This is to certify that the
dissertation entitled

THEORETICAL AND EMPIRICAL ANALYSIS OF
INTERNATIONAL TRADE
WITH HETEROGENEOUS FIRMS

presented by

Na Yang

has been accepted towards fulfillment
of the requirements for the

Ph.D. degree in Economics

Steven J. Matusz
Major Professor's Signature

August 22, 2008
Date

THEORETICAL AND EMPIRICAL ANALYSIS OF INTERNATIONAL TRADE WITH HETEROGENEOUS FIRMS

By

NA YANG

A DISSERTATION

Submitted to
Michigan State University
in partial fulfillment of the requirements
for the degree of

DOCTOR OF PHILOSOPHY

Department of Economics

2008

ABSTRACT

THEORETICAL AND EMPIRICAL ANALYSIS OF INTERNATIONAL TRADE WITH HETEROGENEOUS FIRMS

By

NA YANG

Chapter 1: The logarithmical form of the trade volume does not accommodate the situation of zero trade between certain country pairs. This paper starts with a theoretical framework of heterogeneous firms to show the true property of zero trade: "actual" instead of "potential" and proposes a two-part model framework to deal with zero trade problems. The marginal effect derived from the non-linear combination of the two parts significantly corrects the bias generated by estimating the gravity model using conventional methods.

Chapter 2 (with Isao Kamata): In this paper we examine how factor proportions determine the extensive margin of trade. Different from the existing research that only analyzes the country-level export pattern in varieties, we explore the problem at a disaggregate industry level. A quasi-Heckscher-Ohlin prediction for export varieties emerges from the model: countries export more varieties in the industries that more intensively use their abundant resources as input factors. The model also delivers important implications of opening autarky to trade: besides commonly-accepted facts of larger trade volume for each exporting firm, there is also a stronger selection of firms into the export market in comparative advantage industries.

Chapter 3: In this paper we explore the linkage between population health and inward FDI in a cross-country setting. A semi-IV framework proposed by Frankel and Romer (1999) is used to account for the endogeneity of FDI. We estimate FDI with exogenous geographical variables and also investigate the effect of FDI-induced openness on health conditions.

To my parents

ACKNOWLEDGEMENTS

I would like to acknowledge many people for helping me during my doctoral work. First and foremost, I thank my advisor, Steven Matusz, for his generous time and commitment. Throughout my doctoral study he encouraged me to develop independent thinking and research skills. I have greatly benefited from his valuable feedback on this thesis and everything else I have written. I would also like to thank all the members in my dissertation committee, Dr. Carl Davidson, Dr. Susan Zhu, Dr. Joseph Gardiner and Dr. Jun-Koo Kang, for their guidance and mentorship. I thank the Department of Economics for the financial support of my graduate study all the way through thus making it possible for me to focus on my research. I particularly thank Zhehui Luo and Dr. Joseph Gardiner, for giving me the opportunity to work on their projects so that I was extensively exposed to the empirical study arena and for sharing with me their insights constantly, not only on the econometrics problems, but also on life, which helped me to grow as an individual. I thank Dr. J. Roy Black, to hire me as his Research Assistant when I was just a first year PhD student and knew only the basics of STATA. Dr. Jun-Koo Kang generously provided me the Japanese firm-level data he purchased and loaned me the only copy of the disk he had. I also owe a lot to Professor Amsler for treating me not only as a student and her Teaching Assistant, but also as a friend; I am forever indebted to her encouragement when I was very frustrated with my research.

I extend many thanks to my colleagues and friends, especially my coauthor, Isao Kamata, and the friends from Lansing Chinese Christian Fellowship.

I thank my parents because they have been a constant source of love, support and encouragement. I thank them for their faith in me and allowing me to be as ambitious as I wanted.

And I give thanks to the LORD, for he is good: for his mercy endureth for ever.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

Chapter 1: Treatment of Zero Trade Volume and Re-estimation of Gravity Equation: Analysis Using Two-Part Models

1. Introduction

The gravity model has a long history in the trade literature. The original gravity model assumes the goods produced at an origin and attracted to a destination are proportional to the productions of the two locations, and the friction term adds the impedance of making travels of various durations or distances. Tinbergen(1962) was the first to use gravity model for estimation of bilateral trade flows, by substituting the production levels with two countries' GDPs and using trade resistance for the friction term. Over time, his approach has been vastly cited and furnished with better empirical estimation techniques and used to explain other aspects of international trade than the trade volume only. For example, Anderson and van Wincoop (2003) showed that the gravity model should be augmented with exporter and importer fixed effects because the traditional one does not take the multiple resistance terms into account.

In his seminal paper, Krugman formalized the role played by the geographical proximity in the regionalization process. In Frankel and Romer (1999), they showed that regionalization could be explained by geographical proximity and preferential trade agreements, with country sizes being constant. Moreover, Rauch (1999) showed that differentiated products could exhibit stronger geographical proximity effects than homogeneous products within a gravity model structure.

Though the gravity model has been widely recognized for its empirical success in predicting the trade volume and estimating the effects of the factors that impede bilateral trade, it initially did not have a strong theoretical background. [1]Recently there has been an increasing trend to use both the traditional and new trade theories to derive the gravity model. For instance, Deardorff (1995) derived it from a traditional Hechscher-Ohlin perspective while Eaton and Kortum (1997) used a Ricardian framework. Additionally, Helpman(1987) used both monopolistic competition model and gravity equation for an analysis and argued that the close of fit of the gravity model of trade variable could serve as supportive empirical evidence for the monopolistic competion model.

For empirics, Leamer(1974) used both the gravity equation and the Heckscher-Ohlin model to motivate the explanatory variables in a regression analysis of the trade flows. Notably in Helpman(1987), he applied his test to data on trade of the OECD countries, which yielded supportive evidence to the monopolistic competition model. Hummels and Levinsohn (1995) expanded the test to a much wider variety of countries, using different data and different estimation methods to test whether the data still supports the theory.[2]

All in all, these studies have improved our understanding of the gravity equation as a tool to model and analyze bilateral trade. But what is common in the existing research is that the analysis of gravity model was only applied on sample countries that have positive trade flows between them. However, a direct result of discarding zero trade volumes could result in biased estimates. In this paper we developed a heterogeneous firm model following Melitz (2003) then used the theoretical predictions to show how to amend the gravity model to deal with zero trade flows. The heterogeneity is introduced in a similar way to Melitz (2003): firms face uncertainty about their future productivities; the entry fees for both producing for the domestic market and exporting to foreign markets are costly and irreversible. The model delivers a set of implications for export probability and export volume. Similar to the Melitz's model, this paper allows the fact that none of the firms in one country has such productivity level that they can break even when they enter any other foreign market. As a result, the model incorporates the likelihood of zero volume of trade between some country pairs as well as positive trade volume in one direction from country i to country j, but zero trade flow from country j to country i. For predicted positive two-way trade, the model generates a gravity equation in which the size of trade flow is proportional to the sizes of the partners, but dampened by bilateral barriers.

Using various sources, I then assembled a dataset on bilateral trade and gravity measures for all the countries. The availability of the gravity measures makes it possible for us to accurately construct gravity measures for both country samples with zero trades and positive trade volumes.

