z}} [\min_j \{ t_{ij}^{1-\alpha} \cdot \frac{1}{z_j}]^{1-\eta} \phi(z) dz \tag{29}$$

[26] Since the homogeneous good is the numeraire, the price level in country i is P_i^{μ}.

[27] I owe this proof to Constantino Hevia.

Let P_i^c be:

$$(P_i^c)^{1-\eta} = (\gamma_0 w^{\alpha})^{1-\eta} t^{(1-\alpha)(1-\eta)} \int_{\mathbf{Z}} z_j^{\eta-1} \phi(z) dz,$$

and rewritten as:

$$(P_i^c)^{1-\eta} = (\gamma_0 w_i^{\alpha})^{1-\eta} \int_{\mathbf{Z}} [t_{ii}^{1-\alpha} \cdot \frac{1}{z}]^{1-\eta} \phi(z) dz \tag{30}$$

It follows that $t_{ii}^{1-\alpha} \cdot \frac{1}{z_i} \geq \min t_{ij}^{1-\alpha} \cdot \frac{1}{z_j}$. Comparing (29) and (30), $P_i^{fdi} \leq P_i^c$.$\blacksquare$

In Table 10, I consider the effects of: (i) moving to autarky ($t_{ij} \to \infty, i \neq j$); (ii) reducing costs of MP to a common level across foreign and domestic plants ($t_{ij} = t_{ii}$, for all $j \neq i$),in each country simultaneously ("zero-gravity"); (iii) moving the United States to autarky ($t_{US,j} \to \infty, j \neq US$); (iv) reducing costs of MP within NAFTA, for members only; and (v) reducing costs of MP within the EU, for members only.

	% change (average)		
	welfare	sales of affiliates	
		(inward)	(outward)
Effects of moving from baseline to:			
autarky	-4.13		
"zero-gravity"	31	89	168
United States in autarky	-0.03	-0.5	-8.8
"zero-gravity"among NAFTA members	0.15	1.7	-1.8
"zero-gravity"among EU members	3.1	12.6	-4.7
Corporate tax rate = 0%	0.07	1	1.2
$\lambda_i = \lambda_{USA}$, for all i	0.65	0.3	1.3

baseline: estimates from Table 7; autarky: $t_{ij} \to \infty, i \neq j$; "zero-gravity": $t_{ij} = t_{ii}$, for all $j \neq i$.

Table 10: Welfare gains of changing costs of MP, average.

Using estimates in Table 7, for all countries, the average world real income would decrease by more than 4% if each of the 151 countries in the sample moved to autarky from the baseline case.

Going to a “zero-gravity” world would increase world average real income by 31%; unrealized gains of removing bilateral costs of MP seem quite large. These two estimates are higher than the ones calculated by Eaton and Kortum (2002), for OECD countries, in a model with only trade, and they seem consistent with the finding in Rodriguez-Clare (2006) that the gains from diffusion of ideas are more important in accounting for the overall gains from openness than trade. [28] Welfare would decrease only by 0.3% if the United States moved to autarchy. The average effect on world welfare of lowering costs of MP within NAFTA for members only is also rather small. Conversely, the effect of lowering costs of MP within the EU for members only increases world average real income by 3.2%. The effect of removing corporate tax rates for foreign firms is quite small: welfare increases on average by 0.07%. Finally, if every country in the world had access to the same technology as the United States ($\lambda_i = \lambda_{USA}$), welfare would increase by only 0.65%, pointing out that bilateral costs of MP seem to be the main obstacle to MP between countries rather than the lack of superior (average) productivity.

Table 11 shows welfare changes for the United States, Mexico Canada, and the European Union (25), for the same experiments as in Table 10. Income losses of moving to autarky would be larger for the EU, while gains of removing bilateral costs of MP world-wide (“zero-gravity”) would be more than 30% for each of the countries shown. The effect on neighbors’ countries if United States moved to autarky is larger for Canada than Mexico. Further liberalizing NAFTA (“zero-gravity” among NAFTA members) would be beneficial for all three members, with real income gains above 7%. There are large unrealized gains of further liberalizing MP within the EU for members only: real income would increase by almost 22%!

[28] While Eaton and Kortum calculate a loss of -3.5% for OECD countries, if they closed to trade, I estimate a loss of -4.4% for the same set of countries, if they closed to MP. Analogously, they calculate a gain of 19.9% if OECD countries remove trade costs (“zero-gravity ”), while I find a much higher gain, 30.4%, if they do so for MP.

