Asymmetric Effects of Trade and FDI: South America versus Europe

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November 26, 2013

Abstract

I study the interaction between trade barriers and country size in the location decision of multinational firms, and the resulting effects on different economic outcomes. I construct a heterogeneous firm model of trade with monopolistic competition, asymmetric size countries, and multinational production (MP). I show that MP and bridge multinational production (BMP) -the possibility of foreign firms to export- are crucial to understand the gains from openness. The model is calibrated separately to two trade areas: Europe and the Mercosur in South America. I then focus on the effects of closing countries to international trade. I find that losses are greater in Europe. The reason is that these countries are much more open than South American ones to start with. I explore the effects of eliminating the possibility of BMP, and find that while BMP reduces in 5 percentage points the losses from closing the economies to international trade in the Netherlands, it only reduces them in 1 percentage point in Uruguay. Still, BMP is key for Uruguay to fully benefit from a reduction in trade costs: without BMP, these gains are 5 percentage points lower. Finally, MP and BMP skew the distribution of firm sizes towards large firms.

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1 Introduction

Trade barriers affect not only the decisions of domestic firms to trade but also the location decision of multinational firms. In the presence of fixed costs of multinational production, the size of a country plays an important role in the location decision. I study how trade barriers and country size interact to determine the location of multinational firms, and its effects on GDP, GNP and firm size distribution.

Trade barriers affect the location decision of multinational firms in two ways. First, by changing the relative cost of exporting compared to producing in the consumption location. A firm may decide to become multinational if it is cheaper to serve a market by MP rather than by exporting. Second, by changing the relative costs of exporting from two different locations. Firms may use a country as an export platform to serve a set of neighbor countries. The importance of these two channels depends critically on size. For a small country it is difficult to attract multinational production (MP) to overcome trade barriers since its domestic market is small. Then, for a small country the way of attracting multinational firms is by offering the possibility of serving other countries, i.e. to be used as an export platform. On the other hand, large countries, as they have large markets, can attract MP even with high trade costs (they can attract even a larger amount of MP with trade barriers than without).

I quantitatively compare the performance of large and small countries in two different trading arrangements: MERCOSUR in South America, with high trade barriers; and the European Union, with low trade barriers. In order to do so, I use a heterogenous firm model of trade with monopolistic competition, asymmetric countries, and allowing for MP and BMP. I perform two separate calibrations, one to South America, with three MERCOSUR countries (Argentina, Brazil and Uruguay) plus Chile; and other to Europe, including four members of the European Union (France, Italy, Netherlands and United Kingdom). In both cases I include a fifth country which will be the rest of the world. To calibrate the model I use data on bilateral trade flows, bilateral FDI flows, firm composition (domestic and foreign, exporters and non-exporters), GDP per capita, manufacturing trade deficit, and labor force size.

I find that BMP plays an important role for the small country in the open region but not for the small country in the closed region. In the Netherlands (the smallest country in the open region) the losses in real manufacturing GDP of going to autarky in a world without BMP are 5 percentage points lower than in the case with BMP. On the contrary, Uruguay, the smallest country in the closed region, does not benefit from

\footnote{I call this mechanism bridge multinational production (BMP) following Ramondo and Rodríguez-Clare (2013).}
BMP since the losses in real manufacturing GDP when not allowing for BMP are only 1 percentage point lower than in the case with BMP. However, the losses in Uruguay are not only a consequence of trade barriers, but also from the low productivity that foreign firms face when producing there. By only reducing trade costs in South America to the average level in Europe, real manufacturing GDP would increase 31% in Uruguay. If I also improve the efficiency in Uruguay by 20% with respect to the average in Europe, real manufacturing GDP increases 41%. However, to take advantage of the better efficiency, Uruguay needs BMP. Without BMP the gains in real manufacturing GDP from reducing trade costs and improving efficiency are the same as if I only reduce trade costs.

My second finding is that the differences between what a small and what a big country lose when going to autarky are very different among regions. In South America, the difference in losses are more homogeneous than in Europe. The difference between what Brazil (the largest country) loses in real manufacturing GDP and what Uruguay (the smallest country) loses is of 8.1 percentage points. While in Europe the difference between what the Netherlands and what Italy loses is of 15.1 percentage points. The higher heterogeneity in Europe comes from the fact that is more open than South America which allow an small country like the Netherlands to take advantage from trade and MP.

Finally, I find that internationalization of firms have an important effect on the size distribution of firms. There is a large literature studying the effects of different kind of frictions on the misallocation of resources. There are papers studying the effects of size dependent policies (Guner et al. (2008), Restuccia and Rogerson (2008), García-Santana and Pijoan-Mas (2012)), capital market imperfections (Erosa (2001), Amaral and Quintin (2010), Buera et al. (2011), Greenwood et al. (2010), Allub and Erosa (2013)) and trade (Melitz (2003), Piguillem and Rubini (2012)) on firm size distribution. My theory implies that MP and BMP have also an important effect on the distribution of firm sizes, since they shift it toward large firms. In a world in autarky, the Netherlands and Uruguay would have the same firm size distribution. However, in the benchmark calibration, the Netherlands have a proportion of firms with more than 100 employees that doubles that of Uruguay, and of more than 250 employees which is almost four times that of Uruguay.

There have been papers studying the interaction of trade and MP.2 Ramondo and Rodríguez-Clare (2013) use a ricardian model of trade to address the gains from openness (trade and MP). However, in this kind of model they can not address the effects of

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country size on the location of multinational firms since there is perfect competition and as a result there are no fixed cost. Arkolakis et al. (2013) model trade and MP with monopolistic competition. However, they do not include fixed costs of setting up foreign firms. Fixed costs are important to study the role that the size of a country plays in determining the location of multinationals. With fixed costs there are increasing returns in production which makes the size of a market an important variable to make a location decision. The closest paper to mine is Tintelnot (2012). He includes fixed cost of producing and performing MP and studies the gains from openness (trade and MP) in a monopolistic competition set-up. The focus in my theory is on how BMP shapes the impact of country size and geography (the distribution of trade costs across different countries) on the determination of output and trade across countries. In particular, I use my theory to quantitatively assess and compare the geography of trade and multinational production barriers in South America versus Europe. Finally, I also assess the effects of trade, MP and BMP on the distribution of firm sizes.

2 Facts

Multinational production has been growing in the last three decades. In their book, “Multinational Production in the World Economy”, Barba Navaretti and Venables (2004) describe several stylized facts of multinational production. They show that: (i) multinational production grew dramatically since 1986 until 2000 and then stabilized until 2003; (ii) most of foreign direct investment (FDI) is originated in developed economies; (iii) even though most of FDI goes to developed economies, the share of developing economies has been rising; (iv) multinational enterprises are larger and sometimes more productive than national firms; and (v) multinational firms are increasingly engaged in international production networks. I focus my attention on how FDI interacted with trade in two regions: South America and Europe.

Small countries have higher trade and FDI to GDP ratios. Also countries with larger trade-to-GDP ratio present higher FDI-to-GDP ratios. Figures 1 and 2 show trade and FDI statistics for a selection of countries for the years 1996 and 1995 respectively. In 1996 trade over absorption\(^3\) in Uruguay and Chile was almost 60% half of the one for Netherlands. Also, Argentina and Brazil show ratios of trade over absorption smaller than the rest of countries included. Brazil has a trade over absorption ratio just above 20% while United Kingdom has almost 70%.

The FDI stock as a percentage of GDP was also low for Uruguay compared to small

\(^3\)Absorption in country \(i\) is defined as in Waugh (2010), Gross Mfg. Production\(_i\) − Total Exports\(_i\) + Imports\(_i\).
economies in other regions. The FDI-to-GDP ratio for Uruguay was 5%, while a small economy in Europe like the Netherlands presents ratios of FDI to GDP of 28%, or 40% in Belgium. Large economies in South America do not perform better than large European economies either, since Argentina and Brazil present ratios smaller than those of United Kingdom or France.

In Table 1 and Figures 3 to 5, I present the correlations between trade, measured as exports plus imports over GDP; size, measured as the logarithm of the labor force; and FDI, measured as FDI stock over GDP for the years 1995 and 2010. The data comes from the United Nations and is a sample of all the countries in the world with available data. Table 1 shows that in 2010 the correlation between trade and size is negative, \( -0.33 \); the correlation between size and FDI is also negative, \( -0.33 \); and the correlation between FDI and trade is positive, 0.67.