Along the lines of research on gravity equations, the paper fundamentally differs from the existing research in two dimensions. Theoretically, it uses Melitz(2003) 's heterogeneous firm model to derive the gravity equation for both the export probability and volume besides the established Hechscher-Ohlin structure and traditional monopolistic competition model. With the heterogeneous firm setting, we rationalized the true feature of zero trade, which is significant suggesting the proper handling of zeros. The generalization of the gravity model accounts for the asymmetries between the volume of exports from i to j and the trade volume from j to i. But different from Helpman, Melitz and Rubinstein (2006), the firm-level heterogeneity term does not enter our estimation specification on the country level. Empirically, we propose a two-part model, which has been intensively used in other fields so that we can better address the problem of zero trade and correct the potential bias generated by the conventional estimation methods. We also explained how to compute the correct marginal effects of covariates on actual outcomes with different distributional specifications. A Vuong's test is used to sort out the best fit of the model for actual trade data. In a recent paper, Helpman et al. (2006) proposed a technique similar to sample selection model. We argue that two part model is more appropriate than sample selection in handling the problem of zero trade based on the fact that trade values are actual instead of potential. In two papers by Westerlund and Wilhelmsson (2006), Silva and Tenreyro (2006), they proposed a Poisson maximum likelihood estimator(PMLE). Although the PLME outperforms conventional OLS by removing the need to linearize the model, it makes strong assumptions on count data regression that might be inapplicable when dealing with continuous trade volume.

The remainder of the paper is organized as follows. Section 2 presents the cross country trade pattern. In section 3 we use the model of heterogeneous firm to clarify the true property of zero trade– *actual* instead of *potential* outcomes, and it is addressed that there is no selection bias problem when modeling the actual trade outcomes. Section 4 studies the econometric problems raised by conventional methods and section 5 proposes two-part estimation techniques with different sets of parametric distributions. We also explain how to compute the correct marginal effects for covariates–in this paper, distance and regional trade agreement. Additionally, a Vuong test is used for model selection. Section 6 provides the information of data and estimation results. The results are compared with those generated by OLS, adjusted OLS and non-linear least squares estimations. Section 6 contains concluding remarks.

2. Cross-country trade pattern

Since 1990s, international transactions are playing an increasingly important role in world trade. Table 1 shows the world GDP and world export growth path from 1982 to 2001. The volume of export approximately constitutes around 20% of total world GDP, and grows at a steady rate in levels.

Next we show the composition of country-pairs according to their trade status in figure 1 – country-pairs with two-way trade, one-way trade and no trade

	1982	1990	1996	2001
World GDP (in billion dollars)	11,758	22,610	29,024	31,900
World export (in billion dollars)	2,247	4,261	6,523	7,430
World export as % of GDP	19	19	22	23

Table 1: World International Trade and Production

at all. Years 1980-1997 are considered. From 1980-1997, the country pairs that are involved in either bilateral or unilateral trade constitute around 30%–50% of all possible country pairs.[3] However, the proportion of one way trade relationships stays at a fairly constant level of 10% along the early 90s. These years also witnessed an increasing share of country pairs with positive two-way trade.

Generally, the gravity approach suggests that trade volume is a function of trading partners' sizes and trade barriers. The GDPs are usually used to reflect the sizes of exporters and importers. The importer's market size represents the market demand for bilateral trade, and exporter's size reflects the potential commodity supply. Geographic distance is usually used as the term of resistance, along with other binary variables to proxy other aspects of economics integration factor or trade barrier factor. Using Feenstra(1995)'s trade dataset for year 2000 and country-pair characteristics, in Table 2 we show the correlations between the possibility to trade and gravity variables.

Particularly, the average distance among the group of country pairs that do not have any trade is much bigger than country pairs that have positive trade. The average GDP products are also substantially larger for countries with positive trade. In fact, the GDP products for country pairs with two way trade are almost as twice as that of country pairs with one way trade, and almost 20 times of the products for countries with zero trade. Two-way trade country pairs include larger proportion of both countries affiliated with the same regional trade agreement compared with one-way trade and zero trade. However, the benefit of sharing the common language is not quite clear, this could stem from the fact of the large

	two-way trade	one-way trade	zero trade
Mean distance(in kilometers)	6959	8027	8495.82
%with common language	12.10	12.82	17.96
%with common border	2.95	0.69	1.14
GDP products(in e+19 US $)	17400	8220	922
% of landlocked exporters	13.15	15.58	21.05
% of landlocked importers	13.15	18.22	20.87
mean of # of exporter major cities	21.10	22.92	23.85
mean of # of importer major cities	21.05	23.69	23.85
% of country pairs with common RTA	7.25	4.14	6.42
Number of country pairs	8,940	1,739	25,611
% of all country pairs	24.63	4.79	70.57

Table 2: Relationship between composition of trade and country characteristics, year 2000

economic variation among English-speaking countries. In summary, the evidence presented in the previous tables and figure 1 suggest that size and geography are very important factors to explain the existence of trade and the level of export volumes.

3. The model

The model of trade with heterogeneous firms is built up based on Melitz (2003)[4] The world is comprised of J countries, j=1,2.......J. On the demand side, the preferences of a representative consumer are given by a standard C.E.S. utility function over consumption of a continuum of goods x (n varieties) indexed by l. The varieties of x are imperfect substitutes, where $\sigma = 1/(1-\rho) > 1$ indexes the substitution pattern between varieties of x. Country j's utility is expressed as:

$$U_j = [\int_0^n x(l)^\rho dl]^{\frac{1}{\rho}} \tag{1.1}$$

With consumers maximizing their utilitities subject to the budget constraints, it leads to the demand of variety l in country j:

$$x_j(l) = Y_j P_j^{\sigma-1} p_j(l)^{-\sigma} \tag{1.2}$$

where Y_j is the total income of country j and $P_j = [\int_0^n p(l)^{1-\sigma} dl]^{\frac{1}{1-\sigma}}$ denotes the aggregate price index; p_j is the price of variety l in country j.

For production, labor is the only factor of production and is inelastically supplied in a market. The unit price of labor in country j is parameterized at c_j. There is a large pool of propective entrants into the industry.

The production of differentiated good x is characterized by monopolistic competition. All the potential entrants are the same ex ante. To enter the market, firms in country j need to incur a sunk cost $f_e c_j$ so that they can draw their productivities φ from a distribution $G(\varphi)$. Once the firm knows its productivity, it needs to choose to produce or exit. Successful entrants could make nonnegative profit with high enough productivity; however, if the productivity draw is below a cutoff level, it is best off exiting at once.

The productivity $\varphi(l)$ for firm to produce variety l is drawn from a Pareto distribution with the range of $[\varphi_L, \varphi_H]$ and shape parameter k.[5]

The total cost for production of variety l at q quantity is comprised of two parts: the variable cost and fixed cost (f_D units of labor).

$$\frac{qc_j}{\varphi(l)} + f_D c_j \tag{1.3}$$

In a monopolistic competition characterized economy, the pricing rule of a profit-maximizing firm with efficiency level φ is:

$$p_j(l) = \frac{c_j}{\rho\varphi(l)} \tag{1.4}$$

For a given firm, we could simply express the profit of the firm (with product l) from domestic sale as:

$$\pi_j(l) = (1-\rho)Y_j\ (\frac{c_j}{\rho\varphi(l)P_j})^{1-\sigma} - f_D c_j \tag{1.5}$$

The same derivation applies to the profit from trade, where τ_{ji} is the "melting iceberg" cost which is bigger than one; equally speaking τ_{ji} units of goods need to be shipped in order for one unit to arrive. Thus the profit for the firm (with product l) from country j to export to country i is:

$$\pi_{ji}(l) = (1-\rho)Y_i\ (\frac{\tau_{ji}c_j}{\rho\varphi(l)P_j})^{1-\sigma} - f_{ji}c_j \tag{1.6}$$

f_{ji} is the units of labor needed as fixed cost when firms produce at country j and export to country i, and it is larger than f_D, which is needed to produce for domestic market. Evidently with this assumption, this profit is positive for sales in the domestic markets, because f_{ji} is bigger than f_D. It also follows that only a proportion of country j's firms could export to country i.