	United States	Mexico	Canada	EU
	(% change in real income)			
Effects of moving from baseline to:				
autarky	-2.1	-2.8	-2.3	-4.1
"zero-gravity"	33	32	33	31
United States in autarky	-2.1	-0.01	-1.7	0.0
"zero-gravity" among NAFTA members	7.3	7.7	7.4	0.0
"zero-gravity" among EU members	0.0	0.0	0.0	21.5

baseline: estimates from Table 7; autarky: $t_{ij} \to \infty, i \neq j$; "zero-gravity": $t_{ij} = t_{ii}$, for all $j \neq i$.

Table 11: Welfare gains of changing barriers to multinational production, selected economies.

6 Conclusions

This paper analyzes the determinants of the cross-country allocation and volume of multinational production (MP), quantifies the size of its costs, and the impact on welfare. For that purpose, I introduce MP in a competitive, multi-country model with fixed costs, close to Eaton-Kortum's (2002) and Alvarez and Lucas (2004). The theory is able to capture some stylized facts on cross-country multinational activities: a very small fraction of country-pairs engages in multinational activities with each other; geography remains a significant impediment to these activities; country size in terms of income matters. Similarly to international trade theories, gravity governs positive volumes of multinational activities, modified to deliver zero bilateral flows. However, differently to model of trade in goods, this model highlights the role of absolute advantages in determining the cross-country allocation of multinational activities; while trade in goods is driven by comparative advantages, trade in technologies or ideas is driven by absolute advantages. The intuition is the following: even the best country in the world might not export all goods everywhere because higher wages deter this possibility; however, the link between wages and technology is broken for MP flows because firms can replicate their technology in the host country, and operate it there using local labor.

Using new data on the activities of foreign affiliates at the country-pair level, I quantify the costs of MP, and evaluate welfare gains from opening to MP. I specifically concentrate on bilateral sales of affiliates, but the availability of several bilateral measures of MP activities allows me to accurately construct the sample of country-pairs with no MP relationships. I use a simulation-based procedure to estimate the model, including information on both country-pairs with zero as well as positive bilateral multinational activities.

It turns out that geographical distance between country-pairs is the most important impediment to MP: country-pairs twice as distant face a 56% higher cost than otherwise.

Welfare gains of lowering the cost to MP are large: more than 30% increase in real income for the average country. Moreover, if the EU further liberalized multinational activities among its members, it would experience an increase in real income of 22%. Conversely, welfare losses of moving to autarky are more than 4% of average real income. These numbers are higher than the ones calculated by Eaton and Kortum (2002) for trade in goods, and are consistent with the finding in Rodriguez-Clare (2006) that the gains from diffusion of ideas are much more important in accounting for overall gains from openness than trade. Certainly, MP can be thought as one important mechanism through which technologies and ideas diffuse across countries.

The importance of distance for the location of MP might be indicating a complex relationship between trade and MP flows. Theories where trade and FDI are substitutes would predict that more MP should be observed for countries further away. However, both trade and MP decrease with distance, pointing out to a complementary between these two flows. [29] Indeed, a theory in which trade and MP interact is the next step to pursue. This paper contributes to that discussion by presenting a simple model to analyze and quantify the determinants and impediments of international production across countries. It is an alternative benchmark that complements trade models to evaluate the magnitude of the welfare gains from openness.

[29] Helpman, Melitz and Yeaple (2003) as well as Brainard (1997) find that the *ratio* of exports to sales of affiliates decreases with distance, meaning that exports decrease more than MP.

References

[1] Alvarez F. and Lucas R.E.: "General Equilibrium Analysis of the Eaton-Kortum Model of International Trade", mimeo, the University of Chicago, 2004.

[2] Anderson J. and van Wincoop E.: "Trade Costs", NBER, April 2004.

[3] Brainard L.:"An Empirical Assessment of the Proximity-Concentration Trade-o. between Multinational Sales and Trade", 1997, American Economic Review 87:520.44.

[4] Broda C. and Weinstein D.: "Globalization and the Gains from Variety", working paper, NBER, September 2004.

[5] Burstein A. and Monge-Naranjo A.: "Aggregate Consequences of International Firms in Developing Countries", mimeo, May 2005.