In summary, South American countries perform very poorly in trade and FDI statistics compared to similar countries in other regions. The fact that South America is more closed can be particularly damaging for small countries in the region, like Uruguay, for whom trade would be extremely important.

3 Model

The model is built on Melitz (2003) but adds the possibility of multinational production and bridge multinational production. There is a set of countries with different sizes. In each country there is a representative consumer. In the world economy there are two types of goods: a homogeneous good and a differentiated good, both of them tradable. Each differentiated good is produced by a firm with a given productivity. Differentiated goods have three sub-indices: the first one indicates where the good is consumed, the second one where the good is produced and the last one to which country the firm that produced the good belongs. For example, \( q_{ijk}(\omega) \) is the quantity of good \( \omega \) consumed in country \( i \) and produced in country \( j \) by a firm from country \( k \).

3.1 Countries

The world economy consists of \( i = 1, \ldots, N \) countries; two sectors: an homogeneous-good sector (sector 0) and a differentiated good sector (sector 1); one factor of production, labor; and a continuum of goods indexed by \( \omega \in \Omega \). All goods in the economy are tradable. Each country has a population of \( L_i \) individuals who supply labor inelastically. Let \( w_i \) be the wage in country \( i \) in terms of the homogeneous good. I set the price of the homogeneous good, \( P_0 \), to be the numeraire. In each country there is a large mass
of potential firms producing.

### 3.2 Consumers

In each country there is a representative consumer with Cobb-Douglas preferences:

\[ U_i = q_{0i}^{\mu_0} q_{1i}^{1-\mu_0} \]

where \( \mu_0 \) is the share of the homogeneous good in total consumption and \( q_1 \) is a Dixit-Stiglitz aggregator\(^4\):

\[ q_{i,1} = \left( \int q_i(\omega) \left( \frac{\sigma-1}{\sigma} \right) d\omega \right)^{\frac{\sigma}{\sigma-1}}, \]

where \( \sigma > 1 \) is the elasticity of substitution between varieties and \( q_{i,1} \) are all the varieties consumed in country \( i \).

The above utility function implies that the representative consumer will spend \( \mu_0 \) share of his income on the homogeneous good and \( 1 - \mu_0 \) in differentiated goods. Define \( (1 - \mu_0) \times E = E^1 \) where \( E \) is total expenditure. Then the demand functions are:

\[ \begin{align*}
q_{0i} &= \frac{\mu_0 E_i}{P_{0i}^i}, \\
q_{1i} &= \frac{(1 - \mu_0) E_i}{P_{0i}^i},
\end{align*} \]

where \( P_{0i}^i \) is the aggregate price index in country \( i \) including the homogeneous good sector. I call \( P_i \) the aggregate price index in the differentiated good sector.\(^5\)

**Assumption 1:** A variety is defined by the country of origin of the firm and the country where the good is produced.

In this case a good produced in country \( i \) by a firm from country \( i \) is different from a good produced by the same firm in country \( j \). As a result of assumption 1 we have four kinds of varieties in country \( i \):

- **Domestic varieties:**
  - Goods produced in the domestic country by domestic firms.
  - Goods produced in the domestic country by foreign firms.

- **Imported varieties:**

\(^4\)Where \( \rho = \frac{\sigma-1}{\sigma} \). I will use \( \sigma \) or \( \rho \) in my definitions depending on convenience.

\(^5\)I will give a formula for \( P_i \) later on since I still need to define some concepts used in the definition of \( P_i \).
– Goods produced in country \( j \) by firms from \( j \).
– Goods produced in country \( j \) by firms from any other country.

The demand for variety \( \omega \) is given by:

\[
q_{jki}(\omega) = \frac{E^1_j}{P_j} \left( \frac{P_{jki}(\omega)}{P_j} \right)^{-\sigma},
\]

(3)

where \( E^1_j \) is aggregate expenditure of country \( j \) in differentiated goods and \( P_j \) is the aggregate price. The demand of good \( q_{jki}(\omega) \) is increasing in total expenditure and the aggregate price of the country where the good is consumed (\( E^1_j \) and \( P_j \)), and decreasing in the price of the good.

### 3.3 Homogeneous good

Each country has an exogenous endowment \( z_i \) of the homogeneous good. This good is traded without any cost. This implies that the price of this good will be equalized among countries. We will denote the price of the homogeneous good as \( p_0 \). Each country will be an exporter or importer of this good depending on whether the domestic supply of the good is bigger or smaller than the domestic demand of the good.

Introducing this sector allows the model to have countries with trade deficit in the differentiated good and also a greater outflow of capital (foreign firms sending back profits) than inflow of capital, something that is present in the Latin-American countries I am considering.

### 3.4 Production

To draw the labor productivity \( \phi \) firms need to pay a fixed investment cost \( \kappa_i^e \) denominated in labor units. Then, what a firm pays is \( w_i \ast \kappa_i^e \). I assume that productivities are drawn from a Pareto distribution. After observing the productivity, firms decide whether to produce or not. Production requires only labor. To produce, firms have to pay a fixed cost of operation \( \kappa_i^d \), also denominated in labor units. There are other activities that the firms can choose to perform: to export; to produce in a foreign country to sell there; or to produce in a foreign country and export from there. Each of these activities has an associated fixed and iceberg type cost. Firms producing in country \( i \) and exporting to country \( j \) have to pay a fixed cost \( w_i \ast \kappa_i^e \) and an iceberg cost \( \tau_{ji} \) i.e. they have to send \( \tau_{ji} \geq 1 \) units of the good for one unit to arrive destiny. Firms from country \( i \) producing in country \( j \) have to pay a fixed cost \( w_j \ast \kappa_j^{MP} \) and an iceberg type cost of \( \gamma_{ji} \). \( \kappa_j^{MP} \) includes the domestic cost of producing in country \( j \) and an extra cost for multinational firms i.e. \( \kappa_j^{MP} \geq \kappa_j^d \). Here I make use again of assumption 1. This assumption allows
me to treat each activity as an independent activity. For each activity there will be a productivity cut-off, in contrast with Helpman et al. (2004) who assume that a firm either exports or opens a subsidiary but not both. Later on I will show that all the productivity cut-offs can be expressed in terms of the domestic cut-offs. As a result, in order to solve for all the cut-offs for all countries we need to know only the domestic productivity cut-offs for all the countries.

A firm from country $i$ producing $q_{jki}$ units in country $k$ and selling to country $j$ has the following variable cost:

$$c_{jki}(\omega) = \frac{\tau_{jk} \gamma_{ki} w_k}{\phi} q_{jki}(\omega).$$

If $j = k$ then $\tau_{jk} = 1$, and if $k = i$ then $\gamma_{ki} = 1$. Notice that a firm from country $i$ producing in country $k$ and selling to country $j$, with $i \neq k$ and $j \neq k$, has to pay both costs $\gamma_{ki}$ and $\tau_{jk}$. Maximizing variable profits of the firm,

$$\max_{p(\omega)} \pi = p(\omega)q(\omega) - c(\omega),$$

where $q(\omega)$ was defined in equation (3), we get the price of a variety, given by:

$$p_{jki}(\omega) = \frac{w_k \gamma_{ki} \tau_{jk}}{\rho \phi}.$$  

As each firm produces a different variety we can substitute, without loss of generality, $\omega$ by $\phi$. Using expression (3) and (5) we obtain the revenue associated with each activity.

Selling Domestically $\Rightarrow r_{iii}(\phi) = E_i P_i^{\sigma-1} \left( \frac{\rho \phi}{w_i} \right)^{\sigma-1}$

Exporting from the home country $\Rightarrow r_{kii}(\phi) = E_k P_k^{\sigma-1} \left( \frac{\rho \phi}{w_i \tau_{ki}} \right)^{\sigma-1}$

Doing MP in country $k$ $\Rightarrow r_{kki}(\phi) = E_k P_k^{\sigma-1} \left( \frac{\rho \phi}{w_k \gamma_{ki}} \right)^{\sigma-1}$

Doing BMP in $k$ to sell in $j$ $\Rightarrow r_{jki}(\phi) = E_j P_j^{\sigma-1} \left( \frac{\rho \phi}{w_k \gamma_{ki} \tau_{jk}} \right)^{\sigma-1}$

Assumption 2: Any firm from country $i$ has to pay the domestic cost of producing in $i$.