The free entry condition for firms from country j implies:

$$f_e c_j = (1-G(\varphi_j^*))fc_j h(\varphi_j^*) + (1-G(\varphi_{xji}^*))f_{ji}c_j h(\varphi_{xji}^*) \tag{1.7}$$

and similarly for firms from country i,

$$f_e c_i = (1-G(\varphi_i^*))fc_i h(\varphi_i^*) + (1-G(\varphi_{xij}^*))f_{ij}c_i h(\varphi_{xij}^*) \tag{1.8}$$

where $h(\varphi^*) = (\frac{\widetilde{\varphi(\varphi^*)}}{\varphi^*})^{\sigma-1} - 1$ and φ_{xji}^* is the benchmark productivity needed for exporting to happen from country j to country i. Similarly, φ_{xij}^* is for export from country i to country j. φ_j^* identifies the lowest productivity level to produce at home.

Given these conditions, we can obtain the following:

Lemma 1:

$$\frac{\varphi^*_{xij}}{\varphi^*_j} = \frac{f_{ij}}{f}\tau^{\sigma-1}(\frac{c_i}{c_j})^\sigma\frac{Y_i}{Y_j} = \Omega_1 \quad (1.9)$$

$$\frac{\varphi^*_{xji}}{\varphi^*_i} = \frac{f_{ji}}{f}\tau^{\sigma-1}(\frac{c_j}{c_i})^\sigma\frac{Y_j}{Y_i} = \Omega_2 \quad (1.10)$$

Proof: See appendix A

By substituting (1.9) and (1.10) into (1.7) and (1.8), it leads to a system of equations with two unknowns φ^*_i and φ^*_j :

$$f_e c_j = f c_j(K-1)(\frac{\varphi_L}{\varphi^*_j})^k + f_{ji}c_j(K-1)(\frac{\varphi_L}{\varphi^*_i\Omega_2})^k \quad (1.11)$$

$$f_e c_i = f c_i(K-1)(\frac{\varphi_L}{\varphi^*_i})^k + f_{ij}c_i(K-1)(\frac{\varphi_L}{\varphi^*_j\Omega_1})^k \quad (1.12)$$

where $K = \frac{k}{k+1-\sigma}$. Solving the system yields:

$$(\varphi^*_j)^{-k} = \frac{\frac{f_e}{(K-1)\varphi_L^k}}{f + f_{ji}\frac{f-f_{ji}\Omega_2}{f-f_{ij}\Omega_1}} \quad (1.13)$$

From equation (1.8) and (1.12), the export productivity cutoff is determined by:

$$\varphi^*_{xij} = \frac{f_{ij}}{f}\tau^{\sigma-1}(\frac{c_i}{c_j})^\sigma(\frac{\frac{f_e}{(K-1)\varphi_L^k}}{f + f_{ji}\frac{f-f_{ji}\Omega_2}{f-f_{ij}\Omega_1}})^{-\frac{1}{k}} \quad (1.14)$$

where Ω_1 and Ω_2 are given by equations (1.9) and (1.10), which only consist of exogenous variables.

Define the ratio of cutoff productivity to export and the highest productivity φ_{Hj} as:

$$D_{ji} = \frac{\frac{f_{ij}}{f}\tau^{\sigma-1}(\frac{c_i}{c_j})^{\sigma}\left(\frac{\frac{f_c}{(K-1)\varphi_L^k}}{f+f_{ji}\frac{f-f_{ji}\Omega_2}{f-f_{ij}\Omega_1}}\right)^{-\frac{1}{k}}}{\varphi_j} \tag{1.15}$$

The probability for country j to export to i is determined by $prob(D_{ji} < 1)$, in another word, under the circumstances that the cutoff point to export (from j to i) is bigger than φ_j^*, the bilateral trade volume equals zero. The proportion of the firms that could be involved in exporting activities in a given country is determined by function: $\Lambda(\delta_i, \delta_j, \delta_{ij})$; where δ_k $(k = i, j)$ is country-specific characteristics and δ_{ij} is bilateral gravity covariates. From equations (1.9)-(1.10), the term φ_{xji}^* and φ_{xij}^*— export productivity cutoffs are also determined accordingly.

When trade is possible for two countries, or at least for trade in one direction, the level of trade would be:

$$T_{ji} = (\frac{c_j\tau_{ji}}{\rho P_i})N_jY_i \int_{\varphi_{xji}}^{\varphi_j^*} \varphi^{\sigma-1}dG(\varphi) \tag{1.16}$$

This function is again a function of two countries' variables and bilateral gravity covariates, which we will generalize to the function $\Upsilon(\delta_i, \delta_j, \delta_{ij})$.

For empirical framework, equations (1.15) and (1.16) are related to export probability and export volume separately for cross-border transactions from country j to i. Both the probability to trade and trade volume between two countries could be decomposed into three components as Helpman, Melitz and Rubinstein (2006) showed: one that depends on importer characteristics, one that depends on exporter characteristics, and a third that depends on the country pair characteristics. The decompositition resembles Anderson and van Wincoop (2003)'s gravity equation that embodies all three sets of variables. But unlike Helpman, Melitz and Rubinstein, we do not include the additional term that controls sample selection bias and proportion of the exporters. Instead, we address the question using a two-part model. The distinction between the sample selection model and the two part model is discussed in section 4.2. Other than model selection due to the property of zero trade, empirically, the two part model also outperforms sample selection because the downward bias for the coefficients of the covariates could arise from the high colinearity between the inverse-Mills ratio and the countries' covariates if sample selection is used.

4. Choice between sample selection model and two-part model

The two-part model has been used intensively in the field of health economics to deal with data that includes a large fraction of zero values, such as the cigarette demand, hospital utilization and health insurance coverage. The sample selection model is often misapplied to the corner solution problem, thus deriving the wrong marginal effect as their main interest.

This debate on the choice over Heckman sample selection model and two part model (hereafter, 2PM) went back to the famous "cake debate" of the 1980s. Jones in Handbook of Health Economics documented an excellent history of the "cake debate". The sample selection model has dominated much of the literature in microeconomics and the Heckit estimation procedure is routinely adopted to analyze the problems involving censoring and selection bias. The earlier comparisons are mostly based on theoretical issues [6]and the recent investigations have turned to Monte Carlo simulation experiments[7]. There seems to be a general misunderstanding of the terms "censored" and "selected" samples, especially when applied to the two-part model setting. As Wooldridge (2002) points out, a second kind of application of censored regression models appears more often in econometrics, and unfortunately, is where the label "censored regression" is the least appropriate. Though in many situations the problems we are trying to solve arise from an optimization problem and the true feature is corner solution, the name "censored models" appears to be more entrenched. Besides Wooldridge (2002), Dow and Norton (2003) also clearly addressed several issues regarding the merits and usage of the Heckit and two-part model when applied to data with a large chunk of zero values.