[6] Eaton J., and Kortum S.: "Technology, Geography and Trade", Econometrica, Vol. 70, No. 5, September 2002.

[7] Gourieroux C., Monfort A., and Renault E.: "Indirect Inference", Journal of Applied Econometrics, Vol. 8, Supplement: Special Issue on Econometric Inference Using Simulations Techniques, December 1993.

[8] Helpman E, Melitz M.J., and Rubinstein, Y.: "Trading Partners and Trading Volumes", mimeo, August 2004.

[9] Helpman E, Melitz M.J., and Yeaple S.R.: "Export versus FDI with Heterogenous Firms", NBER, 2003.

[10] Hopenhayn H.: "Entry, Exit, and firm Dynamics in the Long-Run", Econometrica, Vol. 60, Issue 5, September 1992.

[11] Lucas R.E.: "On the Size Distribution of Business Firms", The Bell Journal of Economics, 1978.

[12] Holmes T.: "The Diffusion of Wal-Mart and Eocnomies of Density", working paper, University of Minnesota, May 2006.

[13] OECD: Globalization Database, International Direct Investment Database. 2005.

[14] Razin A., Rubinstein Y. and Sadka E.: "Which Countries Export FDI, and How Much?", NBER Working Paper No. 10145, December 2003.

[15] Rodriguez-Clare A.:"Trade, Diffusion, and the Gains from Openness", Working Paper, Penn State University, September 2006.

[16] Silva S., and Tenreyro, S.: "The Log of Gravity", mimeo, July 2005.

[17] UNCTAD: FDI Statistics, published and unpublished data, 2005.

[18] UNCTAD: "The World Investment Report", 1999, 2002, 2003 and 2004.

A Data

The procedure to estimate barriers to MP requires data from several sources. In particular, I need accurate data on bilateral measures of international production, measures of observable bilateral barriers, and data on GNP of trading partners.

Table 13 summarizes data sources for each variable; Table 15 lists the countries in the sample; and Table 12 presents descriptive statistics.

A.1 Data on bilateral multinational production

Contrary to international trade data, there is no systematic database for bilateral measures of MP. I assemble a bilateral data set that includes six different measures of international production and FDI, using as main sources UNCTAD and OECD.[30] These organisms have data on FDI flows and stocks from country j to i as measured in the Balance of Payment of a country, and variables related to the activity of foreign affiliates from country j in i (sales, number of plants, employment, and assets). For the first two variables, there are 109 countries that are

[30] As basic data source, I use published and unpublished UNCTAD, and complete with OECD's International Direct Investment, and Globalization databases.

information source, for the period 1985-2003. Data related to the activity of foreign affiliates are much more scarce. The sample of countries that are source of information drops to no more than 65, and the number of years for which data is available also shrinks. I hence restrict the analysis to the period 1990-2002. I end up with a sample of 147 (150) countries observed (at least once) as source (host) countries, for at least one of the measures recorded in the database.

Likewise import and export data, most of the countries record both outward and inward volumes of FDI and MP. Thus, I first consider inward magnitudes reported by a given country, and complete missing values with outward magnitudes reported by a partner countries.

Unfortunately, bilateral data on the activity of affiliates of multinational firms are available at the aggregate level, not sector or product level.

The definition of FDI flows and FDI stocks follows the definitions from the IMF Manual of Balance of Payment Statistics. The concept of FDI flows includes capital flows for: (i) acquiring or sell existing firms, (ii) establishing a new firm, (iii) new investments as long as funds come from the parent company or other affiliates, (iv) reinvested earnings, and (v) any debt with the parent company or other affiliates, as long as the foreign resident owns more than 10% of the firm. FDI stocks are the result of accumulating FDI flows. These two variables are comparable across countries.

A foreign affiliate is defined as a plant who has more than 10% of its shares owned by a foreigner. For these plants, I record sales, assets, employment and number of affiliates owned by residents from country j in i.

Data on the activity of foreign affiliates are more prone to have some comparability problems. Specifically, while some countries report these variables for affiliates with more than 10% of foreign capital, others do so for only majority-owned affiliates (more than 50% of ownership). Nonetheless, majority-owned affiliates are the largest part of the total number of foreign plants in a host economy.

In terms of sector coverage, data mostly refer to non-financial affiliates in all sectors. However, some countries report data only on foreign affiliates in manufacturing. These countries are marked in red in Table A.2.