With this assumption we ensure that there are no firm from country $i$ producing in $j$ and not in $i$. As every firm producing domestically has to pay the fixed cost, every

\footnote{Using assumption 1, I can extend the results from Melitz (2003) considering multinational production and BMP just as an additional activity which simplifies the problem.}
firm exporting also sells domestically since the profits of selling domestically without the fixed cost are always positive. A similar argument applies for domestic firms exporting from a third country, they always sells to the country where they are producing.

The profits associated to each activity are given by:

\[
\begin{align*}
\text{Selling Domestically} & \Rightarrow \pi_{iii}(\phi) = \frac{E_{i}^{1}P_{i}^{\sigma-1}}{\sigma} \left( \frac{\rho_{i}^{\phi}}{w_{i}} \right)^{\sigma-1} - \kappa_{d}^{i} w_{i} \\
\text{Exporting from the home country} & \Rightarrow \pi_{kii}(\phi) = \frac{E_{k}^{1}P_{k}^{\sigma-1}}{\sigma} \left( \frac{\rho_{k}^{\phi}}{w_{k}^{\gamma_{k}}} \right)^{\sigma-1} - \kappa_{x}^{k} w_{k} \\
\text{Doing MP in country } k & \Rightarrow \pi_{kki}(\phi) = \frac{E_{k}^{1}P_{k}^{\sigma-1}}{\sigma} \left( \frac{\rho_{k}^{\phi}}{w_{k}^{\gamma_{k}} \tau_{jk}} \right)^{\sigma-1} - \kappa_{fdi}^{k} w_{k} \\
\text{Doing BMP in } k \text{ to sell in } j & \Rightarrow \pi_{jki}(\phi) = \frac{E_{j}^{1}P_{j}^{\sigma-1}}{\sigma} \left( \frac{\rho_{j}^{\phi}}{w_{j}^{\gamma_{jk}}} \right)^{\sigma-1} - \kappa_{x}^{k} w_{k}
\end{align*}
\]

Note that profits from every activity are increasing in \( \phi \) since \( \sigma - 1 > 0 \). More productive firms make higher profits.

Then, the profit made by a firm from country \( i \) is given by the sum of profits from all the activities it performs. This is:

\[
\pi_{i}(\phi) = \pi_{iii}(\phi) + \sum_{k \neq i} \max\{0, \pi_{kii}(\phi)\} + \sum_{k \neq i} \max\{0, \pi_{kki}(\phi)\} + \sum_{k \neq i} \sum_{j \neq k} \max\{0, \pi_{jki}(\phi)\}.
\]

Equating the profits of each activity to zero, we can find the different cut-offs and the revenues associated with them. We will have for country \( i \):

\[
\begin{align*}
1 \text{ Domestic cut-off } & \Rightarrow \phi_{iii}^{*} ; \quad r(\phi_{iii}^{*}) = \sigma \kappa_{d}^{i} w_{i} \\
(N - 1) \text{ Exporting cut-offs } & \Rightarrow \phi_{kii}^{*} ; \quad r(\phi_{kii}^{*}) = \sigma \kappa_{x}^{k} w_{i} \quad (9) \\
(N - 1) \text{ MP cut-offs } & \Rightarrow \phi_{kki}^{*} ; \quad r(\phi_{kki}^{*}) = \sigma \kappa_{fdi}^{k} w_{k} \\
(N - 1)^{2} \text{ BMP cut-offs } & \Rightarrow \phi_{jki}^{*} ; \quad r(\phi_{jki}^{*}) = \sigma \kappa_{x}^{k} w_{k}
\end{align*}
\]

Since profits are increasing in \( \phi \) for each activity there is a unique productivity level at which the activity becomes profitable. All productivities above that level will give positive profits. If the productivity is high enough it can be the case that a firm can perform all the activities.

Now we have all the elements to state the equation for the aggregate price.

\[\text{When a variable is associated to a specific value of } \phi \text{ I will put the sub-indexes in } \phi. \text{ For example, the revenue of the firm with the domestic cut-off level it will be } r(\phi_{iii}^{*}) \text{ for country } i. \text{ On the other hand, for a general value of a } \phi \text{ I will put the sub-indexes in the variable itself, for example the revenue of a domestic firm with productivity } \phi \text{ selling domestically is } r_{iii}(\phi).\]
3.5 Productivity distribution

Productivities are drawn from a Pareto distribution with scale parameter $\phi_i^m$ and shape parameter $\alpha_i$. Define the density function as $g_i(\phi) = \alpha_i (\phi_i^m / \phi)^{\alpha_i}$. As only firms with productivities above $\phi_i^*_{iii}$ will produce in country $i$, then the equilibrium distribution of productivities of domestic firms is:

$$
\mu_i(\phi) = \frac{g_i(\phi)}{1 - G(\phi_i^*)} \text{ if } \phi \geq \phi_i^* ,
$$

and 0 otherwise. The conditional probability of performing each of the other activities is:

- Exporting to country $k \Rightarrow \theta_{kii} = 1 - G(\phi_i^*) / 1 - G(\phi_i^*)$
- Doing FDI in country $k \Rightarrow \theta_{kki} = 1 - G(\phi_i^*) / 1 - G(\phi_i^*)$
- Doing BMP in $k$ to sell in $j \Rightarrow \theta_{jki} = 1 - G(\phi_i^*) / 1 - G(\phi_i^*)$

I can calculate the average productivity for each activity as:

$$
\hat{\phi}_{jki} = \left[ \int_{\phi_i^*}^{\infty} \phi^{\sigma-1} \mu_i(\phi) \, d\phi \right]^{1/(\sigma-1)}
$$

for all $i$, $j$ and $k$. Notice that $\hat{\phi}_{jki}$ only depends on the cut-off productivity.

Following Melitz (2003), we can consider that for each activity there is a representative firm with productivity $\hat{\phi}_{jki}$. The average productivity $\hat{\phi}_{jki}$ summarizes all the information concerning each activity. This is convenient because now aggregate variables for each activity can be expressed in terms of $\hat{\phi}_{jki}$. One difference with respect to the case of Melitz (2003) is that in his case it is possible to calculate an average productivity for the whole economy since he only has domestic firms. In this paper, the average productivity of a country will be given by the domestic firms producing domestically and also by foreign firms producing domestically. Then, aggregate variables for the whole economy will depend not only on the domestic mass of firms but also on the mass of firms of the rest of countries.

Evaluating revenues at the average productivity level and making the ratio of this revenue with a revenue evaluated at any other productivity level we find that:

$$
\frac{r(\hat{\phi}_{iii})}{r_{iii}(\phi)} = \frac{E_i^1 P_i^{\sigma-1} \left( \frac{\hat{\phi}_{iii}}{u_i} \right)^{\sigma-1}}{E_i^1 P_i^{\sigma-1} \left( \frac{\phi}{u_i} \right)^{\sigma-1}} \Rightarrow r_{iii}(\hat{\phi}) = \left( \frac{\hat{\phi}_{iii}}{\phi} \right)^{\sigma-1} r_{iii}(\phi)
$$

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*In a Pareto distribution the scale parameter indicates the minimum value that the random variable can take.*
We can get the previous relation for each activity: exporting; doing MP and doing BMP.