When choosing between the two models, we need to first distinguish between potential values and actual values. Both methods are used when dealing with continuous outcome variables with a large portion of zeros. But the choice over the two models depends primarily on the distinction between actual value and potential value.

When dealing with trade volume, an actual zero volume is observable, whereas positive volumes generally exhibits a skewed-to-the-right continuous distribution. For example, in a specified period patients either have zero health expense or a positive expense, but not negative expenditure; and in the same fashion the zero trade values in our heterogeneous firm model are corner solutions —true zeros instead of missing values, therefore we do not have a sample selection issue to address.

In contrast, the potential outcome is a latent variable that could not be fully observed. Zeros do not represent the fact that true values should be zero. In labor economics, observations without positive wage outcomes do not imply that these people would work for zero wages; instead these wages are non-observable. In the same way, potential expenditures that have never occurred would not affect the health care budget. Dow and Norton (2003) also gave an example of this type. For a person with zero health expenditure, it does not mean his potential expenditure would be zero if he had been examined by a doctor and indeed had sought any health care. The Heckit model would work better in this situation because the observed working people are likely to be different from the unobserved non-working people.

From our theoretical derivation of the last section, we are able to show that the true feature of zero trades here is indeed corner solutions for country pairs because countries choose not to trade when all the firms in their counties have productivities below the necessary benchmark. Therefore two-part modeling is more appropriate when zeros are the actual observed trade volume between two countries and we are interested in the determinants of the actual trade.

In mathematical terms, both models consist of two equations. For Heckit model, the first equation models the probability of having a positive value (selection equation), and the second equation expresses the mean trade volume in the sub-population with the positive trade volume (the conditional equation), the conditional equation usually takes the form of:

$$E(y|y>0,X) = X_2\beta_2 + \gamma_1\lambda(X_1\beta_1) \quad (1.17)$$

where $\lambda(X_1\beta_1)$ is the inverse-Mills ratio term under the assumption of normality of latent variable that denotes the potential trade volume. However, in the two part model, the second equation does not include this term due to the nature of the zeros, which makes it simply:

$$E(y|y>0,X) = X_2\beta_2^* \quad (1.18)$$

Therefore, when sample selection is inappropriately invoked for actual values, $0\ \beta_2$ will only equate β_2^* under special case where there is no selection bias($\gamma_1 = 0$).

The two part model should not be confused with standard Tobit model because the two part model allow the hurdle decision (part one) to be separate from the level decision (part two). Some studies that followed the practice of standard Tobit to estimate gravity equation with zero flows include Rose (2004), Soloaga and Winters (2001) and Anderson and Marcouiller (2002).

5. Specifications of the two-part model

Two-part model is sometimes mentioned in other fields in alternative ways—two-tier model or hurdle model. Different from sample selection[8], the property of latent variable is *actual* instead of *potential*. Parametrically, we model the first part in the following specifications probit and logit. For the distribution of the error term in the second part, we will use lognormal and exponential distribution[9]. The set up and the merits of the models are discussed below. A Vuong's test is used at the end of section 5 for model selection.

5.1 Lognormal Distribution

The estimation procedure works as follows. We define the dummy variable from our trade theory as D_i, therefore D_i means two countries trade [10], otherwise no trade exists. In the second level equations, we use T_i for observation i (a unique country pair)'s trade volume.

I.Probit and Lognormal:

When part one is probit and second part is lognormal, two equations take the following forms:

$$P(D_i = 1|X_{1i}) = P(X_{1i}^{'}\beta_1 + \varepsilon_1 > 0) = \Phi(X_{1i}^{'}\beta_1) \tag{1.19}$$

$$E(T_i|D_i = 1, X_{2i}) = \exp(X_{2i}^{'}\beta_2 + 0.5\sigma^2) \tag{1.20}$$

where the error terms follow the distributions: $\varepsilon_1 \tilde{} N(0,1)$, and $ln(\varepsilon_2) \tilde{} N(0,\sigma^2)$

The unconditional expected value would be:

$$E(T_i|X_{1i}, X_{2i}) = E(T_i|D_i = 1, X_{2i})\Pr(D_i = 1|X_{1i}) = \exp(X_{2i}^{'}\beta_2 + 0.5\sigma^2)\Phi(X_{1i}^{'}\beta_1) \quad (1.21)$$

The log-likelihood function will change accordingly to

$$ln(T_i) = \ln(\Phi(X_{1i}^{'}\beta_1)) + \ln(\phi(\frac{\ln T_i - X_{2i}^{'}\beta_2}{\sigma})) - \ln \sigma T_i \quad (1.22)$$

and marginal effect of variable x_k is:

$$\frac{\partial E(T_i)}{\partial x_k} = \Phi(X_{1i}^{'}\beta_1)\beta_{2k}\exp(X_{2i}^{'}\beta_2 + 0.5\sigma^2) + \phi(X_{1i}^{'}\beta_1)\beta_{1k}\exp(X_{2i}^{'}\beta_2 + 0.5\sigma^2) \quad (1.23)$$

For estimation, when we use total trade volume for level of T_i and for example, x_k is the log form of distance, the elasticity of distance on trade volume is:

$$\frac{\partial E(\ln \text{trade})}{\partial(\ln \text{distance})} = \Phi(X_{1i}^{'}\beta_1)\beta_{2k} + \phi(X_{1i}^{'}\beta_1)\beta_{1k}(X_{2i}^{'}\beta_2) \quad (1.24)$$

The marginal effect of Regional Trade Agreement would take a similar form to average treatment effect:

$$\exp(X_{2i}^{'}\beta_2 + 0.5\sigma^2)\Phi(X_{1i}^{'}\beta_1)|_{RTA=1} - \exp(X_{2i}^{'}\beta_2 + 0.5\sigma^2)\Phi(X_{1i}^{'}\beta_1)|_{RTA=0} \quad (1.25)$$

II. Logit and Lognormal

Similarly, we can also compute the unconditional expected value when part one is logit and second part is lognormal,

$$E(T_i|X_{1i}, X_{2i}) = \exp(X_{2i}^{'}\beta_2 + 0.5\sigma^2)\frac{\exp(X_{1i}^{'}\beta_1)}{\exp(X_{1i}^{'}\beta_1) + 1} \tag{1.26}$$

And the log-likelihood function is:

$$ln(T_i) = \ln(\frac{\exp(X_{1i}^{'}\beta_1)}{\exp(X_{1i}^{'}\beta_1) + 1}) + \ln(\phi(\frac{\ln T_i - X_{2i}^{'}\beta_2}{\sigma})) - \ln \sigma T_i \tag{1.27}$$

and marginal effect of ln(distance) would become:

$$\frac{\exp(X_{1i}^{'}\beta_1)}{\exp(X_{1i}^{'}\beta_1) + 1}\beta_{2k} \exp(X_{2i}^{'}\beta_2 + 0.5\sigma^2) + \frac{\exp(X_{1i}^{'}\beta_1)}{(\exp(X_{1i}^{'}\beta_1) + 1)^2}\beta_{1k} \exp(X_{2i}^{'}\beta_2 + 0.5\sigma^2) \tag{1.28}$$