Data on countries' GDP and GNP are from the World Development Indicators, and International Financial Indicators (IMF). These are nominal values, converted to US dollars, and they are not on purchasing power parity basis.

A.2 Data on bilateral barriers

As observable measures for bilateral barriers to multinational production, I include the following variables: bilateral distance between trading partners, common border, common language, and common colonial past (ever in a colonial relationship). These variables are compiled by the *"Centre d'etudes prospectives et informations internationales (CEPII)"*. Bilateral distance is the distance in kilometers between the largest cities of the two countries. Common language is a dummy equal to one if both countries have the same official language or more than 20% of the population share the same language even if it is not the official one. Common border is equal to one if two countries share a border. Colonial ties is equal to one if the two countries had ever been in a colonial relationship.

Bilateral corporate tax rates are computed from tax rates applied to foreign corporations in country i, corrected by the preferential rate stipulated in the bilateral double taxation treaty, if there were one. A country j that has signed a double taxation treaty with country i, but no data is available on bilateral tax rates, is assigned the average bilateral tax rate in country i. Country pairs without a treaty and missing values for bilateral tax rates are assumed to be subject to the same corporate tax rate as domestic plants.

B Additional Tables and Figures

	Mean	Std. Dev.	Obs.
Bilateral distance (km)	7,270	4,204	22,650
% of country-pairs with common language	14	0.35	22,650
% of country-pairs with common border	2.4	0.15	22,650
% of country-pairs with colonial ties	1.3	0.11	22,650
Bilateral corporate tax rates	31	12	22,650
Sales of affiliates: all possible country-pairs	289	5,736	19,684
Sales of affiliates: country-pairs with $X_{ij} > 0$	6,718	26,896	846
GNP (millions of current dollars)	185,494	767,575	22,650
TFP (current dollars)	4,417	2,449	22,650

Table 12: Summary Statistics.

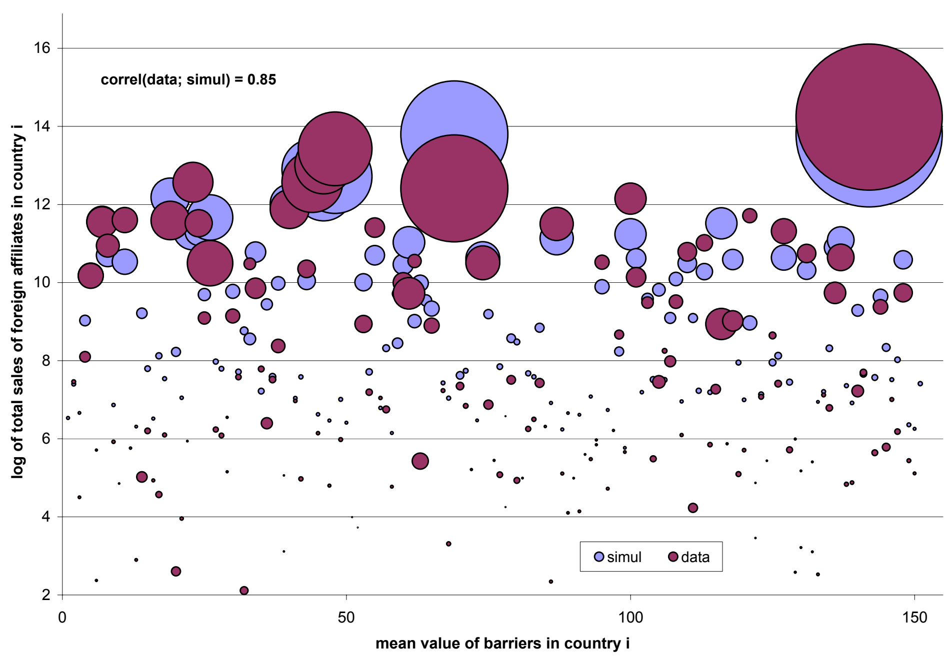

Figure 3: Sales of foreign affiliates and estimated fixed costs, by host country: actual and simulated data (size of bubble is proportional to host country's GNP)