Exporting to country \( k \Rightarrow r(\tilde{\phi}_{kii}) = \left( \frac{\tilde{\phi}_{kii}}{\phi} \right)^{\sigma - 1} r_{kii}(\phi) \)

Doing MP in country \( k \Rightarrow r(\tilde{\phi}_{kki}) = \left( \frac{\tilde{\phi}_{kki}}{\phi} \right)^{\sigma - 1} r_{kki}(\phi) \)

Doing BMP in \( k \) to sell in \( j \Rightarrow r(\tilde{\phi}_{jki}) = \left( \frac{\tilde{\phi}_{jki}}{\phi} \right)^{\sigma - 1} r_{jki}(\phi) \)

### 3.6 Sales distribution

Sales for a given activity are given by

\[
E_j \left( P_i \rho \phi w_i \gamma_{ki} \tau_{jk} \right)^{\sigma - 1},
\]

where \( E_j \) is aggregate expenditure in country \( j \). Given that productivities are drawn from a Pareto distribution it is possible to obtain the distribution of sales for each activity analytically. I will do this for domestic firms selling domestically \( r_{iii}(\phi) \), but the procedure is the same for other activities:

\[
\text{prob}(r_{iii}(\phi) > y) = \text{prob} \left( E_i \left( P_i \rho \phi w_i \gamma_{ki} \tau_{jk} \right)^{\sigma - 1} > y \right)
\]

\[
= \text{prob} \left( \phi > \left( \frac{y}{E_i} \right)^{1/(\sigma - 1)} \frac{w_i}{P_i \rho} \right).
\]

As \( \phi \) is distributed Pareto we can calculate this probability to be

\[
\text{prob}(r_{iii}(\phi) > y) = \left( \frac{\phi_{m,i}}{\phi_{m,i}} \right)^{\alpha} \left( \frac{y}{E_i} \right)^{1/(\sigma - 1)} \frac{w_i}{P_i \rho} \]

where \( \phi_{m,i} \) is the scale parameter (the minimum value that \( \phi \) can take) of the Pareto distribution. We can write the above expression as:

\[
\text{prob}(r_{iii}(\phi) > y) = \left( \frac{E_i (P_i \rho \phi_{m,i} / w_i)}{y^{1/(\sigma - 1)}} \right)^{\alpha}
\]

\[
\text{prob}(r_{iii}(\phi) > y) = \left( \frac{E_i (P_i \rho \phi_{m,i} / w_i)}{y} \right)^{\alpha/(\sigma - 1)}
\]

\[
\text{prob}(r_{iii}(\phi) > y) = \left( \frac{r_{m,i} \phi_{m,i}}{y} \right)^{\alpha/(\sigma - 1)}
\]

where \( r_{m,i}(\phi_{m,i}) = E_i (P_i \rho \phi_{m,i})^{\sigma - 1} \) is the revenue of a firm from country \( i \) with productivity equal to \( \phi_{m,i} \) producing and selling domestically. Then \( r_{iii}(\phi) \) is distributed Pareto with scale parameter \( r_{m,i} \) and shape parameter \( \alpha/(\sigma - 1) \). This would be the
distribution of sales if all the firms were producing. But, as we stated previously, there will be some firms (the ones with productivity between \( \phi_{m,i} \) and \( \phi^*_{iii} \)) which are not going to produce. Then, the true distribution of sales will be a truncation of the previous distribution. The Pareto distribution has the property that if it is truncated, the remaining distribution is still Pareto with the same shape parameter. Then sales \( (r_{iii}(\phi)) \) are distributed Pareto with scale parameter \( r_{iii}(\phi^*) \) and shape parameter \( \alpha/(\sigma - 1) \), where \( r_{iii}(\phi^*) \) are the sales of a firm with the cut-off productivity.

For the rest of activities we can operate in a similar way and we obtain:

- Exporting firms \( \Rightarrow \text{prob}(r_{kii} > y) = \left( \frac{\left( E^1_k \left( \frac{P_k \rho \phi_{m,i}}{w_k \tau_{ki}} \right)^{(\sigma-1)} \right)}{y} \right)^{\alpha/(\sigma-1)} \)

- Doing FDI in country \( k \) \( \Rightarrow \text{prob}(r_{kki} > y) = \left( \frac{\left( E^1_k \left( \frac{P_k \rho \phi_{m,i}}{w_k \gamma_{ki}} \right)^{(\sigma-1)} \right)}{y} \right)^{\alpha/(\sigma-1)} \)

- Doing BMP in \( k \) to sell in \( j \) \( \Rightarrow \text{prob}(r_{jki} > y) = \left( \frac{\left( E^1_j \left( \frac{P_j \rho \phi_{m,i}}{w_k \tau_{jk} \gamma_{ki}} \right)^{(\sigma-1)} \right)}{y} \right)^{\alpha/(\sigma-1)} \)

where the numerator of each equation are the sales for each activity that corresponds to the minimum productivity level. As in the case of domestic sales, the equilibrium distribution of sales for each activity is going to be Pareto with shape parameter \( \alpha/(\sigma - 1) \) and scale parameter \( r(\phi^*_{jki}) \), where \( r(\phi^*_{jki}) \) is sales of a firm with the cut-off productivity level for a firm from country \( i \) producing in country \( k \) and selling to country \( j \).

Notice that profits and revenues have the same shape for all countries but they are scaled by aggregate expenditures \( E_i \). Aggregate expenditure is determined, among other factors, by the population size. Hence, the profitability of a foreign firm depends on the selling country size. Given that two countries have similar variable and fixed trade costs, a multinational plant will prefer to get installed in the bigger country. As a result, a small country will attract less investment than a bigger one. To better understand this, consider equation (7). Assume that the country where the good is going to be consumed is Uruguay, and a firm from Japan is considering the different possibilities of serving Uruguay. If the fixed export cost in Japan is high, then it could be better to produce the good directly in Uruguay. This will be the case if the fixed cost to open a subsidiary in Uruguay is not very high and also the productivity loss for producing abroad (\( \gamma_{Uru,Jap} \)) is low. Now, imagine that Japan is also considering to sell to Argentina, and that the productivity loss of producing in Argentina for a Japanese firm is the same as in Uruguay \( \gamma_{Uru,Jap} = \gamma_{Uru,Jap} \). Then, as Argentina is bigger, \( E^1_{Arg} \) > \( E^1_{Uru} \). If aggregate prices,
wages and fixed costs are not very different the Japanese firm will prefer to produce in Argentina to producing in Uruguay. In other words, the productivity required by a Japanese firm to start producing in Argentina is lower (ceteris paribus) than the one required to produce in Uruguay. This implies that more firms get located in Argentina. Size, then, is crucial to attract foreign investment.

3.7 Profits

Using equations (7), (9) and (12), we can calculate average profits in terms of average productivities and cut-offs. The average profit of firms performing each activity is:

Selling Domestically ⇒ \( \bar{\pi}_{iii} = \kappa_i^d w_i \left( \frac{z_{\phi_{iii}}}{\phi_{\kappa_{iii}}} \right)^{\sigma-1} - 1 \)

Exporting from the home country ⇒ \( \bar{\pi}_{kii} = \kappa_i^{x} w_i \left( \frac{z_{\phi_{kii}}}{\phi_{\kappa_{kii}}} \right)^{\sigma-1} - 1 \)

Doing MP in country \( k \) ⇒ \( \bar{\pi}_{kki} = \kappa_k^{MP} w_k \left( \frac{z_{\phi_{kki}}}{\phi_{\kappa_{kki}}} \right)^{\sigma-1} - 1 \)

Doing BMP in \( k \) to sell in \( j \) ⇒ \( \bar{\pi}_{jki} = \kappa_k^{x} w_k \left( \frac{z_{\phi_{jki}}}{\phi_{\kappa_{jki}}} \right)^{\sigma-1} - 1 \)

We can calculate the average profit of a firm from country \( i \) as:

\[
\bar{\pi}_i = \bar{\pi}_{iii} + \sum_{k \neq i} \theta_{kii} \bar{\pi}_{kii} + \sum_{k \neq i} \theta_{kki} \bar{\pi}_{kki} + \sum_{k \neq j} \sum_{k \neq i} \theta_{jki} \bar{\pi}_{jki}.
\]  

3.8 Mass of Firms

Define \( M_i^e \) to be the total mass of firms taking a productivity draw, and \( M_i \) as the mass of firms finally operating. By definition, the total mass of firms operating should be equal to the total mass of firms making a productivity draw times the probability of successful entry, which is \( \theta_{iii} M_i^e = M_i \). In the case of open economy without FDI we can obtain \( M_i \) in the same way as Melitz (2003). \( M_i = R_i / \bar{r}_i \), where \( R_i = w_i L_i \) denotes aggregate revenue and aggregate expenditure. In Melitz (2003), aggregate revenue and total payment to labor are equal because total profits (\( \Pi \)) are equal to the payment to labor used in making the productivity draw (\( \kappa_i^e w_i \)) in equilibrium and only domestic firms produce in country \( i \). However, when foreign firms are allowed to produce in the domestic country \( R_i \neq w_i L_i \). The equality does not hold because foreign firms send their profits abroad, and domestic firms producing abroad bring their profits home, making total expenditure in the country also a function of profits of domestic firms abroad.
However, it is still true that \( w_i L_i^e = \Pi_i \) \(^9\), but the determination for labor used in production is different. Now the total payment to labor in country \( i \) is equal to revenue minus profits of firms producing in \( i \), which can include foreign firms. In equations, \( w_i L_i^p = \hat{R}_i - \hat{\Pi}_i \) where \( \hat{R}_i \) and \( \hat{\Pi}_i \) are revenues and profits of firms producing in country \( i \) (domestic or foreign).