It can be shown that the elasticity of distance on trade is:

$$\frac{\exp(X_{1i}^{'}\beta_1)}{\exp(X_{1i}^{'}\beta_1) + 1}\beta_{2k} + \frac{\exp(X_{1i}^{'}\beta_1)}{(\exp(X_{1i}^{'}\beta_1) + 1)^2}\beta_{1k}(X_{2i}^{'}\beta_2) \tag{1.29}$$

while the effect of RTA on trade is:

$$\exp(X_{2i}^{'}\beta_2 + 0.5\sigma^2)\frac{\exp(X_{1i}^{'}\beta_1)}{\exp(X_{1i}^{'}\beta_1) + 1}|_{RTA=1} -$$

$$exp(X_{2i}^{'}\beta_2 + 0.5\sigma^2)\frac{\exp(X_{1i}^{'}\beta_1)}{\exp(X_{1i}^{'}\beta_1) + 1}|_{RTA=0} \tag{1.30}$$

For the standard gravity estimation, which uses positive trade volumes only, the marginal effect of distance is β_{2k}, which would be a biased result if we want to know the true effect of distance on the level of trade. What we are interested in should be $\frac{\partial E(\ln \text{trade})}{\partial(\ln \text{distance})}$ instead of $\frac{\partial E(\ln \text{trade}|\text{trade}>0)}{\partial(\ln \text{distance})}$. In another word, we need to investigate the effect of the barriers on overall trade for all countries, not just the sub-sample of positive trades. For both sets of models (probit and lognormal, logit and lognormal), it can be shown that x_k affects $E(T_i)$ in three ways: through its effect in the hurdle equation, captured in β_1 ; through its direct effect in the conditional equation (captured in β_2); and through the density function of equation one ($\phi(X_{1i}^{'}\beta_1)$ in model one and $\frac{\exp(X_{1i}^{'}\beta_1)}{(\exp(X_{1i}^{'}\beta_1)+1)^2}$ in model 2).

The two part model is different from sample selection in that it does not include an inverse-Mills-ratio part due to the zero trade property, therefore there is also efficiency gain in 2PM because inverse-Mills ratio term usually generates multicollinearity problem. When dependant variables are actual values and sample selection is mistakenly used, the mis-specification is analogous to adding a single higher order term of X_1 in the second equation.

5.2 Exponential distribution:

Another leading case for functional forms that ensure a positive value for the second part is exponential function. In that case, our second part's function would take the form of:

$$E(T_i|X_{2i}, T_i > 0) = \exp(X_{2i}^{'}\beta_2)$$

A commonly used parameterization is to define the probability density function (pdf) of an exponential distribution as:

$$f(x) = \frac{1}{\lambda}\exp(-\frac{x}{\lambda}) \text{ if } x >= 0$$

$= 0$ if $x < 0$

where $\lambda > 0$ is a parameter of the distribution. The exponential distribution is used to model Poisson process, in which situation an object initially in state A can change to state B with constant probability per unit time λ. The exponential distribution may be also viewed as a continuous counterpart of the geometric distribution that describes the number of Bernoulli trials necessary for a discrete process to change state.

A detailed description of the derivations of log likelihood functions and marginal effects are discussed in Appendix A.2.

5.3 Vuong's test for model selection:

In this section, we invoke Vuong (1989)'s test to select from the four sets of models[11] and choose one that is the closest to the true trade data generating process. The models are considered non-nested if neither models can be represented as a special case of the other. Models with different non-nested distributions and models with different non-nested functional forms for the conditional mean are called strictly non-nested. The formal definition is given in Vuong (1987) and Pesaran (1987). In the econometrics literature, starting from Cox (1961, 1962a), the hypothesis testing is performed in a non-standard framework. A brief review is given in Davidson and MacKinnon (1993). Mizon and Richard (1986) proposed the encompassing principle, which leads to a quite general framework for testing one model against the other. Wooldridge (1990b) derived encompassing tests for the conditional mean in nonlinear regression models with heteroskedasticity. In this paper, we follow Vuong (1989) for model selection by discriminating between models on the basis of their distance from the true data-generating process, where distance is measured using the Kulback-Liebler information criterion. The following statistic is proposed:

$$T_{LR,NN} = \frac{1}{\sqrt{n}}\sum_{i=1}^{n}\ln\frac{f(y_i|x_i,\widehat{\theta})}{g(y_i|x_i,\widehat{\gamma})} \div \{\frac{1}{n}\sum_{i=1}^{n}(\ln\frac{f(y_i|x_i,\widehat{\theta})}{g(y_i|x_i,\widehat{\gamma})})^2 - (\frac{1}{n}\sum_{i=1}^{n}\ln\frac{f(y_i|x_i,\widehat{\theta})}{g(y_i|x_i,\widehat{\gamma})})^2\}$$

where

$$T_{LR,NN} \rightarrow Normal(0,1)$$

under the null hypothesis:

$$H_0 : E_h[\frac{f(y_i|x_i,\theta)}{g(y_i|x_i,\gamma)}] = 0$$

We will reject at significant level 5% the null hypothesis of equivalence of the models in favor of F being better than G if $T_{LR,NN} > z_{5\%}$ (or $T_{LR,NN} < -z_{5\%}$). The null hypothesis is not rejected if $|T_{LR,NN}| < z_{2.5\%}$.

6. **Estimation Result**

6.1 The data

The goal is to get consistent estimates of the parameters on observable barriers and calculate bilateral costs of export. Considering the fact that country-specific variables and barrier variables, such as distance and common language, do not vary much in time dimension, we instead investigate the cross-sectional feature of the model without looking at the panel data.

We use year 2000 world trade data, which makes the analysis cover a cross section of 191 countries. Therefore the data consists of 36290 (191*190 country pairs) observations of bilateral trade flow. Table 3 provides the list of country names. Out of this number, 25611 unique combinations of these countries have zero trade, which is around 70%.

Information on bilateral trade comes from World trade data compiled by

Feenstra etc. (2005). Countries GDPs are from Penn World Table 6.2 and complemented by the World Bank's World Development Indicators (2002). Gravity measures, including dummy variables for contiguity[12]and colonial ties[13]come from various sources: CEPII, CIA's World Factbook and Jon Haveman's website. The bilateral distance is calculated following the great circle formula, which uses latitudes and longitudes of the most important city (in terms of population) or of its official capital.[14]The number of major cities for both exporters and importers are from Henderson's World City Data. Table 4 provides the summary statistics of the variables.

The data on regional trade agreement (RTA) is constructed from World Trade Organization documents on RTA dated on Oct. 11, 2000. Figure 4 shows the level of engagement of individual countries and customs territories in RTAs in the year 2000. The figures indicate the total number of each country's trade agreements. Such a map allows for a quick comparison of different countries and regions. Some countries are not involved in any RTA, while others are signatories to more than a dozen. We use a simple dummy variable to represent the RTA relationship between country i and j, so I_{ji} =1 if country i and j are in the same RTA and 0 otherwise.