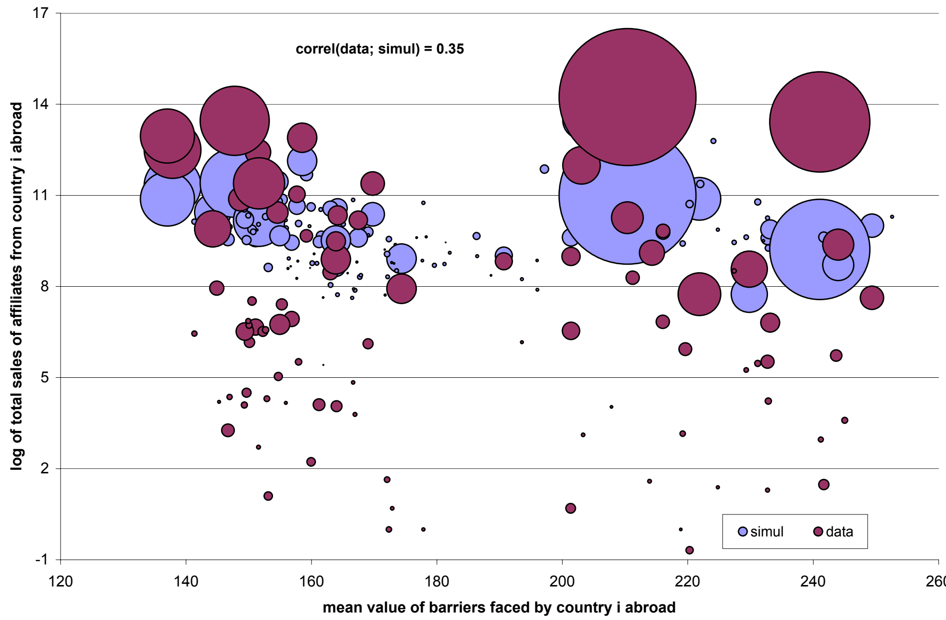

Figure 4: Sales of affiliates abroad and estimated fixed costs: actual and simulated data (size of bubble is proportional to source country's GNP)

Variables	**Sources**
Sales, employment, assets,	*FDI database for individual countries, UNCTAD*
and number of affiliates	*(published and unpublished data)*
	International Direct Investment Database, OECD
FDI Stocks and Flows	*FDI database for individual countries, UNCTAD*
	(published and unpublished data)
	International Direct Investment Database, OECD
Gross National Product	*WDI, World Bank*
(in current dollars)	*International Financial Statistics, IMF*
TFP	*Torsten Persson's data set*
(in current dollars)	
Distance	*Centre d'etudes prospectives et informations*
Common Language	*internationales (CEPII)*
Common Border	*(www.cepii.fr/anglaisgraph/bdd/distance.htm)*
Colonial Ties	
Bilateral Corporate Tax Rates	*World Tax Database from U. of Michigan*
	(www.taxanalysts.com)

Table 13: Data Sources.

Parameters	All Countries		OECD countries		Definition
	ρ_d	$\rho_s(\Delta^*)$	ρ_d	$\rho_s(\Delta^*)$	
a_d	-1.13**	-2.00**	-0.85**	-1.52	OLS bilateral distance
a_c	-	-	0.81**	0.98	OLS common border
a_l	0.48*	0.58**	-	-	OLS common language
a_{col}	0.83**	1.87**	-	-	OLS common colonial past
σ_e^2	1.32	1.19	1.24	1.44	Variance of OLS error term
d_0	5,862	2,805	5,232	1,734	mean distance
c_0	0.08	0.14	0.09	0.24	common border
l_0	0.14	0.33	0.10	0.13	common language
col_0	0.05	0.05	0.04	0.07	common colonial past
t_0	17	29	12	12	mean corporate tax
Y_0	728,764	151,583	866,878	526,540	mean GNP
TFP_0	6,339	4,362	7,237	7,395	mean TFP
X_0	8,015	1,302	12,757	2,145	mean sales of affiliates
d_2	7,505	9,045	10,190	9,525	mean distance
c_2	0.02	0.00	0.00	-	common border
l_2	0.14	0.06	0.00	-	common language
col_2	0.01	0.001	0.00	-	common colonial past
t_2	34	32	32	13	mean corporate tax
Y_2	82,576	198,727	142,143	1,251,295	mean GNP
TFP_2	4,039	4,399	5,882	7,186	mean TFP
d_1	7,027	6,620	7,402	5,677	mean distance
c_1	0.03	0.01	0.03	0.02	common border
l_1	0.13	0.17	0.07	0.07	common language
col_1	0.02	0.01	0.00	-	common colonial past
t_1	26	31	14	13	mean corporate tax

Z_0: country-pairs with $X_{ji} > 0$ and $X_{ij} > 0$; Z_1: country-pairs with $X_{ji} > 0$ and $X_{ij} = 0$; Z_2: country-pairs with $X_{ji} = 0$ and $X_{ij} = 0$. ** significant at 1%; * significant at 5%.