The total mass of firms performing each of the other activities is obtained by multiplying the mass of firms operating \( M_i \) by the conditional probability of performing the activity \( M_{jki} = \theta_{jki} M_i \). Now we have all the elements to state the following equation for the aggregate price in country \( i \):

\[
P_i = \left[ \int_{\phi_{ii}} (p_{ii}(\phi))^{1-\sigma} M_i \mu_i(\phi) d\phi + \sum_{k \neq i} \int_{\phi_{ikk}} (p_{ikk}(\phi))^{1-\sigma} M_{ikk} \mu_k(\phi) d\phi \right]^{\frac{1}{1-\sigma}} \]

\[+ \sum_{k \neq i} \int_{\phi_{ik}} (p_{ik}(\phi))^{1-\sigma} M_{iik} \mu_k(\phi) d\phi + \sum_{k \neq j} \sum_{k \neq i} \int_{\phi_{jk}} (p_{ijk}(\phi))^{1-\sigma} M_{ijk} \mu_j(\phi) d\phi \] \hspace{1cm} (14)

### 3.9 Trade and Multinational Production

Trade of a country will be given by the amount of exports and imports. Exports are composed by all the sales to foreign countries from firms (either domestic or foreign) producing in the domestic country. The expression for total exports in the differentiated good sector is given by:

\[
\text{Exports}_i = X_i = \sum_{k \neq i} M_{kii} r_{kii}(\tilde{\phi}_{kii}) + \sum_{k \neq i} \sum_{k \neq j} M_{jik} r_{jik}(\tilde{\phi}_{jik}) .
\]

In a similar way, imports in the differentiated good sector are all the goods consumed in the domestic country and produced in a foreign country. So total imports are:

\[
\text{Imports}_i = IM_i = \sum_{k \neq i} M_{ikk} r_{ikk}(\tilde{\phi}_{ikk}) + \sum_{k \neq i} \sum_{k \neq j} M_{ijk} r_{ijk}(\tilde{\phi}_{ijk}) .
\]

The Current Account is the sum of Trade Balance (\( TB \)) \( TB_i = (z_i - q_{i0}) + X_i - IM_i \) where \( (z_i - q_{i0}) \) is net exports of the homogeneous good, and the capital account balance, which is the difference between profits of domestic firms abroad and profits of foreign firms producing in the domestic country. The CA balance equation can be written as:

\[
\text{CA}_i = (z_i - q_{i0}) + X_i - IM_i + \sum_k \sum_{j \neq i} M_{kji} \tilde{\pi}_{kji} - \sum_k \sum_{j \neq i} M_{kij} \tilde{\pi}_{kij} . \hspace{1cm} (15)
\]

\(^9\)This is obtained using the equation for total payment to labor used in investment and the free entry condition, which I explain later.
The amount of multinational production in a country can be calculated as the sum of revenues from all foreign firms producing in the domestic country i.e.

\[ MP_i = \sum_{k \neq i} M_{ik}r_{ik}(\tilde{\phi}_{ik}) + \sum_{k \neq i, k \neq j} M_{kij}r_{kij}(\tilde{\phi}_{kij}) \]

Foreign firms selling in \( i \)  Foreign firms producing in \( i \) and exporting

3.10 Aggregation

Define \( M^p_i \) as the mass of firms producing in country and \( M^s_i \) as the mass of firms selling goods to country \( i \). Then,

\[ M^p_i = M_i + \sum_{k \neq i} M_{ik} + \sum_{k \neq i, i \neq j} M_{ijk} , \]

\[ M^s_i = M_i + \sum_{k \neq i} M_{ik} + \sum_{k \neq j, i \neq j} M_{ijk} . \]

Having defined the mass of firms producing and selling in each country we can define the weighted average productivity of firms producing \( (\tilde{\phi}_i^P) \) and selling \( (\tilde{\phi}_i^S) \) as:

\[ \tilde{\phi}_i^P = \left\{ \frac{1}{M^p_i} \left[ M_{iii}\tilde{\phi}_{iii}^{\sigma-1} + \sum_{k \neq i} M_{kii} \frac{E_k}{E_i} \left( \frac{P_k}{\tau_{ki}P_i} \right)^{\sigma-1} \tilde{\phi}_{kii}^{\sigma-1} + \sum_{k \neq i} M_{ik} \left( \frac{1}{\gamma_{ik}} \right)^{\sigma-1} \tilde{\phi}_{ik}^{\sigma-1} \right] \right\}^{\frac{1}{\sigma-1}}, \]  \quad (16)

\[ \tilde{\phi}_i^S = \left\{ \frac{1}{M^s_i} \left[ M_{iii}\tilde{\phi}_{iii}^{\sigma-1} + \sum_{k \neq i} M_{ikk} \left( \frac{w_k\tau_{ik}}{w_i} \right)^{1-\sigma} \tilde{\phi}_{ikk}^{\sigma-1} + \sum_{k \neq i} M_{ik} \gamma_{ik}^{1-\sigma} \tilde{\phi}_{ik}^{\sigma-1} \right] \right\}^{\frac{1}{1-\sigma}}, \]  \quad (17)

Using these two equations we can define aggregate price and aggregate production in the differentiated good sector in country \( i \) as:

\[ P_i = (M_i^p)^{1-\sigma} p(\tilde{\phi}_i^S) = (M_i^s)^{1-\sigma} \frac{w_i}{\rho \tilde{\phi}_i^S} , \]

\[ GDP_i = M^p_i E_i \left( \frac{P_i \tilde{\phi}_i^p}{w_i} \right)^{\sigma-1} . \]  \quad (19)

3.11 Equilibrium

In order to solve for the equilibrium we need to find \( 3 * N + 1 \) variables: \( N \) cut-offs \( (\phi_{iii} \forall i) \); \( N \) numbers for the mass of firms for each country \( (M_i \forall i) \); \( N \) wages \( (w_i) \) and 1 Price \( (p_0) \). Normalizing the price of the homogeneous good to one we end up with
endogenous variables. In order to solve for these variables we are going to proceed as follows:

Equation (13) defines the Zero Cut-off Profit Condition (ZCPC). This equation relates the domestic cut-off for all countries \((\phi^*_i \forall i)\) with the average profits for a firm making the draw in country \(i \forall i\). The net value of a firm from country \(i\) is then \(v_i = \bar{\pi}_i\). As there is free entry, the expected profit of a firm before making a draw should be zero, otherwise more firms will enter until this condition is satisfied. Define the net value of an entering firm as \(v^e_i\). In equilibrium \(v^e_i\) should be equal to zero. Then the free entry condition (FEC) can be expressed as:

\[
v^e_i = \theta_{iii} \bar{\pi}_i - \kappa^e_i w_i = 0 , \text{ FEC , (20)}
\]

which says that the average value of a firm producing in country \(i\) times the probability of successful entry should be equal to the investment cost (the cost of making the productivity draw). \(\theta_{iii}\) is a function of the scale \((\phi_{m,i})\) and shape \((\alpha)\) parameter of the productivity distribution and of the domestic cut-off \((\phi^*_i)\). Rearranging terms in equation (20) we get that \(\bar{\pi}_i = \frac{\kappa^e_i w_i}{\theta_{iii}}\) which relates \(\bar{\pi}_i\) and \(\phi^*_i\). Equating the ZCPC and the FEC for each country we get a set of \(N\) equations. The labor-market-clearing conditions give us a set of \(N\) additional equations. Finally, the last \(N\) equations are the current account condition. In equilibrium, the current account for each country has to be equal to zero. Then we have a system of \(3N\) equations in \(3N\) unknowns.

**Definition:** Given \(z_{i0}, \tau_{ij}, \gamma_{ij}, \kappa^e_i, \kappa^d_i, \kappa^M_i g_i(\phi), L_i\) and \(N \forall i, j = 1, ..., N\), a **multinational production equilibrium** is a set of wages \(w_i\), price indices, \(P_i\), income, GNP, mass of firms \(M_i\), mass of entrants, \(M^e_i\), allocations for the representative consumer \(q_{jki}(\phi)\) and prices, \(p_{jki}(\phi)\), for firms such that:

1. In all countries, given prices and aggregate expenditure, consumers demand choices \((q_{jki}(\phi)\) and \(q_{io}\)) satisfy (2) and (3).
2. In all countries, firms maximize profits from all activities (equation (5) solves (4)).
3. \(P_i\) satisfies equation (14)
4. Labor markets clear.
5. Free entry condition: \(v^e_i = 0\) (see equation (20)).
6. Current Account balance condition is zero (see equation (15)).
7. The mass of firms producing is equal to the mass of firms taking the productivity draw times the probability that the draw is bigger than the domestic cut-off, \(M_i = \theta_{iii} M^e_i\)
8. World demand of the homogeneous good is equal to world supply: $\sum_i z_i = \sum_i q_i 0$.

