Estimating Trade and Investment Flows: Partners and Volumes*

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Abstract

I present empirical evidence from a large sample of countries for the period 1986-1996. Bilateral foreign direct investment (FDI) flows are almost never observed in absence of bilateral trade flows, thus configuring a sort of *ordering* of trade and investment flows.

I propose a model where heterogeneous firms face a proximity concentration tradeoff deciding whether to serve foreign markets through export or FDI, along the lines of Helpman, Melitz and Yeaple (HMY, 2004). I derive theory-based gravity-type equations for the aggregate bilateral trade and investment flows. I then suggest a two-stage estimation procedure along the lines proposed by Helpman, Melitz and Rubinstein (HMR, 2008). In a first stage, an *ordered Probit* model is used to retrieve consistent estimates of the terms needed to correct the flows equations for heterogeneity and selection. In the second stage, maximum likelihood or a semi-parametric estimator is applied to the corrected trade and investment flows equations.

The preliminary results of the analysis are as follows. 1) Distance coefficients obtained using the two-stage procedure are lower than the one obtained with OLS in both the FDI equation and in the trade equation. 2) As predicted by the model, the coefficients on the terms representing distance are smaller in the FDI than in the trade equations, regardless of the methodology used. 3) When FDI are observed, failing to take this into account when correcting for heterogeneity and selection in the trade equation leads only to marginal differences in the results.

JEL classification: F10, F14, F21, F23

Keywords: Trade Flows, Investment Flows, Gravity, Two-stage Estimation Procedure

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1 Introduction

Three facts constitute the background of this work. First, trade and Foreign Direct Investment (FDI) have been among the fastest growing economic activity around the world in the last decades (Helpman, 2006). While clearly interconnected, these two phenomena have been often treated separately in the economic literature. An important exception is represented by Helpman, Melitz and Yeaple (2004, henceforth HMY), who extend the Melitz (2003) model of trade to the case of trade and *horizontal* FDI.[1] Second, bilateral trade flows are characterized by the presence of a lot of zeroes. This observation motivated Helpman, Melitz and Rubinstein (2008, henceforth HMR) to propose a two stage estimation methodology that corrects the gravity-type specification for bilateral trade flows for selection and, more importantly, for firms' heterogeneity. Third, work by Razin and Sadka (2007) showed that selection plays an important role also in the FDI case, and they illustrate the advantages of using sample selection models when estimating bilateral investment flows.

In this paper, I start showing empirical evidence from a large sample of countries for the period 1986-1996. Bilateral investment flows are almost never observed in absence of bilateral trade flows, thus configuring a sort of *ordering* of trade and investment flows.

Consistently with this evidence, I present a model where heterogeneous firms face a proximity concentration tradeoff deciding whether to serve foreign markets through export or FDI, along the lines of HMY. If a firm serve the foreign market through export, it pays a lower fixed cost but bear an higher variable cost, due to the existence of an *iceberg* transportation cost. If it decides to invest abroad, the fixed cost is higher[2] but the variable cost is lower. Departing from HMY, I assume that investing abroad implies the existence of a *monitoring cost* of the foreign affiliate, which is conveniently defined as a fraction of the transport cost and depends on the *economic distance* between countries. This allows me to derive the implications of the model for aggregate trade and investment flows in the form of theory-based gravity-type equations.

I then suggest a two-stage estimation procedure along the lines proposed by HMR. In a first stage, an *ordered Probit* model is used to retrieve consistent estimates of the terms needed to correct the flows equations for heterogeneity and selection. The ordered probit is completely derived from

[1] defined as the investment abroad aimed at serving the foreign market, as opposed to the *vertical* FDI, which are aimed at reducing costs through the vertical disintegration of the production process, such as the case of the Mexican *Maquiladoras*.

[2] A multiple of the fixed cost of exporting.

theory and from the definition of appropriate latent variables, under the assumption that the marginal cost in case of investment is a fraction of the marginal cost in case of export. In the second stage, maximum likelihood (ML) and a semi-parametric series estimator can be applied to the corrected trade and investment flows equations.

The preliminary results of the analysis are as follows. 1) Distance coefficients obtained using the two-stage procedure are lower than the one obtained with OLS in both the FDI equation and in the trade equation. 2) As predicted by the model, the coefficients on the terms representing distance are smaller in the FDI than in the trade equations, regardless of the methodology used. 3) When FDI are observed, failing to take this into account when correcting for heterogeneity and selection in the trade equation leads to marginal differences in the results.

This paper is linked to several strands of the literature. First, this work is related to the literature on models of trade with heterogeneous firms (Melitz, 2003 ; HMY) as well as to the gravity models of trade bilateral flows (Anderson, 1979; Anderson and van Wincoop, 2003) and to the recently proposed HMR procedure of estimating trade flows correcting for selection and heterogeneity. Santos Silva and Tenreyro (2006) provides some qualifications that will be addressed later in the paper.

Secondly, this work is related ot the literature on FDI. Kleinert and Toubal (2009) derive gravity-type equations for bilateral FDI flows. The explanation they propose is based on the dependence of fixed cost of exporting on distance and is different from the one proposed in this paper, based on the existence of *monitoring cost*. Aisbett (2007) explore the importance of Bilateral Investment Treaties on bilateral investment flows[3]. Razin and Sadka (2007) propose a detailed study of aggregate bilateral FDI flows showing the importance of selection also in this context.

Third, some recent work has tried to consider jointly trade and investment flows. Aviat and Coeurdacier (2007) explore the complementarity between bilateral trade in goods and asset holdings in a simultaneous gravity equation framework. Bergstrand and Egger (2007) augment with physical capital a 2x2x2 Knowledge capital model and provide a rationale for gravity-type equations for FDI. Lastly, Lai and Zhu (2006) propose a non linear joint ML estimation for trade and foreign affiliate sales for the US based multinational firms. I improve on this literature by explicitly correcting for selection and heterogeneity as in HMR.

[3]I'm particularly grateful to her for providing the data for a preliminary work on the key idea of this paper

The paper is organized as follows. Section 2 contains a quick glance at the data that establish the ordering of trade and investment flows. Section 3 contains the model and section 4 the empirical methodology. In section 5 I presents the preliminary results of the analysis and section 6 concludes suggesting some lines for future research.

2 A Glance at the Data

The data source is a combination of two datasets. The dataset used by HMR[4] provides information about bilateral trade flows for roughly 150 countries for the period 1980-1996. This dataset was also used to retrieve information about bilateral distance and a series of indicator variables regarding common language, colonial ties, FTA membership, common border, legal system and common religion. The OECD International Investment Database[5] was used to retrieve information about FDI flows. In particular, inward FDI flows for 30 OECD reporting countries and roughly 150 partner countries are available for the period 1985-2006. After pruning the HMR dataset and the OECD dataset to be able to match the information, I'm left left with 27 reporting countries and 146 partner countries for the period 1985-1996. The panel, though, is highly unbalanced, with a total of 8,842 country-pair-year observations

The indicator variables TRADE and FDI indicate the presence of positive flows. A word of caution is due regarding the data for the investment flows. I chose be conservative and to consider proper zeroes only the entries in which a zero is effectively reported. Table 1 report the distribution of available observations into the four possible cases (NO TRADE-NO FDI, TRADE-NO FDI, TRADE-FDI and NO TRADE-FDI) for the entire time period. Two observations stands out. First, the number of zeroes is clearly not irrelevant both for the trade and the investment flows. The reason why in the case of trade flows the zeroes are much less than that documented in HMR (2008) is the fact that the table excludes all the observations which report a missing for the investment flows. Second, probably most interestingly, the case of FDI- NO TRADE seems irrelevant, thus suggesting a sort of *ordering* of trade and investment flows, for which the existence of bilateral trade flows is a necessary condition for the existence of bilateral investment flows.