6.2 The result

The exact specifications of the 2-part model of the gravity equation used are as follows:

$$E(D_{ji}=1) = f[\beta_0+\beta_1*\ln(Y_i)+\beta_2*\ln(Y_j)+\beta_3*\ln(dist_{ij})+\beta_4*ex\_landlk+\beta_5*im\_landlk+\beta_6*com\_lan+\beta_7*com\_border+\beta_8*Clononial+\beta_9*ex\_cities+\beta_{10}*im\_cities+\beta_{10}*I_{ji}]$$

$$\ln T_{ji} = \beta_0+\beta_1*\ln(Y_i)+\beta_2*\ln(Y_j)+\beta_3*\ln(dist_{ij})+\beta_4*ex\_landlk+\beta_5*im\_landlk+\beta_6*com\_lan+\beta_7*com\_border+\beta_8*Clononial+\beta_9*ex\_cities+\beta_{10}*im\_cities+\beta_{10}*I_{ji}+\varepsilon_{ij}$$

where the subscript i and j denote the trading partners, exporter for j, importer for i;

Y_k $(k = i, j)$ is the GDP;

$dist_{ij}$ is the distance between the trading partners;

com_border is the dummy variable for common border;

Clononial is the dummy variable for colonial relationship after 1945;

ex_landlk takes the value of unity if the exporter is landlocked;

im_landlk takes the value of unity if the importer is landlocked;

ex_cities is the number of cities in exporter country;

im_cities is the number of cities in importer country;

$I_{ji} = 1$ if country i and j are in the same RTA;

ε_{ij} represents the omitted other factors that influence the bilateral trade;

The functional form of f(.) is probit or logit, and error term ε_{ij} will follow the previously specified lognormal or exponential distributions.

Table 5 presents the estimation outcomes of various techniques proposed by traditional methods. The first column corresponds to the OLS estimates by using the logarithm forms of exports as dependent variable, and only using the subgroup of country pairs with positive trade value. The second column uses OLS as well but the dependent variable is in the logarithm form of sum of one and trade value, in this way we could also include zero trade observations in the estimation to deal with the problem of no log form for zero. The third and forth columns correspond to Poisson pseudo-maximum likelihood estimation proposed by Silva and Tenreyro for all observations and for positive trade only.

In table 6 and 7, we show the results from two part models. Table 6 contains our benchmark estimation. In another word, we treat all the country pairs as equally important without assigning any weight. However, it is not realistic to treat the trading relationships equally for country pairs like US and China and country pairs like Haiti and Uganda, two small developing countries. Therefore in table 7, we use two countries' GDP product as a weight, so that larger country partners are given bigger weight in the 2PM estimation.

The various estimations reveal that the coefficients of log of the GDPs, are consistent with general belief, which is close to one. The coefficients of gravity measures, however, differ from each other in different models. But the general message is that countries further apart trade less, while larger countries trade more. The effects of GDPs and distance measures are large and highly statistically significant, which is in line with the estimates from the literature. Countries belonging to the same regional trade association trade more, as do countries sharing the same language, the same border, and a shared colonial history. Other gravity effects are quite mixed. The table also clearly shows that the same variables affect both the probability of trade and trade volumes.

Comparing the second part of 2PM and OLS for positive trade sub-sample, the following observations are in order. The elasticities of exporter/importer GDPs, and distance are substantially smaller under 2PM. Common colonial ties have stronger effects under OLS. The negative coefficients on number of major cities in exporters and importers in both models lead to some puzzling results.

However, the major interest of this research rests on the marginal effect of the distance and RTA on the level of trade. The results from other models are reported in table 8. And our results from 2PM are reported in Table 9 and 10 separately for estimations without and with sampling weight. Though the marginal effects of distance are quite similar for results of unweighted 2PM and weighted 2PM, the weighted 2PM marginal effect of RTA is relatively smaller than the unweighted result. This could be due to the correlation between existence of RTA for certain country pairs and their trade volume. Therefore, countries that are involved in RTA are also assigned a larger weight. However, this correlation for distance is less apparent. The two model specifications for 2PM yield larger marginal effect than traditional methods except OLS on positive samples only.

The result for the Vuong test is reported in Table 11. The test is applied to probit versus logit and then lognormal versus exponential distributions separately. As shown by LR statistics, there is no significant difference between the methods. The LR tests suggest that we can not reject one model against the other. As a matter of fact, how to specify the parameterization seems to be rather a less important issue compared with the choice of an appropriate model to deal with the zeros. To summarize, we have been able to find evidence that traditional methods generate biases and are economically incorrect.

7. Conclusion

In this paper, we provide a thorough analysis and discussion on the methods applied on zero trades, in light of prevailing knowledge on the theoretical foundation of gravity model and the econometric techniques. The general message is that estimates are biased if zero values are discarded. Additionally, applying two part model to deal with the zero trade problem is more appropriate than the conventional models, such as sample selection. We showed persuasive evidence by comparisons between our estimated result and the existing research. The estimated elasticity of distance on trade value and average treatment effect of RTA are significantly different in two part models from the existing models.

To understand the correct marginal effect of trade barriers is essential for our understanding of international trade pattern and policy makings. What policy makers should analyze is the marginal effect of a trade agreement on overall trade level for all possible country pairs, as we showed in the paper, not just for countries that are involved in bilateral trade.

Several caveats are in order. Due to the limitation of data, we can only explore the total trade up to the year 2000. A potential future work is to include more years when data becomes available and look at the time series. Another problem caused by the unavailability of trade data is the precision of the RTA effect. As Baier and Bergstrand (2006) showed, a foreign trade agreement approximately doubles two members' bilateral trade after 10 years, which could not be addressed in our cross sectional data. However, the essential problem we want to address in this paper is the appropriateness of different models for application of zero trade volume and we want to provide the policy makers with more alternatives on an unbiased estimates of the marginal effects of distance and average treatment effect of RTA.

The supportive evidence for 2PM against other methods we presented may seem surprising in light of the proliferation of the traditional ways to deal with zeros in international trade. We hope the further research could acknowledge the importance of zero trades and come to appreciate the need to adjust by using appropriate econometric techniques.

Chapter 2: Explaining Export Varieties: the Unexplored Role of Comparative Advantage

1. Introduction

The recent trade literature on export/import variety has grown rapidly. The seminal work by Krugman (1979) first brought product variety into focus through a monopolistic competition model of international trade. Although the increases in product varieties have long been known as important source of gains from trade, empirical studies on the significance of the growth of the product varieties, or "extensive margin" of trade, in international trade are relatively new. For example, Kehoe and Ruhl (2003) show that the trade of new goods (extensive margin) explains a larger proportion of the growth of trade following trade liberalization than the increase in the volume of previously-traded goods (intensive margin) does. A series of empirical studies by Funke and Ruhwedel (2001a, 2001b, 2005) indicates that the growth of product variety in exports has a significant effect on the economic growth in various countries and regions. Feenstra and Kee (2004) also provide evidence supporting the positive impact of export variety on productivity growth for a large sample of developed and developing countries. Broda and Weinstein (2004) empirically show how much the increase in imported variety mattered for the welfare of United States. Their results suggest that the U.S. welfare has increased by 3% due to the increase in the extensive margin of trade.

Although these previous studies have examined the cross-country patterns of product varieties in international trade, few explored the trade patterns of product varieties across countries. In this paper we examine whether the traditional theory of comparative advantage explains the cross-industry patterns of product varieties in the exports of countries. Our approach also considers the modern framework of firm-level heterogeneity. We first construct a theoretical model in which countries vary in factor endowment, industries differ in factor intensity, and firms belonging to the same industry are heterogeneous in productivity. This model is used to derive a prediction that relates product varieties in a country's exports to the degree of relative factor intensity of industries. To empirically test the prediction we employ the data on U.S. imports in 1990 from Feenstra, Romalis, and Schott (2002), which finely classifies imported commodities according to the 10-digit Harmonization System (HS). We also use the data on input factor use in various industries from 1992 U.S. Census of Manufactures, as well as the data from Hall and Jones (1999) for factor abundance of countries. The empirical tests support our semi-Heckscher-Ohlin prediction for product varieties in trade; that is, countries export more varieties in the indutries that more intensively use their abundant resources as input factors.