4 Calibration

4.1 Data

I use data from four different sources to calibrate the model: The World Bank Enterprise Survey (WBES), the United Nations (UNCTAD), OECD Stan, and the data base on bilateral trade flows from Waugh (2010).

**World Bank Enterprise Survey:** This database is a stratified sample of the universe of firms in developing countries. I use the standardized survey, which has data starting in 2006. This database is being updated continuously, and for many countries there is a panel of two years already. I use this database to obtain statistics related to firms performance: a) proportion of exporting firms; b) proportion of foreign firms. I consider only firms in the manufacturing sector.

**UNCTAD:** I use the Foreign Direct Investment profile for the Latin-American countries under study. I use data on the origin of the stock of foreign direct investment by country.

**OECD Stan:** I use data on the production by multinational and proportion of firms exporting for Europe.

**Waugh (2010):** This data base contains information on trade for a large set of countries for the year 1996, including Latin-American and European countries. I use trade statistics (exports and imports) by origin and destiny in order to construct bilateral trade flows between countries and the absorption measure reported.

4.2 Calibration Strategy:

The model is calibrated separately to two regions: (i) South America using data from Argentina, Brazil, Chile, Uruguay; and (ii) Europe using data from France, Italy, Netherlands and United Kingdom. In both cases I include in the calibration a fifth country (rest of the world) representing the aggregate of the rest of countries not included in the region. I will use data for 1996 whenever it is possible.\footnote{In 1995 the MERCOSUR members should have had the last reduction in tariffs for trade within the region, and a common tariff for the rest of the world. For a more detailed discussion on this see Bustos (2011).} For most of the FDI statistics I only have data for the late 2000’s, so and I will use data for 2007. The parameters I need to calibrate are:
• **Size** ($L_i$): I use data from the UNCTAD on labor force. I normalize Uruguay’s size to 1 ($L_{Uruguay} = 1$). Countries sizes are then $L_{Arg} = 9.47$, $L_{Bra} = 48.94$, $L_{Chi} = 3.69$ and $L_{RW} = 1582.5$.\(^\text{11}\) For Europe country sizes are: $L_{Fra} = 16.8$, $L_{Ita} = 14.9$, $L_{UK} = 18.7$ and the $L_{RW} = 1567.3$.

• **Substitutability between varieties** ($\sigma$): I use a value of 6 which generates a mark-up of 20%, as is common in the literature.

• **Productivity distribution**: I assume that productivities are drawn from a Pareto distribution with scale parameter $\phi_m = 1$ for all countries. I will assume that all countries have the same shape parameter $\alpha$. Given the Pareto assumption for productivities, sales are distributed Pareto with shape parameter $\alpha/(\sigma - 1)$. There is a large discussion in the literature about the value of $\alpha$ and $\alpha/(\sigma - 1)$. Chaney (2008) finds that $\alpha_i/(\sigma - 1)$ is around 2 for the US, but he does not calculate the value of $\alpha$ and $\sigma$. Ramondo and Rappoport (2010) use $\alpha = 4$. Breinlich and Cuñat (2010) estimates $\alpha/(\sigma - 1)$ and find values ranging from 1.13 to 4.88. Arkolakis et al. (2013) use $\alpha = 4.2$. Finally, Arkolakis and Muendler (2010) estimates $\alpha/(\sigma - 1)$ from brazilian data and find a value of 1.21. I use the estimate of Arkolakis and Muendler (2010) for two reasons. First, because they estimate the shape parameter of sales from Brazilian data, one of the countries I am studying. Second, because $\sigma = 6$ implies $\alpha = 6.05$ which is in the middle range of previous estimates.

• **Fixed entry cost** ($\kappa_e^i$): In order to make a productivity draw, firms in country $i$ should pay a fixed cost $\kappa_e^i$. I calibrate this parameter to match the GDP per capita in each country relative to the RW for the year 1996.

• **Fixed operating cost** ($\kappa_d^i$): If a firm decides to operate, it has to pay a fixed cost ($\kappa_d^i$). I will set the value of this parameter such that the smallest firm producing in each country demands 5 workers. The amount of labor demanded by the smallest firm is:

$$\ell(\phi^i_{\text{min}}) = \sigma \kappa_d^i.$$  \hspace{1cm} (21)

As equation (21) shows, labor demand of the firm with productivity level equal to the domestic cut-off productivity only depends on $\sigma$ and $\kappa_d^i$.\(^\text{12}\) As all countries have the same $\sigma$, all countries should have the same $\kappa_d^i$ in order to obtain that the smallest firm demands five workers in all countries. I thus set $\kappa_d^i = 5/6$ for all $i$.

• **Fixed cost of exporting** ($\kappa_x^i$): In order to export, a firm has to pay an additional fixed cost ($\kappa_x^i$). This cost directly affects the mass of firms deciding to export. I will

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\(^{11}\)To calculate the RW I take out Russia and Germany from all the variables, two big countries not included in Waugh (2010).

\(^{12}\)See proof in the appendix.
use the proportion of firms exporting as a fraction of the total number of operating firms. For South America I use firm-level data from the World Bank Enterprise Survey to calculate this statistic in the data. For Europe, I use the OECD Stan dataset

- **Fixed cost of doing MP** ($\kappa_{MP}^{i}$): To operate in a foreign country, a firm has to pay a fixed cost of ($\kappa_{MP}^{i}$) in the country where the firm will open the plant. I will calibrate this parameter to match the proportion of foreign firms in a given country. As this cost increases, the proportion of foreign firms decreases. I use data from the World Bank Enterprise Survey to construct this statistic in the data for South America and OECD Stan for Europe.

- **Iceberg cost of exporting** ($\tau_{ji}$): In order to deliver one unit to country $j$, firm in country $i$ has to deliver $\tau_{ji}$ units. These parameters are pinned down to target $Trade_{ji}$ over $Absorption_{i}$\textsuperscript{13} across the countries in my study. I use data from Waugh (2010) on trade of manufactures to construct these targets.

- **Iceberg cost of multinational production** ($\gamma_{ji}$): When a firm produces abroad there is a productivity loss of $\gamma_{ji}$. To calibrate this parameter I use the proportion of sales from foreign firms in the domestic country. Using data from the WBES I compute the participation of foreign sales in total sales. Unfortunately, this database does not have the country of origin of foreign firms. So, I use the composition of FDI stock in manufactures to impute these values. The data on FDI stock in manufactures come from the UNCTAD Foreign Direct Investment profile for South America and OECD Stan for Europe.

- **Endowment of the homogeneous good** ($z_{i}$): I use the trade deficit in the manufacturing sector to calibrate this parameter.

### 4.3 Calibration Results

Tables 2 to 7, present the calibrated parameters. Panel A of each table present the results for South America, while Panel B presents the results for Europe. The model performs well in matching the selected targets. The GDP per capita of the RW is normalized to 1. The model does a good job matching the GDP per capita. To match the much higher GDP per capita in Europe relative to the RW I need to impose much lower entry costs in Europe than in South America. The model also does a good job in

\textsuperscript{13}$Trade_{ji}$ is imports of country $i$ from country $j$ plus exports from country $i$ to country $j$. Absorption is calculated as $GDP_{i} + Imports_{i} - Exports_{i}$.
matching the trade balance over absorption in the manufacturing sector, even though it slightly overestimates Italy trade surplus (9.4 in the model versus 8.9 in data). For the proportion of firms exporting and the participation of foreign firms sales in total sales, the model is able to match the data almost perfectly for all countries. The model requires lower fixed costs of doing MP in Europe to account for the larger participation of foreign sales in total sales.