More insights can be gained when considering the dynamic evolution over time. Tables 2-4

[4]available on their website
[5]available on-line

report the same statistics for three different years (1986, 1991, 1996). The deepening of the process of globalization is reflected in the fact that the share of country-pairs for which both trade and investment flows are observed is increasing over the period considered. In order to maximize the available observations, however, I leave aside these possible dynamic considerations, and I just concentrate on the cross section dimension.

Summarizing, the data reported in table 1-4 seem to suggest a story where trade flows are a necessary condition to observe investment flows. The theoretical model presented in the next section implies exactly this feature for the aggregate flows.

Table 1: **Selection in FDI and TRADE, 1986-1996**

Year	**No Trade**	**Trade**	**Total**
No FDI	402	4,213	4,615
FDI	**76**	4,151	4,227
Total	478	8,364	8,842

Table 2: **Selection in FDI and TRADE, 1986**

Year	**No Trade**	**Trade**	**Total**
No FDI	24	315	339
FDI	**5**	238	243
Total	29	553	582

Table 3: **Selection in FDI and TRADE, 1991**

Year	**No Trade**	**Trade**	**Total**
No FDI	40	373	413
FDI	**5**	373	378
Total	45	756	791

Table 4: **Selection in FDI and TRADE, 1996**

Year	**No Trade**	**Trade**	**Total**
No FDI	41	358	399
FDI	**7**	449	456
Total	48	807	855

3 Theory

Consider a world economy made up of J countries. In each country, a representative consumer derives utility from a continuum of goods, defined as follows for a generic country j:

$$u_j = \left(\int_{l \in \Omega_j} x_j(l)^{\alpha} dl \right)^{\frac{1}{\alpha}} \tag{1}$$

where $x_j(l)$ is the consumption of product l and Ω_j is the set of available variety in country j and $\epsilon = \frac{1}{1-\alpha} > 1$ is the elasticity of substitution, assumed to be equal across countries. Call Y_j the income in country j (equal to expenditure). Then, the consumer utility maximization problem allows to express the demand for every single good as:

$$x_j(l) = \frac{\check{p}_j(l)^{-\epsilon}}{P_j^{1-\epsilon}} Y_j \tag{2}$$

where $\check{p}_j$ is the price of product l in country j and P_j is the standard CES ideal price index[6]. As for technology, in country j the unit production cost of the firms is represented by a cost minimizing combination of inputs that costs $c_j a$, where c_j is country specific, while a is a (firm-specific) inverse indicator of productivity. Firms draw a randomly from a distribution $G(a)$. The support for a is exogenously defined to be $[a_L, a_H]$. There are not fixed production costs, hence firms never exit from the domestic market.

The market structure is the usual monopolistic competition, hence the firms profit maximization problem gives the optimal pricing rule as a constant mark-up over marginal cost:

$$p_{jj}(l) = \frac{c_j a}{\alpha} \tag{3}$$

where p_{jj} is the mill price of a variety produced in country j and sold in country j. There is

[6] expressed by $P_j^{1-\epsilon} = \int_{l \in \Omega_j} \check{p}_j(l)^{1-\epsilon} dl$

no entry and the number of firms in country j is N_j[7].

A domestic firm, besides serving the domestic market, can decide to serve foreign market i in two ways. If it decides to export, it has to bear a fixed cost $c_j f_{ij}^x$ and it is subject to an iceberg melting cost $\tau_{ij} > 1$[8]. The price in i of a good shipped from j to i will be therefore:

$$p_{ij}(l) = \tau_{ij} \frac{c_j a}{\alpha} \tag{4}$$

On the other hand, if the firm decides to invest abroad, it has to bear a fixed cost $c_j f_{ij}^I$ but it does not have to pay the transport cost. Departing here from HMY, I assume that multinational operations involves higher costs than domestic operation due to *monitoring costs* that affect also variable production costs. Hence p_{ii}^*, the price charged in country i by a multinational firm whose headquarter is located in country j will be:

$$p_{ii}^*(l) = \tau_{ij}^I \frac{c_i a}{\alpha} \tag{5}$$

τ_{ij}^I is the monitoring cost, which is assumed to be increasing in the *cultural distance* between the two countries. τ_{ij}^I is defined for convenience to be a fraction of the transportation cost: $\tau_{ij}^I = \tau_{ij}^b$ with $b < 1$. The firms, in this way, still face the concentration-proximity trade-off empirically documented by previous literature (Brainard, 1997).

Substituting the demand expression and the pricing rule into the expression for firms profits and assuming a symmetric equilibrium, it is possible to express the *additional* profit that a firm get from exporting as:

$$\pi_{ij}^x = (1-\alpha) \left(\frac{\tau_{ij} c_j a}{\alpha P_i} \right)^{1-\epsilon} Y_i - c_j f_{ij}^x \tag{6}$$

Notice the dependence of profits on firm specific productivity a. Similarly, the additional operational profits for a firm that invests abroad can be expressed as

$$\pi_{ij}^I = (1-\alpha) \left(\frac{\tau_{ij}^b c_i a}{\alpha P_i} \right)^{1-\epsilon} Y_i - c_j f_{ij}^I \tag{7}$$

Following HMY, and calling $A_i = (1-\alpha)\frac{1}{(\alpha P_i)^{1-\epsilon}} Y_i$, I can re-write the previous expressions as :

[7] like in HMR, but differently from HMY and Melitz(2003)

[8] as usual, $\tau_{jj} = 1$

$$\pi_{ij}^{x} = A_i(\tau_{ij}c_j)^{1-\epsilon}a^{1-\epsilon} - c_j f_{ij}^{x} \tag{8}$$

and

$$\pi_{ij}^{I} = A_i(\tau_{ij}^{b}c_i)^{1-\epsilon}a^{1-\epsilon} - c_j f_{ij}^{I} \tag{9}$$

Note that, with $\epsilon > 1$, the previous expressions are linear functions of a variable increasing in productivity. Figure 1 shows on the same graph equations (8) and (9), where I further impose two parameter restrictions:

$$(\tau_{ij}c_j)^{1-\epsilon} \quad < \quad (\tau_{ij}^{b}c_i)^{1-\epsilon} \tag{10}$$

$$\left(\frac{c_j}{c_i}\right)^{1-\epsilon} f_{ij}^{I} \quad > \quad \tau^{(1-b)(\epsilon-1)} f_{ij}^{x} \tag{11}$$

Eq (10) is needed to guarantee that we will observe FDI for some country-pairs. Equation (11) implies that FDI flows are observed only in presence of trade flows, consistently with the evidence presented in section two[9]. As it is clear from Figure 1, there will be a productivity cut-off $(a_{ij}^{x})^{1-\epsilon}$ below which the firm will not find profitable to export. Most interestingly, though, there will be a second cut-off productivity $(a_{ij}^{I})^{1-\epsilon}$, above which firms will prefer to invest abroad.