Table 14: Moments: simulations ($\rho_s(\Delta *)$) and data (ρ_d). All and OECD countries.

Parameters	All Countries		OECD countries		Definition
	ρ_d	$\rho_s(\Delta^*)$	ρ_d	$\rho_s(\Delta^*)$	
Y_1	355,964	179,878	284,711	762,039	mean GNP
TFP_1	5,117	4,474	6,923	7,073	mean TFP
Y_1^h	95,558	228,591	216,355	763,464	mean GNP, country i (host)
Y_1^s	615,050	131,165	353,067	760,615	mean GNP, country j (source)
TFP_1^h	3,997	1,302	6,312	2,145	mean TFP, country i (host)
TFP_1^s	6,237	127	7,533	579	mean TFP, country j (source)
X_1	16	127	308	579	mean sales of affiliates
f_2	0.77	0.52	0.01	0.26	% of country-pairs
f_0	0.11	0.16	0.91	0.31	% of country-pairs
$\ln(X_{ji}/Y_i)$	-7.12	-6.31	-5.91	-6.94	mean value of OLS dependent variable
X_{ij}	251	247	11,635	915	mean sales of affiliates, all country pairs

Z_0: country-pairs with $X_{ji} > 0$ and $X_{ij} > 0$; Z_1: country-pairs with $X_{ji} > 0$ and $X_{ij} = 0$; Z_2: country-pairs with $X_{ji} = 0$ and $X_{ij} = 0$. ** significant at 1%; * significant at 5%.

Table 14 continued

Country	source	host	Data source for:				
			FDI	sales	assets	employ.	plants
Afghanistan	X	X					
Albania	X	X					
Algeria	X	X	X	X	X	X	X
Angola	X	X	X	X	X	X	X
Argentina	X	X	X	X	X	X	X
Armenia	X	X	X	X		X	X
Australia	X	X	X			**X**	
Austria	X	X	X				X
Azerbaijan	X	X	X				
Bangladesh	X	X	X				
Belarus	X	X					
Belgium	X	X	X				
Belgium/Luxembourg	X	X	X				
Benin	X	X	X				
Bolivia	X	X	X	X	X	X	X
Bostwana	X		X	X	X	X	X
Bosnia and Herzegovina	X	X					
Brazil	X	X	X	X	X	X	X
Bulgaria	X	X	X				
Burkina Faso	X	X	X	X	X		X
Burundi	X	X	X				
Cambodia	X	X	X				X
Cameroon	X	X	X	X	X	X	X
Canada	X	X	X	X	**X**	X	
Central African Republic	X	X	X	X	X		

(**X**): Source OECD, Globalization data set. Includes only manufacturing sector.

Table 15: List of countries, by observed source/host status, and data availability.

Country	source	host	Data source for:				
			FDI	sales	assets	employ.	plants
Chad	X	X	X				
Chile	X	X	X	X	X	X	X
China	X	X	X				
Colombia	X	X	X	X	X	X	X
Congo, Republic of	X	X					
Costa Rica	X	X	X	X	X	X	X
Cote d'Ivoire	X	X					
Croatia	X	X	X				
Cuba	X	X	X		X	X	X
Czech Republic	X	X	X	X		X	
Dem. People's Rep. of Korea	X	X					
Denmark	X	X	X	**X**		**X**	X
Dominican Republic	X	X	X	X	X	X	X
Ecuador	X	X	X	X	X	X	X
Egypt	X	X					
El Salvador	X	X	X	X	X	X	X
Estonia	X	X	X				
Ethiopia	X	X	X				
Finland	X	X	X	X	X	X	X
France	X	X	X	X		**X**	
Gabon	X	X					
Gambia	X	X	X				
Georgia	X	X	X				
Germany	X	X	X	X	X	X	X
Ghana	X	X					

(**X**): Source OECD, Globalization data set. Includes only manufacturing sector.