This paper contributes to the literature by extending the theoretical model of Bernard, Redding and Schott (2006), which integrates a heterogeneous firm model by Melitz (2003) into the 2-country, 2-factor and 2-sector framework, to a multi-industry setting as Dornbusch, Fischer and Samuelson (1980) and Romalis (2004). The paper also goes empirically further than others by explicitly linking the factor endowment and industry-wise factor use to the number of varieties in their exports.

The paper proceeds as follows. Section 2 develops the theoretic model in order to provide an implication for the relationship between factor proportions and export variety. Section 3 proposes an empirical approach to test the theoretical prediction, and Section 4 describes the data. The results of the empirical tests are also presented in Section 4. Section 5 concludes.

2. The Model

This paper adopts the monopolistic competition model with CES function and a fixed cost of exporting to account for market entry. The model features a framework where countries differ in endowment and increase in the exposure to trade leads to inter-firm and inter-industry reallocation toward more productive firms and industries with more comparative advantage.

We consider a world of two countries, two factors, multiple industries and a continuum of heterogeneous firms. Countries share the same technologies but differ in terms of factor endowments. We use H for home country that is skill-abundant and F for foreign country that is skill-scarce, so that $\frac{S_H}{L_H} > \frac{S_F}{LF}$, where S stands for skilled-labor and U for unskilled-labor.

2.1 Consumption

The representative consumer derives his utility from consumption over the output from all M industries. And each industry consists of a large number of differentiated varieties with each variety indexed by one firm. In what follows, we use i to index firms, and m for industries. The utility function takes the following form:

$$U = C_1^{\alpha 1} C_2^{\alpha 2} \ldots . C_M^{\alpha M} \qquad \sum_{m=1}^{N} \alpha_m = 1 \tag{2.1}$$

C_m represents the consumption index over industry m, which produces a set of Ω_m individual varieties, with quantity of each variety as $q(i)$.

$$C_m = [\int_{i \in \Omega_m} q(i)^{\rho} di]^{\frac{1}{\rho}} \tag{2.2}$$

Accordingly, the price index P_m over individual varieties is defined as

$$P_m = [\int_{i \in \Omega_m} p_m(i)^{1-\sigma} di]^{\frac{1}{1-\sigma}} \tag{2.3}$$

where $\sigma = \frac{1}{1-\rho}$ is the constant elasticity of substitution across varieties.

2.2 Production

As Melitz(2003)'s model, we model the production cost as a combination of two parts, fixed cost and variable cost. The fixed costs are the same for all firms in the same industry within a country, however, the variable costs vary across firms with their productivities $\varphi \in (0, \infty)$. Therefore, we assume the cost function for firm i of industry m is:

$$Total\ cost(m,i) = \left[f + \frac{q}{\phi(m,i)}\right] s_{\lambda}^{\beta_m} w_{\lambda}^{1-\beta_m},\ 1 > \beta_M > \beta_{M-1} \dots > 0 \tag{2.4}$$

where s is the wage for skilled labor, w is the wage for unskilled labor, $\lambda = H, F$ is the country index. By ranking the skill intensity of industries(β_m), we assume the industries are more skilled-labor intensive as m gets larger. The fixed cost and variable cost of each firm features the same factor intensity. There is no difference in factor proportion use within the same industry across countries.

For domestic production, the profit maximization rule implies that equilibrium price for domestic sale will equal to a constant mark-up over marginal cost:

$$p_{m,i}(\phi) = \frac{s_{\lambda}^{\beta_m} w_{\lambda}^{1-\beta_m}}{\rho\phi} \tag{2.5}$$

With the pricing rule, the firms' equilibrium domestic revenue is in the following form:

$$r_{\lambda m,i}(\phi) = \alpha_i Y_{\lambda}\left(\frac{s_{\lambda}^{\beta_m} w_{\lambda}^{1-\beta_m}}{\rho\phi P_{\lambda m}}\right)^{1-\sigma} \tag{2.6}$$

Y_{λ} is the total income of country λ. Each firm's revenue is increasing proportionately with its idiosyncratic productivity ϕ, the domestic aggregate income

Y, the industry price index P_m, and the inverse measure of mark-up. The profit of each firm would equal the revenue minus fixed cost of production and variable cost:

$$\pi_{m,i}(\phi) = \frac{r_{m,i}(\phi)}{\sigma} - f s_\lambda^{\beta_m} w_\lambda^{1-\beta_m} \tag{2.7}$$

There is a sunk entry cost for each firm in order to draw a productivity parameter from distribution $G(\phi)$, which is a Pareto distribution with shape parameter k with the support of $[\phi_L, \phi_H]$. The entry cost takes similar form as fixed production cost, which used the same proportion of the two factors:

$$f_e s_\lambda^{\beta_m} w_\lambda^{1-\beta_m} \tag{2.8}$$

In summary, there is common factor intensity for fixed, variable and entry cost. In the equilibrium, the firms keep entering until the profit is zero, therefore the benchmark productivity for domestic production is determined by zero-profit productivity cutoff:

$$r_m(\phi^*_{\lambda m}) = \sigma f s_\lambda^{\beta_m} w_\lambda^{1-\beta_m} \tag{2.9}$$

In country λ, all the firms with productivity higher than or equal to ϕ^*_λ will continue producing while firms with ϕ lower than the benchmark productivity will exit.

The value of the firm is also determined on a discount basis of future profit flow, with δ as the probability of death, we have:

$$V_m(\phi) = \max\{0, \sum_{t=0}^{\infty}(1-\delta)\pi_m(\phi)\} = \max\{0, \frac{\pi_m(\phi)}{\delta}\} \tag{2.10}$$

In the long run equilibrium, the expected value V_m should equal the sunk cost in each industry. The expected future value of entry is the *ex ante* expected probability of successful entry multiplied by expected profit, therefore we get the *free-entry* condition:

$$[1 - G(\phi^*_{\lambda m})]\frac{\overline{\pi}_m(\phi)}{\delta} = f_e s_\lambda^{\beta_m} w_\lambda^{1-\beta_m} \tag{2.11}$$

where $\overline{\pi}_m(\phi)$ stands for the average or expected profit from successful entry for industry m.

By combining the free entry condition and the zero profit condition, we could simply express the function of $\phi^*_{\lambda m}$ in one equation:

$$\frac{f}{\delta}\int_{\phi^*_{\lambda m}}^{\infty}[(\frac{\phi}{\phi^*_{\lambda m}})^{\sigma-1} - 1]g(\phi)d\phi = f_e \tag{2.12}$$

where $g(\phi)$ is the probability density function of Pareto distribution. The left hand side of equation (2.12) monotonically decreases with the increase in the value of $\phi^*_{\lambda m}$ with the right hand side of equation (2.12) being constant, therefore a unique value of $\phi^*_{\lambda m}$ is guaranteed.

For export, we assume the export cost includes both the fixed and variable parts. In order to export a manufacturing variety to another country, a fixed export cost must be spent for each firm, and it uses the same factor intensity as production cost. Additionally, the variable trade cost takes the standard iceberg form with parameter $\tau > 1$, this term is symmetric across industries and countries.