The two cut-off are implicitly defined by the following conditions:

$$(1-\alpha)\left(\frac{\tau_{ij}c_j a_{ij}^{x}}{\alpha P_i}\right)^{1-\epsilon} Y_i = c_j f_{ij}^{x} \tag{12}$$

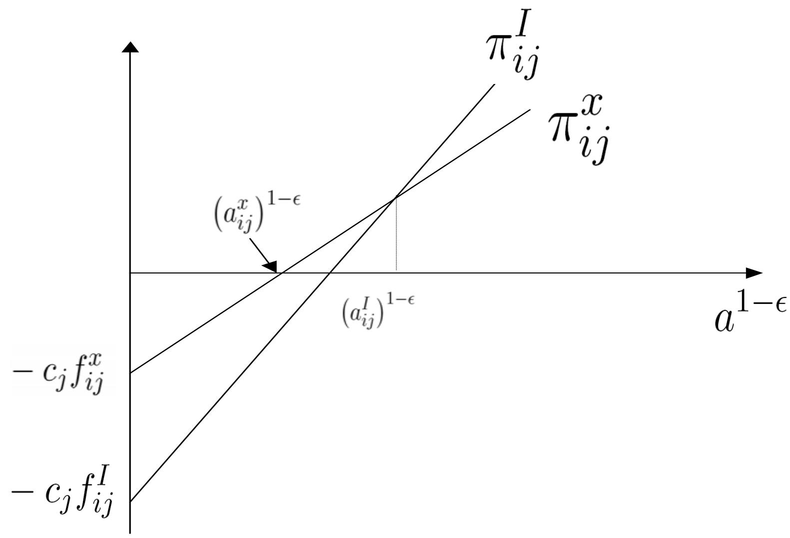
and

$$(1-\alpha)\frac{Y_i}{(\alpha P_i)^{1-\epsilon}}\left[\left(\tau_{ij}^{b}c_i\right)^{1-\epsilon} - (\tau_{ij}c_j)^{1-\epsilon}\right]\left(a_{ij}^{I}\right)^{1-\epsilon} = c_j\left(f_{ij}^{I} - f_{ij}^{x}\right) \tag{13}$$

In eq(12) the cutoff a_{ij}^{x} is defined as the productivity of the firm which is just indifferent on whether to export or not, given that its additional profits from exporting are just enough to pay for the fixed costs. Eq (12), instead, defines the second cut-off a_{ij}^{I} as the productivity of the firm that is indifferent on whether to serve the foreign market by exporting or by FDI. The reason is

[9] Eq (11) is the similar to the parameter restriction imposed in HMY

Figure 1: **Self-Selection into Export and FDI**



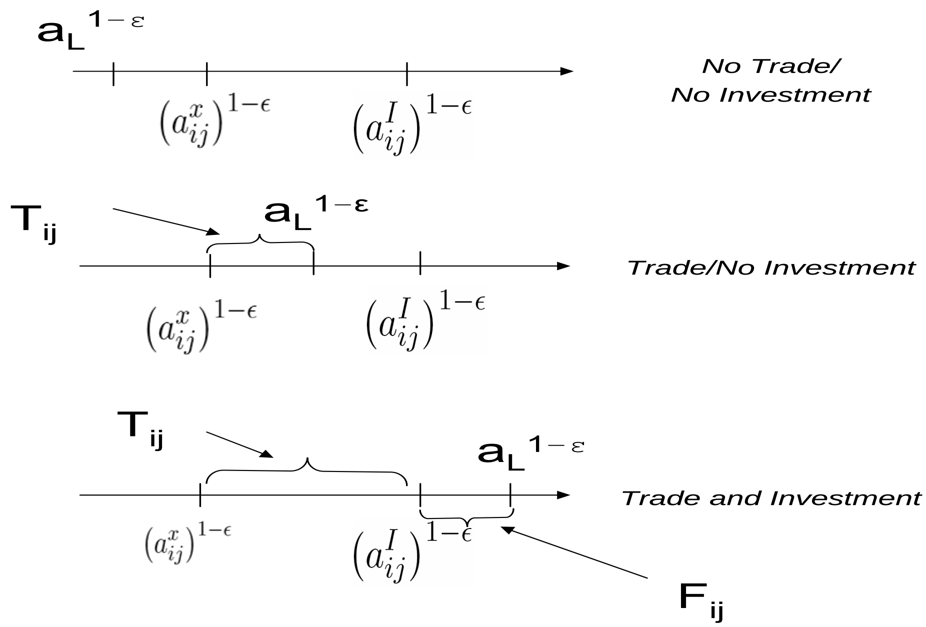
that the additional profits are the same in the two cases.

The pattern of possibilities that emerge from the interaction between the two cut-offs implicitly identified by (12) and (13) and the exogenous support for the productivity draws is very rich and extends the possibilities allowed for by HMR. Figure 2 helps visualize the three possibilities. If $a_L^{1-\epsilon}$[10] is lower than the trade productivity cut off, nor trade nor FDI flows will be observed between

[10]the level of productivity of the most productive firm

the two countries. If $a_L^{1-\epsilon}$ is between the two cut-offs, a fraction T of firm will find profitable to export, hence we will observe trade, but not FDI between the two countries. Finally, if $a_L^{1-\epsilon}$ is bigger than both cut-offs, we will observe both firms investing abroad (a fraction F of them) and exporting (a fraction T). In this case we will observe both FDI and bilateral trade flows. The three possible outcome, hence, are fully consistent with the empirical evidence presented in section 2.

Figure 2: **Possibilities**



Finally, it is possible to derive expressions for the bilateral trade and investment flows as follows.

First, let's define two variables that represents the fraction of firms exporting and investing from country j to country i respectively:

$$T_{ij} = \begin{cases} \int_{a_{ij}^I}^{a_{ij}^x} a^{1-\epsilon} dG(a) & \text{if } a_L < a_{ij}^I \\ \int_{a_L}^{a_{ij}^x} a^{1-\epsilon} dG(a) & \text{if } a_{ji}^I < a_L < a_{ij}^x \\ 0 & \text{otherwise} \end{cases}$$

$$F_{ij} = \begin{cases} \int_{a_L}^{a_{ij}^I} a^{1-\epsilon} dG(a) & \text{if } a_L < a_{ij}^I \\ 0 & \text{otherwise} \end{cases}$$

Then, the *value of imports* in country i from country j is given by:

$$M_{ij} = \left(\tau_{ij} \frac{c_j}{\alpha P_i}\right)^{1-\epsilon} Y_i N_j T_{ij} \tag{14}$$

and the *value of the foreign affiliate sales (FAS) flows* to country i from country j would be given by:

$$FDI_{ij} = \left(\tau_{ij}^b \frac{c_i}{\alpha P_i}\right)^{1-\epsilon} Y_i N_j F_{ij} \tag{15}$$

It is important to stress that eq(15) refers to FAS more than to FDI. To take the model to the data, what I'm implicitly assuming is that foreign affiliate sales are proportional to FDI. In order to document the reasonableness of this implicit assumption, figure 3 reports a plot of FDI and Foreign Affiliates Sales for a sample of 23 developed and developing countries. The data source is the UNCTAD World Investment Report 2007 on-line dataset. As the picture shows, the proportionality assumption is not unrealistic.[11] In order to test whether the proportionality documented in figure 3 is purely driven by country size, I also show in figure 4 the scatter of the residuals obtained by regressing both FAS and FDI on per capital GDP. Even conditionally on country size, the positive correlation between FDI and FAS appears to be strong.