Table 15 continued

Country	source	host	Data source for:				
			FDI	sales	assets	employ.	plants
Greece	X	X	X				
Guatemala	X	X	X	X	X	X	X
Guinea	X	X					
Guinea-Bissau	X						
Haiti	X	X	X	X	X	X	X
Honduras	X	X	X	X	X	X	X
Hong Kong (China)	X	X	X				X
Hungary	X	X	X				
India	X	X	X	X			X
Indonesia	X	X	X				
Iran	X	X					
Iraq	X	X					
Ireland	X	X	X	X		X	X
Israel	X	X					
Italy	X	X	X	X		X	X
Jamaica	X	X	X	X	X	X	X
Japan	X	X	X	X	**X**	X	X
Jordan	X	X					
Kazakhstan	X	X	X				
Kenya	X	X					
Korea	X	X	X				
Kuwait	X	X					
Kyrgyzstan	X	X	X				
Laos	X	X					
Latvia	X	X	X				
Lebanon	X	X					

(**X**): Source OECD, Globalization data set. Includes only manufacturing sector.

Table 15 continued

Country	source	host	Data source for:				
			FDI	sales	assets	employ.	plants
Lesotho	X	X					
Liberia	X	X					
Libya	X	X					
Lithuania	X	X	X				
Madagascar	X	X					
Malawi	X	X	X	X	X	X	X
Malaysia	X	X	X				
Mali	X	X	X	X	X	X	X
Mauritania	X	X					
Mauritius	X	X	X				
Mexico	X	X	X	X	X	X	X
Moldova	X	X	X				
Mongolia		X	X				
Morocco	X	X	X	X	X	X	X
Mozambique	X	X					
Myanmar		X	X				X
Namibia	X	X					
Nepal	X	X					
Netherlands	X	X	X	**X**	**X**	**X**	X
New Zealand	X	X	X				
Nicaragua	X	X	X	X	X		X
Niger		X					
Nigeria	X	X					
Norway	X	X	X	X		**X**	X
Oman	X	X					
Pakistan	X	X	X				

(**X**): Source OECD, Globalization data set. Includes only manufacturing sector.

Table 15 continued

Country	source	host	Data source for:				
			FDI	sales	assets	employ.	plants
Panama	X	X	X	X	X	X	X
Papua New Guinea	X	X	X				
Paraguay	X	X	X	X	X	X	X
Peru	X	X	X	X	X	X	X
Philippines	X	X	X				
Poland	X	X	X	X	X	X	X
Portugal	X	X	X	X		**X**	**X**
Puerto Rico	X	X					
Romania	X	X					
Russia	X	X	X				
Rwanda	X	X	X		X		
Saudi Arabia	X	X					
Senegal	X	X					
Serbia and Montenegro	X	X					
Sierra Leone	X	X	X				
Singapore	X	X	X				
Slovak Republic	X	X	X				
Slovenia	X	X					X
Somalia	X	X	X		X	X	
South Africa	X	X	X				
Spain	X	X	X	**X**		**X**	
Sri Lanka	X	X	X				
Sudan	X	X					
Suriname	X	X	X	X	X	X	X
Sweden	X	X	X	X	**X**	X	X
Switzerland	X	X	X			X	

(**X**): Source OECD, Globalization data set. Includes only manufacturing sector.

Table 15 continued

Country	source	host	Data source for:				
			FDI	sales	assets	employ.	plants
Syria	X	X					
TFYR Macedonia	X	X	X				
Taiwan	X	X	X				
Tajikistan	X	X					
Tanzania		X	X				X
Thailand	X	X	X				
Togo		X					
Trinidad and Tobago	X	X	X	X	X	X	X
Tunisia	X	X	X				
Turkey	X	X	X	**X**		**X**	
Turkmenistan	X	X					
Uganda	X	X	X	X	X	X	X
Ukraine	X	X					
United Arab Emirates	X	X					
United Kingdom	X	X	X	X		X	X
United States	X	X					
Uruguay	X	X		X	X	X	X
Uzbekistan	X	X	X	X		X	X
Venezuela	X	X	X	X	X	X	X
Vietnam	X	X	X				
Yemen	X	X					
Zambia	X	X	X	X	X	X	X
Zimbabwe	X	X	X	X	X	X	X
Zaire	X	X					

(**X**): Source OECD, Globalization data set. Includes only manufacturing sector.

Table 15 continued