To match the trade statistics I use variable and fixed trade costs. Note that Argentina and Brazil, the two largest countries in the region, show lower ratios of Trade-to-Absorption, 35.8% and 22.8%. On the other hand, Chile and Uruguay, the smallest countries, show much higher ratios: 59.4% and 58.3%. In order to match the large proportion of domestic firms exporting in Argentina, I need a small fixed cost of exporting. This also allows smaller firms to enter in the export market, making it possible to match at the same time the large proportion of firms exporting and the relatively low trade over absorption ratio. The importance of the RW as a trade partner is also shown in the calibrated parameters. The country with highest trade with the RW is Chile, where 86% of total trade is done with the RW, then the average variable trade of Chile with the RW is the lower in the region (1.91), followed by Brazil (where trade with the RW represents 83% of total trade) with a value of 1.98, Argentina 2.1 and finally Uruguay with a value of 2.38. On the other hand, Uruguay has low values of average variable trade with its main partners: Argentina and Brazil. For Europe we can immediately observe that trade over absorption is much higher than in South America. Italy, the country with the lowest ratio has a value of 44.1%, while the Netherlands, the country with the highest ratio, exhibit a ratio of 118.1%. In order to match the higher ratio, I need much smaller trade costs. This is shown in figure 6, where I plot the average trade costs by country (both the simple average or a weighted by trade composition average). It can be easily seen that South American countries face much higher average trade costs than European countries. The weighted average trade cost in South America is 91% (so the average variable cost is $\tau = 1.91$), while in Europe it is 60% (the average variable cost in Europe is $\tau = 1.598$). Another interesting fact is that while in Europe the smallest country, Netherlands, face the lowest trade cost, in South America the smallest country, Uruguay, faces the highest average trade costs.

Similar observations apply to multinational production. As in the case of trade costs, the efficiency parameter $\gamma$ is much higher for South America than Europe. This implies that foreign firms are much less productive operating abroad in South America than in Europe. The average value of this parameter is 1.92 in South America, while

\[14\] I set a value of 100 to $\gamma_{ij}$ when there are zeros in the data
is 0.58 in Europe. The fact that in Europe the average $\gamma$ is smaller than one is mainly driven by the productivity of firms from the RW operating. Firms from the rest of the world operating in Europe are three times more efficient than in their domestic countries. Then, as most of the MP comes from the RW, the average $\gamma$ in Europe is smaller than one.

To sum up, the baseline model is consistent with cross country evidence on bilateral trade flows and multinational production for the set of selected countries.

5 Experiments

In this section I use the calibrated model to perform a set of counterfactual experiments. I study:

1. Changes in real manufacturing GDP and GNP of going to autarky in a world with and without BMP.

2. Changes in real manufacturing GDP and GNP of decreasing trade costs in South America to the average level in Europe:
   - With the same multinational production costs.
   - With an increase in the efficiency of foreign firms producing in South America of 20%.
   - With an increase in the efficiency of foreign firms producing in Uruguay of 20%

3. Effects of MP and BMP on firm size distribution in Uruguay and the Netherlands.

5.1 Autarky

In this experiment I set $\gamma_{ij} = \tau_{ij} = \infty$ i.e. a world in autarky. Table 8 presents the changes in real manufacturing GDP and GNP for the economies with and without BMP. The first thing to notice is that, as expected, countries from Europe lose more than what South American countries do. While a small country in Europe, like the Netherlands, loses 21% of its real manufacturing GDP, a small country in South America loses 11.9%. Also there is a large heterogeneity in these results. While there is a difference of 15.1 percentage points between the country that loses the most and the one that loses the least in Europe, this difference in South America is just 8.1 percentage points. The results are similar if I consider the real manufacturing GNP instead. This heterogeneity in the results indicates that South America as a region is more closed than Europe.
What role does BMP play? In South America the losses of going to Autarky in a world with and without BMP are very similar. In Uruguay, BMP only decreases by 1 percentage point the losses of going to autarky. This is because South American countries are not exploiting the benefits from BMP. High trade costs reduce the benefit of using a third country as an export platform decreasing the inflows of multinational firms in small countries. In Europe, on the other hand, the results are different. A small country like the Netherlands would lose 5 percentage points less of what it loses in the benchmark case if I do not allow for BMP. Low trade costs promote the inflow of multinational firms in the Netherlands since they not only sell there but also export from there to the rest of countries. As a result, the losses of not allowing for BMP are larger in the Netherlands.

5.2 Reducing trade costs and improving efficiency

Panel A of Table 9 presents the result of only reducing trade costs in South America to the average level in Europe (i.e. imposing $\tau = 1.598$ to all South American countries). All countries gain by reducing trade costs, but the smallest country, Uruguay, gains significantly more. The gains in Uruguay are 31.1% of real manufacturing GDP, while in Brazil, the largest country, are just 4.6%. I find, as Eaton and Kortum (2002), that the gains from reducing trade costs are larger than the losses of going to autarky.

Panel B of Table 9 presents the results of an increase in the efficiency of multinationals operating in South American countries in addition to the previous reduction in trade costs. The increase is such that the gap between South American efficiency and European efficiency is reduced by 20%. There is a large gain in real manufacturing GDP in all countries, but specially in large countries. However, since multinational firms send their profits back, the increase is not reflected in a large increase in real manufacturing GNP, except for Uruguay. In Uruguay, real manufacturing GDP increases by 4 percentage points with respect to the previous exercise, while real manufacturing GNP increases by almost 10 percentage points.

Panel C of Table 9 shows the result of only increasing the efficiency to multinationals operating in Uruguay. The increase is of the same magnitude as in the previous exercise. Changes in real manufacturing GDP for the rest of countries are the same as in the case of only reducing trade costs, while in Uruguay it further increases 10 percentage points.

Bridge Multinational Production

The previous experiments reflect the importance of BMP for an small country. Real manufacturing GDP increases in all cases. However, if we do not allow for BMP, the
extra gains in real manufacturing GDP of improving efficiency when compared to just reducing trade costs are almost zero. This indicates that, in order for Uruguay to take advantage of MP, it needs to be able to export to the rest of countries in the region.

Finally, an interesting result from these experiments is that Uruguay would gain more if the efficiency improves only domestically compared to the case where it improves in all the countries of the region. This is because if the efficiency only improves in Uruguay there is a larger set of multinationals going to Uruguay. However, when all costs decrease, now Uruguay competes with the rest of countries to attract MP and its gains are reduced.

5.3 Firm size distribution

There is a large literature studying the effects of different kind of frictions on the misallocation of resources. There are papers studying the effects of size dependent policies (Guner et al. (2008), Restuccia and Rogerson (2008), García-Santana and Pijoan-Mas (2012)), capital market imperfections (Erosa (2001), Amaral and Quintin (2010), Buera et al. (2011), Greenwood et al. (2010), Allub and Erosa (2013)) and trade (Melitz (2003), Piguillem and Rubini (2012)) on firm size distribution. In this section I analyze how MP and BMP affect the size distribution of firms. Panel A of Table 10 reports the proportion of firms with more than 100 and more than 250 employees in Uruguay and the Netherlands; and Panel B reports the changes in the proportion of those firms with respect to the benchmark case from closing the economy to BMP, to MP, and from going to autarky.

In the benchmark case the Netherlands have more than twice as much firms with more than 100 employees and almost 4 times as much firms with more than 250 employees than Uruguay. If we do not allow for BMP, the proportion of firms with more than 100 employees decreases by 5% in both countries, however the proportion of firms with more than 250 employees decreases much more in the Netherlands than in Uruguay. If we do not allow for MP at all, the proportion of both types of firms decreases significantly in the Netherlands (30% the proportion of firms with more than 100 employees and 53% the one with more than 250 employees). While in Uruguay this proportion also decreases, the changes are much smaller, 15% and 16% respectively. In autarky, both countries have the same firm size distribution, which implies that in the Netherlands the proportion of both types of firms dramatically decreases. In autarky, in the Netherlands the proportion of firms with more than 250 employees is less than 20% of its value in the benchmark case, while in Uruguay is 65%.

To sum up, trade and MP has important effects on the size distribution of firms. While trade seems to have a bigger effect on the proportion of medium size firms (with
more than 100 employees), MP seems to have a bigger effect on the proportion of large firms. Uruguay can not attract multinational firms (and domestic firms do not grow as much), as a result of the closeness of South America and its low efficiency, which shifts the size distribution of firms toward small firms.

6 Conclusions

In this paper I construct a heterogeneous firms model of trade with asymmetric countries, MP, and BMP to study the effects of trade barriers and country size in the location decision of multinational firms. I find that BMP is crucial for a small country to attract MP and to take full advantage from trade liberalization and efficiency improvements. BMP explain up to 20% of the gains from openness in the Netherlands while only 10% in Uruguay.