[11] Note that this simplifying assumption is made because of data availability. It is much more difficult, in fact, to find bilateral foreign affiliate sales for a large set of countries. I'm well aware that ideally, one would want to use the methodology proposed in this paper on a different dataset.

Figure 3: **FDI and FAS**

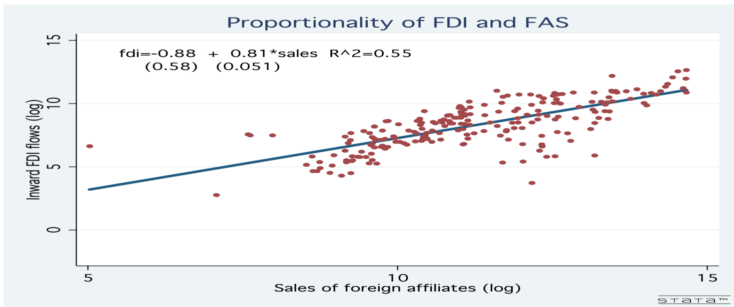
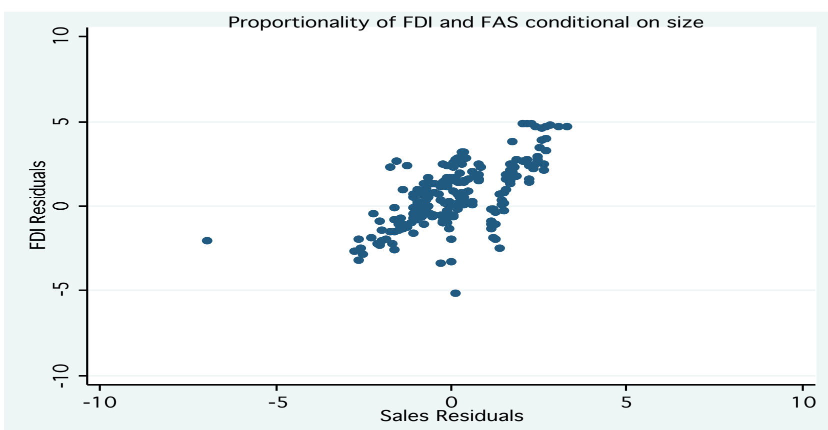


Figure 4: **FDI and FAS, conditional on size**



4 Empirical framework

Productivity is assumed to be drawn from a Pareto distribution , hence $G(a) = \frac{a^k - a_L^k}{a_H^k - a_L^k}$. Analogously to HMR, we can easily find F_{ij} as

$$F_{ij} = \frac{k a_L^{k-\epsilon+1}}{(k-\epsilon+1)(a_H^k - a_L^k)} W_{ij}^1 \tag{16}$$

where

$$W_{ij}^1 = max\left[\left(\frac{a_{ji}^I}{a_L}\right)^{k-\epsilon+1} - 1, 0\right] \tag{17}$$

Things are more complicated, instead, for the trade equation, since now the fraction of exporting firms depends on whether there are firms investing from country j to country i or not. In particular, we would have

$$T_{ij} = \begin{cases} \frac{k a_L^{k-\epsilon+1}}{(k-\epsilon+1)(a_H^k - a_L^k)} W_{ij}^2 & \text{if } F_{ij} = 0 \\ \frac{k a_L^{k-\epsilon+1}}{(k-\epsilon+1)(a_H^k - a_L^k)} W_{ij}^3 & \text{if } F_{ij} \neq 0 \end{cases}$$

where

$$W_{ij}^2 = max\left[\left(\frac{a_{ij}^x}{a_L}\right)^{k-\epsilon+1} - 1, 0\right] \tag{18}$$

and

$$W_{ij}^3 = \left[\left(\frac{a_{ij}^x}{a_L}\right)^{k-\epsilon+1} - \left(\frac{a_{ij}^I}{a_L}\right)^{k-\epsilon+1}\right] \tag{19}$$

From (15), it is possible to express the investment flow equation in its log-linear form as:

$$fdi_{ij} = (\epsilon-1)ln\alpha - (\epsilon-1)lnc_i + n_j + (\epsilon-1)p_i + y_i + b(1-\epsilon)ln\tau_{ij} + f_{ij} \tag{20}$$

where the lower case variables represent the natural logarithm of the upper case ones. Crucially, I assume the following functional form for τ_{ij}:

$$\tau_{ij}^{\epsilon-1} = D_{ij}^{\gamma} e^{-u_{ij}^{1}} \tag{21}$$

where D_{ij} is an indicator of the economic distance between j and i and u_{ij}^1 is assumed to be i.i.d. normally distributed with mean zero and variance σ_1^2. Given (21) it is possible to derive the following estimation equation (20):

$$fdi_{ij} = \theta_0 + \Psi_j^I + \Upsilon_i^I - \gamma_1 d_{ij} + w_{ij}^1 + bu_{ij}^1 \tag{22}$$

where $\Psi_j^I = n_j$ is a home country fixed effect and $\Upsilon_i^I = -(\epsilon - 1)lnc_i + (\epsilon - 1)p_i + y_i$ is an host country fixed effect, $\gamma_1 = b\gamma$ and θ_0 contains also the elements present in F_{ij} besides W_{ij}^1. bu_{ij}^1 is i.i.d. normally distributed with mean zero and variance $b^2\sigma^2$.

On the other hand, taking logs of eq (14) and taking into account of equations (18), (19) and (21), it is possible to express the trade flow equation as the following estimable equation:

$$m_{ij} = \theta_1 + \Psi_j^x + \Upsilon_i^x - \gamma d_{ij} + w_{ij}^s + u_{ij}^1 \tag{23}$$

where $\Psi_j^x = n_j - (\epsilon - 1)lnc_j$ is an exporter fixed effect, $\Upsilon_i^x = (\epsilon - 1)p_i + y_i$ is an importer fixed effect and θ_1 includes all the elements in T_{ij} besides W^s, with $s = [2, 3]$.

Looking at equations (22) and (23), four things are worth noticing. First, not taking into account of the term W^s might lead to inconsistent estimates of all the coefficients. Second, the model has clear prediction also regarding the relative magnitute of the distance coefficients in the trade and fdi flows equation, which are expected to be higher in the trade flows equation. Third, the form of the estimating equation for the trade flow will differ according to whether FDI are observed or not. What changes is the correction term for firm heterogeneity (w_{ij}). Not recognizing the possibility for a firm to serve a foreign market by directly investing instead of exporting leads to an overestimate of the fraction of exporting firms that might affect the estimates of all the coefficients in eq. (23). The relevance of this possible bias is ultimately an empirical question. Finally, the error terms in the two equations are correlated, and taking into account of this could improve the efficiency of the estimates.

The next subsection outline a two stage procedure aimed at consistently estimate equations (22) and (23).

4.1 First Stage: Selection

As explained before, this framework allows for endogenous selection in Export and FDI. The best way to understand how in the first stage we can evaluate the self selection problem is to think at a three-steps process.

The first step consists of defining adequate latent variables. In particular, analogously to HMR, I can define a latent variable Z^x_{ij} determining whether we should observe trade flows from country j to country i as follows:

$$Z^x_{ij} = \frac{(1-\alpha)\left(\frac{\tau_{ij}c_j}{\alpha P_i}\right)^{1-\epsilon} Y_i a_L^{1-\epsilon}}{c_j f_{ij}} \tag{24}$$

Z^x_{ij} represents the ratio of the variable export profit for the most productive firms to the fixed export costs and $f^x_{ij} = f_{ij}$. Clearly, we would observe export from j to i only if $Z^x_{ij} > 1$.

For simplicity, I assume the investment fixed cost to be a multiple of the trade fixed cost, i.e. $f^I_{ij} = q f_{ij}$ with $q > 1$. Then, starting from eq(12), it is possible to define a second latent variable Z^I_{ij}, expressing the ratio between the difference of the variable profit in case of investment and export and the difference in the fixed costs:

$$Z^I_{ij} = \frac{(1-\alpha)\frac{Y_i}{(\alpha P_i)^{1-\epsilon}}\left[\left(\tau^b_{ij}c_i\right)^{1-\epsilon} - (\tau_{ij}c_j)^{1-\epsilon}\right](a_L)^{1-\epsilon}}{(q-1)c_j f_{ij}} \tag{25}$$

if $Z^I_{ij} > 1$ we should observe both trade and FDI between countries. Now it is convenient to define a third *auxiliary* latent variable Z_{ij}, representing the ratio of the variable profits from investment to the fixed cost of investment for the most productive firm:

$$Z_{ij} = \frac{(1-\alpha)\left(\frac{\tau^b_{ij}c_i}{\alpha P_i}\right)^{1-\epsilon} Y_i a_L^{1-\epsilon}}{c_j q f_{ij}} \tag{26}$$

In other words, $Z_{ij} > 1$ implies that the most productive firm *could* profitably invest abroad, even though it *might* prefer to export instead, if its productivity is lower than $\left(a^I_{ij}\right)^{1-\epsilon}$. Eq (26) is particularly helpful because it allow to express the other two latent variables as a function of Z. In fact, from (24) and (26) we can see how:

$$Z_{ij}^{x} = Z_{ij} q \left(\frac{\tau_{ij} c_j}{\tau_{ij}^{b} c_i} \right)^{1-\epsilon} \quad (27)$$

Hence, we would observe trade between country i and j if $Z_{ij} > \Delta_1$, where $\Delta_1 = \frac{1}{q} \left(\frac{\tau_{ij} c_j}{\tau_{ij}^{b} c_i} \right)^{\epsilon-1}$, which according to (11) is a quantity smaller than one. Importantly, I'm assuming here that $\left(\frac{\tau_{ij} c_j}{\tau_{ij}^{b} c_i} \right)^{\epsilon-1}$ is a constant (smaller than 1 by equation (10)). The economic meaning of this assumption is that the variable cost of a firm with productivity a who decides to invest abroad is a fraction of the variable cost that the same firm faces if it decides to export abroad instead.[12]

In a similar fashion, from (24) (25) (26) and (27) we can derive

$$Z_{ij}^{I} = \frac{q}{q-1} Z_{ij} - \frac{1}{q-1} Z_{ij}^{x} = \frac{q\Delta_1 - 1}{\Delta_1 (q-1)} Z_{ij} \quad (28)$$

Hence we will observe FDI between country j and country i if $Z_{ij}^{I} > 1$, or $Z_{ij} > \Delta_2$ where $\Delta_2 = \frac{\Delta_1(q-1)}{q\Delta_1 - 1}$, which given our parameter restrictions is a quantity bigger than 1. In order to derive an estimable equation from (26), I assume that fixed trade costs are stochastic due to unmeasured frictions. Specifically, I assume that:

$$f_{ij} = e^{\kappa \phi_{ij} - u_{ij}^{2}} \quad (29)$$

where ϕ_{ij} are a series of factors that influence the fixed costs of exporting (possibly common to the elements that enter in the definition of economic distance) and u_{ij}^{2} is assumed to be i.i.d. normally distributed with mean zero and variance σ_2^2.With this assumption, i can express (26) as

$$z_{ij} = \theta_2 + \Psi_j + \Upsilon_i - \gamma d_{ij} - \kappa \phi_{ij} + e_{ij} \quad (30)$$

where Ψ_j are exporter/home fixed effects, Υ_i are importer/host fixed effects and $e_{ij} = bu_{ij}^{1} + u_{ij}^{2}$ is i.i.d. normally distributed with mean zero and variance $\sigma_{e_{ij}}^{2} = b^2\sigma_1^2 + \sigma_2^2$. Notice also that, given the definitions of Δ_1 and Δ_2, it is possible to express the latent variables $z_{ij}^{x} = lnZ_{ij}^{x} = z_{ij} - \delta_1$ and $z_{ij}^{I} = lnZ_{ij}^{I} = z_{ij} - \delta_2$, where $\delta_1 = ln\Delta_1$ and $\delta_2 = ln\Delta_2$.

The dependence of both Z_{ij}^{I} and Z_{ij}^{x} from Z_{ij} allows to use an *ordered probit* model to control

[12] Essentially I'm parametrizing the well accepted existence of a proximity-concentration trade-off by making the fixed cost os investing a multiple of the fixed cost of exporting and the variable cost of investing a fraction of the variable cost of exporting.

for selection and heterogeneity. So the second step in the procedure is to define an *ordered outcome* variable $GLOBAL_{ij}$, which can take values zero ($TRADE_{ij} = 0, FDI_{ij} = 0$), one ($TRADE_{ij} = 1, FDI_{ij} = 0$) or two ($TRADE_{ij} = 1, FDI_{ij} = 1$), consistently with the pattern showed in section two.

Following HMR, I do not impose unitary variance for the error process and I divide equation (30) by $\sigma_{e_{ij}}$. It is thus possible to obtain the following ordered probit model:

$$z_{ij}^* = \theta_2^* + \Psi_j^* + \Upsilon_i^* - \gamma^* d_{ij} - \kappa^* \phi_{ij} + e_{ij}^* \tag{31}$$

with

$$\begin{cases} TRADE_{ij} = 0, FDI_{ij} = 0 & \text{if } z_{ij}^* < \delta_1^* \\ TRADE_{ij} = 1, FDI_{ij} = 0 & \text{if } \delta_1^* < z_{ij}^* < \delta_2^* \\ TRADE_{ij} = 1, FDI_{ij} = 1 & \text{if } z_{ij}^* > \delta_2^* \end{cases}$$

where the starred coefficients represent the original coefficients divided by the relevant standard deviation and e_{ij}^* is now i.i.d. unit normally distributed. Importantly, as stressed by HMR, the selection equation is derived from firm-level decision and does not contain the unobserved terms W_{ij}^s.