If trade costs are reduced in South America to the average level in Europe, Uruguay’s real manufacturing GDP increases 31%. If I do not allow for BMP this increase is reduced by 5 percentage points. If in addition we improve the efficiency of multinationals operating in Uruguay by 20%, real manufacturing GDP increases 41.5%. However, all the additional increase in manufacturing real GDP is explained by BMP, since without BMP the increase is 26%, the same as without any improvement in the efficiency of multinationals.

Finally, MP and BMP shift the distribution of firms toward large firms reinforcing the effect of trade. While in autarky the Netherlands and Uruguay have the same distribution of firms, in the calibrated version of the model, the Netherlands have a proportion of firms with more than 100 employees which doubles that of Uruguay, and with more than 250 employees which is four times larger.

References


Table 1: Calibrated Parameters

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Table 2: Calibrated Parameters

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Table 3: Calibration Results-Iceberg Export Costs

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Table 4: Calibration Results-Iceberg FDI costs

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Table 5: Performance of the Model-Trade Composition

Trade (as % of Absorption)-Data vs Model

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<th>M</th>
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Panel B

|       | Fra  | UK   | Ita  | Neth | RW   | Data | Model | D    | M    | D    | M    | D    | M    | D    | M    | D    | M    | D    | M    |
|-------|------|------|------|------|------|------|-------|------|------|------|------|------|------|------|------|------|------|------|
| Fra   | -    | -    | 8.5  | 7.1  | 8.6  | 8.3  | 13.8  | 12.6 | 2.3  | 1.7  |      |      |      |      |      |      |      |      |
| UK    | 6.7  | 7.8  | -    | -    | 4.4  | 4.9  | 18.6  | 19.0 | 2.6  | 2.7  |      |      |      |      |      |      |      |
| Ita   | 7.6  | 7.9  | 5.0  | 4.2  | -    | -    | 9.7   | 9.5  | 1.7  | 1.3  |      |      |      |      |      |      |      |
| Neth  | 3.4  | 4.1  | 5.8  | 5.6  | 2.7  | 3.3  | -     | -    | 1.2  | 1.2  |      |      |      |      |      |      |      |
| RW    | 34.2 | 34.1 | 49.5 | 49.8 | 28.4 | 28.5 | 76.2  | 76.6 | -    | -    |      |      |      |      |      |      |      |
| Total | 51.9 | 53.9 | 68.9 | 66.7 | 44.1 | 45.0 | 118.4 | 117.8| 7.7  | 7.0  |      |      |      |      |      |      |      |
Table 6: Performance of the Model-foreign Production Composition

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Table 7: Calibration Results: Aggregate Targets

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Table 8: Experiment Results-Closing the Economies

Panel A

<table>
<thead>
<tr>
<th></th>
<th>Changes in %</th>
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<th>Changes in %</th>
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<tbody>
<tr>
<td></td>
<td>Autarky with BMP</td>
<td>Autarky without BMP</td>
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<td></td>
</tr>
<tr>
<td></td>
<td>Real GDP</td>
<td>Real GNP</td>
<td>Real GDP</td>
<td>Real GNP</td>
</tr>
<tr>
<td>South-America</td>
<td>-5.4</td>
<td>-3.4</td>
<td>-5.2</td>
<td>-3.5</td>
</tr>
<tr>
<td>Argentina</td>
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<td>-4.9</td>
<td>-9.1</td>
<td>-5.3</td>
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<td>-2.5</td>
<td>-3.6</td>
<td>-2.5</td>
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<tr>
<td>Chile</td>
<td>-11.9</td>
<td>-8.5</td>
<td>-10.9</td>
<td>-8.8</td>
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<tr>
<td>Uruguay</td>
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<td>-11.3</td>
<td>-10.7</td>
<td>-10.8</td>
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Panel B

<table>
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<tr>
<th></th>
<th>Changes in %</th>
<th></th>
<th>Changes in %</th>
<th></th>
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</thead>
<tbody>
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<td>Autarky without BMP</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Real GDP</td>
<td>Real GNP</td>
<td>Real GDP</td>
<td>Real GNP</td>
</tr>
<tr>
<td>Europe</td>
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<td>-7.5</td>
<td>-9.5</td>
<td>-7.4</td>
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<tr>
<td>France</td>
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<td>-6.6</td>
<td>-8.3</td>
<td>-6.3</td>
</tr>
<tr>
<td>UK</td>
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<td>-8.8</td>
<td>-12.2</td>
<td>-9.1</td>
</tr>
<tr>
<td>Italy</td>
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<td>-3.7</td>
<td>-5.1</td>
<td>-3.6</td>
</tr>
<tr>
<td>Netherlands</td>
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<td>-17.4</td>
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Table 9: Experiment Results-Reducing Costs

Panel A

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<tr>
<th>Changes (in %)</th>
<th>Same MP costs</th>
<th>Same MP Costs-No BMP</th>
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<tbody>
<tr>
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<td>South-America</td>
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<td>6.7</td>
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<tr>
<td>Argentina</td>
<td>12.1</td>
<td>12.2</td>
</tr>
<tr>
<td>Brazil</td>
<td>4.6</td>
<td>4.5</td>
</tr>
<tr>
<td>Chile</td>
<td>14.0</td>
<td>13.4</td>
</tr>
<tr>
<td>Uruguay</td>
<td>31.1</td>
<td>31.5</td>
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</table>

Panel B

<table>
<thead>
<tr>
<th>Changes (in %)</th>
<th>Improve 20% efficiency</th>
<th>Improve 20% efficiency- No BMP</th>
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<tbody>
<tr>
<td></td>
<td>Real GDP</td>
<td>Real GNP</td>
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<td>South-America</td>
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Panel C

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<tr>
<th>Changes (in %)</th>
<th>Improve 20% efficiency only in Uruguay</th>
<th>Improve 20% efficiency only in Uruguay-No BMP</th>
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<td>Real GNP</td>
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<td>South-America</td>
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<td>6.8</td>
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<tr>
<td>Argentina</td>
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<td>12.2</td>
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<tr>
<td>Chile</td>
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<tr>
<td>Uruguay</td>
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</table>

For all the experiments I use the average trade costs in Europe ($\tau = 1.598$)
Table 10: Experiment Results-Firms Size Distribution

<table>
<thead>
<tr>
<th>Panel A</th>
<th>Proportion of firms with more than $x$ employees</th>
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<td>Benchmark</td>
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<tr>
<td>Netherlands</td>
<td>7.9</td>
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<table>
<thead>
<tr>
<th>Panel B</th>
<th>Change with respect to benchmark</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Benchmark</td>
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<td>-</td>
</tr>
<tr>
<td>Netherlands</td>
<td>-</td>
</tr>
</tbody>
</table>
Figure 1: $\frac{\text{Trade}}{\text{GDP}}$ - Selection of Countries

Source: Author’s elaboration based on Waugh (2010)
Figure 2: $\frac{FDI_{Stock}}{GDP}$ - Selection of Countries

Source: Author’s elaboration based on UNCTAD
Figure 3: Correlation-Trade and Ln(Labor Force)

Source: Author’s elaboration based on UNCTAD

Figure 4: Correlation-FDI and Ln(Labor Force)

Source: Author’s elaboration based on UNCTAD
Figure 5: Correlation-FDI and Trade

Source: Author’s elaboration based on UNCTAD
Figure 6: Average iceberg trade costs
7 Appendix

7.1 Labor for the smaller firm operating

The amount of labor demanded by the smaller firm is:

\[
\ell(\phi_{iii}^*) = \frac{q(\phi_{iii}^*)}{\phi_{iii}^*} + \kappa_i^d
\]

\[
q(\phi_{iii}^*) = \frac{r(\phi_{iii}^*)}{p(\phi_{iii}^*)}
\]

From equation (9) → \(r(\phi_{iii}^*) = \sigma w_i \kappa_i^d\)

And from equation (5) → \(p(\phi_{iii}^*) = \frac{\sigma w_i}{\sigma - 1 \phi_{iii}^*}\)

Then → \(q(\phi_{iii}^*) = (\sigma - 1) \kappa_i^d \phi_{iii}^*\)

\[
\ell(\phi_{iii}^*) = \sigma \kappa_i^d
\]