Finally, as a third step, from the ordered Probit estimates it is possible to recover consistent estimates of the W_{ij}^s, which can then be used in the flow equation to correct for heterogeneity. Let $\hat{p}_{ij}^0$ be the predicted probability of not observing trade nor FDI flows between countries j and i. Then, $\hat{z}_{ij}^{x*} = -\Phi^{-1}\left(\hat{p}_{ij}^0\right)$ is the predicted value of the latent variable $z_{ij}^{x*} = \frac{z_{ij}^x}{\sigma_{e_{ij}}}$.[13] In a similar fashion, calling $\hat{p}_{ij}^2$ the predicted probability of observing both trade and FDI between country i and j, $\hat{z}_{ij}^{I*} = \Phi^{-1}\left(\hat{p}_{ij}^2\right)$ is the predicted value of the latent variable $z_{ij}^{I*} = \frac{z_{ij}^I}{\sigma_{e_{ij}}}$.[14]With these two predicted values, we can obtain consistent estimates of the W_{ij}^s $s = [1, 2, 3]$ as follows:

[13]To see this, define for simplicity $\theta_2^* + \Psi_j^* + \Upsilon_i^* - \gamma^* d_{ij} - \kappa^* \phi_{ij} = x_{ij}\beta^*$. Then $p_{ij}^0 = Prob\left[x_{ij}\beta^* + e_{ij}^* < \delta_1^*\right] = \Phi\left(\delta_1^* - x_{ij}\beta^*\right)$. Hence $-\Phi^{-1}\left(\hat{p}_{ij}^0\right) = (x_{ij}\widehat{\beta^*} - \delta_1^*) = \hat{z}_{ij}^{x*}$.

[14]defining $x_{ij}\beta^*$ as in in the previous note, $p_{ij}^2 = Prob\left[x_{ij}\beta^* + e_{ij}^* > \delta_2^*\right] = \Phi\left(x_{ij}\beta^* - \delta_2^*\right)$. Hence $\Phi^{-1}\left(\hat{p}_{ij}^2\right) = (x_{ij}\widehat{\beta^*} - \delta_2^*) = \hat{z}_{ij}^{I*}$.

$$W_{ij}^1 = max\left[\left(Z_{ij}^{I*}\right)^{\zeta} - 1, 0\right] \quad (32)$$
$$W_{ij}^2 = max\left[\left(Z_{ij}^{x*}\right)^{\zeta} - 1, 0\right] \quad (33)$$
$$W_{ij}^3 = \left[\left(Z_{ij}^{x*}\right)^{\zeta} - \left(Z_{ij}^{I*}\right)^{\zeta}\right] \quad (34)$$

with $\zeta = \sigma_{e_{ij}} \frac{k-\epsilon+1}{\epsilon-1}$.[15]

4.2 Second Stage: FDI and TRADE Log-Linear Equations

In order to estimate consistently equations (22) and (23), I need to correct for both heterogeneity and selection. This requires to estimate different expected values for w_{ij} for the different case of trade and trade and FDI flows between countries, hence I need $E\left[w_{ij}^1|., GLOBAL_{ij} = 2\right]$, $E\left[w_{ij}^2|., GLOBAL_{ij} = 1\right]$ and $E\left[w_{ij}^3|., GLOBAL_{ij} = 2\right]$. Moreover, I need also the evaluate the expected values of the error terms in the different cases, that is to say I need also $E\left[u_{ij}^1|., GLOBAL_{ij} = 1\right]$ and $E\left[u_{ij}^1|., GLOBAL_{ij} = 2\right]$. Analogously to HMR, I exploit here the dependence of all these terms from e_{ij}^*, which is unit normal. In particular, using the properties of the truncated standard normal, I can derive:

$$E\left[e_{ij}^*|., z_{ij}^* > \delta_2^*\right] = \frac{\phi\left(\hat{z}_{ij}^{I*}\right)}{\Phi\left(\hat{z}_{ij}^{I*}\right)} = \hat{\eta}_{ij}^1 \quad (35)$$
$$E\left[e_{ij}^*|., z_{ij}^* > \delta_1^*\right] = \frac{\phi\left(\hat{z}_{ij}^{x*}\right)}{\Phi\left(\hat{z}_{ij}^{x*}\right)} = \hat{\eta}_{ij}^2 \quad (36)$$
$$E\left[e_{ij}^*|., \delta_1^* < z_{ij}^* < \delta_2^*\right] = \frac{\phi\left(-\hat{z}_{ij}^{x*}\right) - \phi\left(-\hat{z}_{ij}^{I*}\right)}{\Phi\left(\hat{z}_{ij}^{I*}\right) - \Phi\left(\hat{z}_{ij}^{x*}\right)} = \hat{\eta}_{ij}^3 \quad (37)$$

where $\phi()$ and $\Phi()$ are the p.d.f. and the c.d.f. of the standard normal. Using (35), (36) and

[15] See Equations (13) and (25) to derive equation (32) and equations (11) and (23) to get equations (33) and (34).

(37) I can get consistent estimates for the w_{ij} as follow:

$$\hat{w}_{ij}^{1} = ln\left\{exp\left[\zeta\left(\hat{z}_{ij}^{I*}+\hat{\eta}_{ij}^{1}\right)\right]-1\right\} \quad (38)$$

$$\hat{w}_{ij}^{2} = ln\left\{exp\left[\zeta\left(\hat{z}_{ij}^{x*}+\hat{\eta}_{ij}^{2}\right)\right]-1\right\} \quad (39)$$

$$\hat{w}_{ij}^{3} = ln\left\{exp\left[\zeta\left(\hat{z}_{ij}^{x*}+\hat{\eta}_{ij}^{3}\right)\right]-exp\left[\zeta\left(\hat{z}_{ij}^{I*}+\hat{\eta}_{ij}^{1}\right)\right]\right\} \quad (40)$$

Hence, it is possible to consistently estimate equation (23) using the following transformation:

$$fdi_{ij}=\theta_0+\Psi_j^I+\Upsilon_i^I-\gamma_1 d_{ij}+ln\left\{exp\left[\zeta\left(\hat{z}_{ij}^{I*}+\hat{\eta}_{ij}^{1}\right)\right]-1\right\}+\beta^1\hat{\eta}_{ij}^{1}+e_{ij}^{1} \quad (41)$$

where e_{ij}^{1} is an i.i.d error for which $E\left[e_{ij}^{1}|.,GLOBAL_{ij}=2\right]=0$. Equation (41) can be estimated via non-linear least squares (as in HMR) or through Maximum Likelihood.

Consistent estimation of equation (22) now depends on whether we observe also investment flows between the two countries. If only trade is observed, then it is possible to estimate the trade flows gravity-type equation as:

$$m_{ij}=\theta_1+\Psi_j^x+\Upsilon_i^x-\gamma d_{ij}+ln\left\{exp\left[\zeta\left(\hat{z}_{ij}^{x*}+\hat{\eta}_{ij}^{2}\right)\right]-1\right\}+\beta^2\hat{\eta}_{ij}^{2}+e_{ij}^{2} \quad (42)$$

where e_{ij}^{2} is an i.i.d error for which $E\left[e_{ij}^{2}|.,GLOBAL_{ij}=1\right]=0$. On the other hand, if also FDI are observed between countries, then the correct way to estimate equation (22) becomes:

$$m_{ij}=\theta_1+\Psi_j^x+\Upsilon_i^x-\gamma d_{ij}+ln\left\{exp\left[\zeta\left(\hat{z}_{ij}^{x*}+\hat{\eta}_{ij}^{3}\right)\right]-exp\left[\zeta\left(\hat{z}_{ij}^{I*}+\hat{\eta}_{ij}^{1}\right)\right]\right\}+\beta^3\hat{\eta}_{ij}^{3}+e_{ij}^{3} \quad (43)$$

where e_{ij}^{3} is an i.i.d error for which $E\left[e_{ij}^{3}|.,GLOBAL_{ij}=2\right]=0$ and it is potentially correlated with e_{ij}^{1}.

Before proceeding to the results, it is probably useful to briefly summarize the notation-intensive procedure. Essentially, I'm proposing a two-stage procedure for the estimation of trade and FDI flows bilateral flows. In a first stage, the definition of convenient latent variables allows to describe the self-selection of heterogeneous firms into trade and FDI through an ordered probit estimation.

From the order Probit it is possible to back out variables that allows to correct in the flows equations for selection and for the fraction of exporting/investing firms.

An important caveat to this methodology is the same that has been noted about the original HMR methodology, hence the possible inconsistency deriving by using in the correction terms elements correlated to the errors. As pointed out by Santos Silva and Tenreyro (2008), though, the correction method proposed can be considered approximately right for many practical situation.[16]

5 Preliminary Results

This section reports the results obtained using the dataset used in section two. All the values of trade and investment flows are in 2000 US dollars, converted using the US CPI.

An important caveat that need to be discussed at this point regards the distinction between *Horizontal* and *Vertical* FDI. While the framework proposed here clearly applies only to the FDI aimed at serving foreign markets, the data might contain potentially both type of investment flows, with limited possibilities of distinguish between the two. The period of reference of the analysis presented here (1986-1996), though, was one characterized by a prevalence of horizontal type of FDI.[17] Hence, while assuming that 100% of the FDI flows observed are horizontal is certainly an approximation, it is likely to be a pretty reasonable one for the time period considered here.

I will first present the results obtained through traditional estimation technique and then the ones obtained using the two-stage procedure outlined in the previous section.

5.1 Traditional Estimates

Table 5 reports the results obtained using OLS. The column reports the results obtained for the FDI equation. Although ideally this model, given its static nature, should be estimated using just a large cross section, data limitation impose to pool the data coming from different years. Including years fixed effects aims at mitigating the impact on the results of possible cyclical variation in the variables of interest. As the table shows, the distance coefficient has the expected negative sign. The presence of a common border and of a Free Trade Area (fta) between the two countries has a

[16] An obvious step for future research is to correct this problem through the use of different econometric techniques such as the pseudo-maximum likelihood proposed by Santos Silva and Tenreyro (2006) or the simulated Maximum Likelihood

[17] see Braconier et al, 2005 for some evidence of this.

positive and significant effect on the volume of FDI flows, as well as the presence of a colonial link and the same legal system. Interestingly, the presence of a currency union (cu) does not seem to affect investment flows, while the dummy for common language display a surprising negative sign, although it is only marginally significant.

The second column reports the results obtained for the trade flows. Three characteristics stands out. First, the coefficients on distance are negative signed, as expected. Moreover, they are interestingly higher in magnitude than the one obtained for the FDI flows. This is a first prediction of the model presented in section three that seem to be verified in the data. Second, colonial bondage and same legal system appear to have a positive effect on bilateral trade flows, while the sharing of a border does not seem to have an effect. Third, the common language variable appear to have a positive coefficient.

Column three and four report the results obtained for the trade equation using two different subsamples of countries. In column three only the country-pairs in which no FDI is observed are considered, while column four includes only those country pairs where FDI are observed. Interestingly, there are several differences between the two cases. The most apparent one is that the coefficient on distance is smaller when also FDI are observed. Although the model presented in the previous section has no specific prediction for this results, the fact that distance might matter less among countries that have positive bilateral flows does not seem to be unreasonable. More research is needed to properly address this issue. Finally, the fifth column contains, for completeness, the results coming using the full sample of observation available for trade flows. The biggest difference between column (5) and column (2) are the coefficients on fta and cu, which are positive and statistically significant when considering the full sample.

Table 5: **OLS results**

Dep Variable	**fdi**	**trade**	**trade NO FDI**	**trade FDI**	**trade TOTAL**
distance	-0.608***	-0.989***	-1.192***	-0.807***	-1.154***
	(0.034)	(0.021)	(0.046)	(0.016)	(0.013)
border	0.352***	-0.106	-0.154	0.240***	-0.056
	(0.096)	(0.072)	(0.549)	(0.047)	(0.065)
fta	0.188*	0.097	0.212	0.242***	0.276***
	(0.082)	(0.059)	(0.183)	(0.040)	(0.057)
cu	-0.162	-1.041*	0.000	-0.742**	1.101***
	(0.532)	(0.424)	(0.000)	(0.259)	(0.152)
colonial	0.832***	0.961***	1.544***	0.448***	1.136***
	(0.111)	(0.068)	(0.146)	(0.054)	(0.050)
language	-0.197*	0.258***	0.403***	-0.031	0.303***
	(0.085)	(0.052)	(0.106)	(0.041)	(0.026)
legal	0.572***	0.299***	0.170*	0.322***	0.452***
	(0.057)	(0.036)	(0.076)	(0.028)	(0.021)
Imp/Host FE	Yes	Yes	Yes	Yes	Yes
Exp/Home FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
R-squared	0.699	0.866	0.729	0.908	0.781
N	4167	8364	4213	4151	46490

5.2 Two Stage Estimation

Table 6 reports the result of the ordered Probit regression. Given that all the coefficients have been divided by σ_e, the quantitative magnitude is not very revealing. Distance, as expected, decreases the probability of observing trade or FDI flows between countries. Colonial links and common legal systems seem to be the most relevant variable in determining the probability of observing positive trade/investment flows. Moreover, in order to avoid relying on identification through functional forms in the estimation of eq (41) (42) an (43), it is necessary to include in the first stage a variable that is then excluded in the second stage. Following HMR, I use a variable about common religion as the excluded variable.[18] As Table 6 shows, common religion is a significant factor in determining the probability of observing trade and investment flows between countries, thus making of it a useful excluded variable.

Table 6: **Ordered Probit Results**

Period	**1986-1996**
distance	-0.452***
	(0.037)
border	0.407
	(0.282)
fta	-0.029
	(0.127)
cu	6.720
	(2.90e+07)
colonial	0.770***
	(0.118)
language	0.141*
	(0.085)
legal	0.522***
	(0.065)
religion	0.351***
	(0.115)
Imp/Host FE	Yes
Exp/Home FE	Yes
Year FE	Yes
pseudo R squared	0.584
N	8604

[18]expressing the probability that randomly picking two individuals in the two countries they belong to the same religion

Table 7 reports the result obtained for the FDI bilateral flow equation (41). The first column reports the OLS estimates to ease the comparison. The second column results are obtained by estimating eq (41) through maximum likelihood. The coefficient for distance, colonial and legal are sensibly smaller when using the two-stage procedure than the OLS ones. The coefficient on border becomes insignificant while the coefficients on δ and $\hat{\eta}^1$ are positive and statistically significant, thus indicating the importance of correcting for selection and heterogeneity. In the third column, following HMR, I drop the assumption of Pareto distribution for $G(a)$, and in order to correct for heterogeneity, I rely on a polynomial expansion (or series estimator). Specifically, I assume $\omega_{ij}^1 = g\left(\hat{z}_{ij}^{I*} + \hat{\eta}_{ij}^1\right) = g\left(HET\_I\right)$ with $g\left(HET\_I\right)$ approximated through a third order polynomial. Then I estimate (41) through OLS. The results look similar. Thus the analysis confirms that also in the case of FDI flows, the coefficients on several variables related to the economic distance between two countries can affect more the probability of actually observing the flows, rather than the volumes of those flows.

Table 8 reports the results obtained estimating equation (42), namely the trade equation in absence of FDI flows. Again, both the ML and the Polynomial expansion techniques are used. In this case, the polynomial approximation takes the form $\omega_{ij}^2 = g\left(\hat{z}_{ij}^{x*} + \hat{\eta}_{ij}^2\right) = g\left(HET\_x_1\right)$ with $g\left(HET\_x_1\right)$ again approximated through a third order polynomial. The results confirm to a certain extent the finding for FDI and the original HMR findings. The coefficients on distance, colonial and language drop compared to the OLS case, at least in the ML estimates. The results for the polynomial approximation are more puzzling, given that the coefficients appears to be magnified, instead than dampened. Moreover, the coefficients on δ and $\hat{\eta}^2$, which are now not significantly different from zero, cast doubt on the need of correcting for heterogeneity and selection, at least in this case. A possible explanation for this is the low number of zeroes in the bilateral trade flows considered, which is constrained by the lack of extensive data on the bilateral investment flows. On this front, it would be clearly very interest to see what happens when applying this methodology to a more detailed dataset.

Finally, table 9 reports the results for the trade bilateral flow equation when also FDI are observed. Here, due to computational issues[19], besides the OLS estimates, I only present the results obtained using series estimators. In particular, I assume $\omega_{ij}^3 = g\left(\left(\hat{z}_{ij}^{x*} + \hat{\eta}_{ij}^3\right), \left(\hat{z}_{ij}^{I*} + \hat{\eta}_{ij}^1\right)\right) =$

[19] Convergence problems in the ML estimates.

$g\left(HET\_x_2, HET\_I\right)$ with $g\left(HET\_x_2, HET\_I\right)$ approximated using a third order polynomial with a full set of cross terms. Column (2) of table 9 report the results obtained by correcting equation (43) appropriately taking into account also of the presence of FDI flows. Column (3) of table 9 reports instead the results of estimating equation (43) correcting for selection and heterogeneity as in the equation (41) (using plain HMR). The coefficients on distance, border, colonial and legal drops in both cases. On the other hand, the coefficient on fta increases in both cases and is now statistically significant. The coefficient on custom union is negative and amplified when using the HMR correction, while becomes positive (but marginally significant) using the correction proposed in eq(43). Overall, though, for the majority of the coefficients, the point estimates obtained using the two different corrections are very close. Hence, I conclude that failing to realize that in certain cases we do not observe only trade, but also FDI flows, leads only to marginal differences in the results.

6 Conclusion

While I have already summarized the main findings in the introduction, I'll propose some lines for future research.

First, the immediate next step is obtain the results using non linear least squares in the second stage.

Second, it would be interesting to implement the methodology proposed in this paper on a more detailed and possibly comprehensive dataset, ideally coming from firm-level data.

Third, the econometric problem that the methodology proposed here share with the original HMR methodology call for the attempt to use even more refined econometric techniques, such as simulated- ML or pseudo-ML for the estimation of the flow equations.

Finally, and possibly more ambitiously, it would be interesting to develop a dynamic version of the model and to test its prediction exploiting also the time dimension of the data.

Table 7: **FDI results**

Technique	**OLS**	**ML**	**Polynomial**
distance	-0.608***	-0.334***	-0.235**
	(0.034)	(0.087)	(0.096)
border	0.352***	0.037	-0.040
	(0.096)	(0.117)	(0.124)
fta	0.188**	0.176**	0.153*
	(0.082)	(0.080)	(0.082)
cu	-0.162	-2.086***	-2.638***
	(0.532)	(0.760)	(0.819)
colonial	0.832***	0.379**	0.269
	(0.111)	(0.177)	(0.191)
language	-0.197**	-0.241***	-0.284***
	(0.085)	(0.085)	(0.087)
legal	0.572***	0.242**	0.080
	(0.057)	(0.110)	(0.119)
ζ		0.608**	
		(0.229)	
$\hat{\eta}^1$		0.427*	0.808***
		(0.221)	(0.266)
HET_I			3.363***
			(0.566)
HET_I^2			-0.616***
			(0.170)
HET_I^3			0.047***
			(0.018)
Imp/Host	Yes	Yes	Yes
Exp/Home FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
R-squared	0.699		0.708
N	4167	4167	4167

Table 8: **Trade results with no FDI**

Technique	**OLS**	**ML**	**Polynomial**
distance	-1.192***	-1.011***	-1.287***
	(0.046)	(0.063)	(0.191)
border	-0.154	-0.251	0.074
	(0.549)	(0.540)	(0.589)
fta	0.212	0.227	0.227
	(0.183)	(0.179)	(0.184)
cu	0.000		0.000
	(0.000)		(0.000)
colonial	1.544***	1.247***	1.688***
	(0.146)	(0.159)	(0.332)
language	0.403***	0.337***	0.427***
	(0.106)	(0.105)	(0.122)
legal	0.170**	-0.057	0.293
	(0.076)	(0.093)	(0.247)
ζ		0.015	
		(0.179)	
$\hat{\eta}^2$		-0.043	0.306
		(0.217)	(0.556)
HET_x_1			0.397
			(0.693)
$HET\_x_1^2$			-0.149
			(0.162)
$HET\_x_1^3$			0.009
			(0.015)
Imp/Host	Yes	Yes	Yes
Exp/Home FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
R-squared	0.729		0.730
N	4213	4213	4213

Table 9: **Trade results with FDI**

Technique	**OLS**	**Polynomial**	**Polynomial**
distance	-0.807***	-0.515***	-0.523***
	(0.016)	(0.084)	(0.084)
border	0.240***	0.046	0.050
	(0.047)	(0.091)	(0.091)
fta	0.242***	0.276***	0.273***
	(0.040)	(0.040)	(0.040)
cu	-0.742***	5.378*	-3.821***
	(0.259)	(3.143)	(1.316)
colonial	0.448***	-0.032	-0.010
	(0.054)	(0.147)	(0.147)
language	-0.031	-0.119***	-0.121***
	(0.041)	(0.046)	(0.046)
legal	0.322***	-0.039	-0.044
	(0.028)	(0.105)	(0.105)
$\hat{\eta}^3$		-3.156***	
		(1.066)	
HET_x_2		-7.031***	
		(2.497)	
$\hat{\eta}^2$			0.239
			(2.146)
HET_x_1			0.948***
			(0.288)
Imp/Host	Yes	Yes	Yes
Exp/Home FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
R-squared	0.908	0.909	0.909
N	4151	4151	4151

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