With the export costs, the equilibrium price is still a constant mark-up over the marginal cost,

$$p^{\lambda}_{m,ix}(\phi) \equiv \tau p^{\lambda}_{m,i}(\phi) = \frac{\tau s_{\lambda}^{\beta m} w_{\lambda}^{1-\beta m}}{\rho\phi} \tag{2.13}$$

For firms from home, depends on their productivity levels, their profits will be domestic profit only or both domestic profit and export profit:

$$\begin{aligned} r^{\lambda}_{m}(\phi) &= r^{\lambda}_{m}(\phi) && \text{for domestic production only} \\ &= r^{\lambda}_{m}(\phi) + r^{\lambda}_{mx}(\phi) && \text{for both domestic production and export} \end{aligned}$$

To solve the cutoff points of export as well, we need similar equations for zero-profit condition and free entry condition.

However, the expected profit now consists of two parts:

$$\pi^{\lambda}_{m,itotal}(\phi) = \pi^{\lambda}_{m,i}(\phi) + \max\{0, \pi^{\lambda}_{m,ix}(\phi)\} \tag{2.14}$$

The zero profit condition consists of two equations:

Zero-profit domestic production condition, which involves $\phi^*_{\lambda m}$

$$r^{\lambda}_{m}(\phi^*_{\lambda m}) = \sigma f s_{\lambda}^{\beta m} w_{\lambda}^{1-\beta m} \tag{2.15}$$

Zero-profit export condition, which involves $\phi^*_{\lambda mx}$

$$r^{\lambda}_{mx}(\phi^*_{\lambda mx}) = \sigma f_x s_{\lambda}^{\beta m} w_{\lambda}^{1-\beta m} \tag{2.16}$$

Equations (2.6), (2.15) and (2.16) jointly determine the relationship between cutoffs $\phi^*_{\lambda m}$ and $\phi^*_{\lambda mx}$, which is

$$\phi^{*-k}_{Hm} = \phi^{*-k}_{Fmx} \;\; \Lambda^{H}_{m} \tag{2.17}$$

$$\phi^{*-k}_{Fm} = \phi^{*-k}_{Hmx} \ \Lambda^F_m \tag{2.18}$$

where $\Lambda^H_m = [\tau^{1-\sigma}\frac{f}{f_x}(\frac{A_H}{A_F})^{\sigma}]^{\frac{-k}{\sigma-1}}$, $\Lambda^F_m = [\tau^{1-\sigma}\frac{f}{f_x}(\frac{A_F}{A_H})^{\sigma}]^{\frac{-k}{\sigma-1}}, A_\lambda = s_\lambda^{\beta_m} w_\lambda^{1-\beta_m}$

Assumption 1: $f_x > f$

With this assumption, there is a selection effect into export market, which means only a portion of firm with successful entry could export. Of all the firms from the home country, a fraction of $G(\phi^*_{x\lambda})$ will exit because their revenues could not cover the fixed production cost, a fraction of $G(\phi^*_{\lambda mx}) - G(\phi^*_{\lambda m})$ firms will serve market λ only but could not be able to cover the higher export cost. Only the most productive ones, those who could draw high enough productivity will export.

The free entry condition is also modified because now the expected value of entry is the sum of two parts: the ex ante probability of successful entry times expected profit of domestic production and ex ante probability of export times expected profit from the export market. The expected value should be required to equal to the sunk entry cost, which means:

$$[1 - G(\phi^*_{\lambda m})]\frac{\overline{\pi}^{\lambda}_m(\phi)}{\delta} + [1 - G(\phi^*_{\lambda mx})]\frac{\overline{\pi}^{\lambda}_{mx}(\phi)}{\delta} = f_e s_\lambda^{\beta_m} w_\lambda^{1-\beta_m} \tag{2.19}$$

By using the two zero profit conditions and the specification of Pareto distribution condition, we can write free entry condition in the following way:

$$f(K-1)\phi^k_L \Lambda^H_m \phi^{-k}_{Fmx} + f_x(K-1)\phi^k_L \phi^{-k}_{Hmx} = f_e\delta \tag{2.20}$$

$$f(K-1)\phi_L^k\Lambda_m^F\phi_{Hmx}^{-k}+f_x(K-1)\phi_L^k\phi_{Fmx}^{-k}=f_e\delta \tag{2.21}$$

where $K=\frac{k}{k+1-\sigma}$.The existence and uniqueness of $\{\phi^*_{Hmx},\phi^*_{Fmx}\}$ is derived by linking these two equations. In such a model with multiple industries, two factors and heterogeneous firms, opening from autarky state to costly trade would have different impacts on asymmetric countries and on different industries. As a result of asymmetry between two countries' factor intensities, the profits derived from exporting also vary across different industries in different countries.

With other things being equal, we could compare the export varieties (number of exporting firms or probability of exporting) between countries and industries.

The ratio of countries' export varieties in the same industry m is given by:

$$1-G(\phi^*_{Hmx})=(\frac{\phi_L}{\phi^*_{Hmx}})^k=\frac{f_e\delta(\Lambda_m^F-\frac{f_x}{f})}{(K-1)(\Lambda_m^F\Lambda_m^H f-\frac{f_x^2}{f})} \tag{2.22}$$

The term $1-G(\phi^{*H}_{mx})$ not only stands for the share of firms that are involved in exporting activities, but also represents the export variety of country H in industry because each firm accounts for one variety.

Assumption 2: $\tau^k(\frac{f_x}{f})^{\frac{k+1-\sigma}{\sigma-1}}>(\frac{A_F}{A_H})^{\frac{\sigma k}{\sigma-1}}$

This requires both variable and fixed trade cost are fairly large.

Under autarky, home country's relative skill abundance leads to a lower relative price of skilled labor and of the skill-intensive good. Under free trade without trade cost, both goods and factors are mobile. As Samuelson (1949), Dixit and Norman (1980) showed, we allow two countries' relative endowments of the two factors lie in between of the integrated equilibrium factor intensity, thus the equilibrium of free trade is characterized by FPE, which means the equilibrium wage equals the value for the integrated world economy. However, the existence of fixed and variable cost of trade in our model results in an intermediate relative wage.

From autarky to opening to trade, it leads to a decrease in the rewards for the abundant factor, thus the unskilled relative wage w_{λ} will fall in skill-abundance country (Home) and the skill relative wage s_{λ} will decrease in skill-scarce country (Foreign).

$$\left(\frac{\frac{s_H}{w_H}}{\frac{s_F}{w_F}}\right)^{A} < \left(\frac{\frac{s_H}{w_H}}{\frac{s_F}{w_F}}\right)^{CT} < \left(\frac{\frac{s_H}{w_H}}{\frac{s_F}{w_F}}\right)^{FT}$$

where the superscripts A, CT, FT indicate autarky, costly trade and free trade.

Proposition 1: For fixed country pairs, the cross-industry trade has the following patterns:

(a) the skill-abundant countries will export more varieties in skilled-labor intensive industries (bigger β)

(b) the skill-scarce countries will export more varieties in unskilled-labor intensive industries (smaller β)

Proof: see appendix B

In appendix B, we show that the absolute term of industry-level export variety of home country increases with skill intensity of the industry. The reason why home country could produce and export more varieties in skill intensive industries stems from the fact that home country has more skilled labor. It could either use skilled labor more intensively for each industry or have more skill-intensive varieties. Our model assumes there is no technology difference within industries across countries; therefore, home country capturing a larger share in terms of exported varieties in skill intensive industries seems to be a natural result. The extensive margin of the trade structure is relative factor abundance among countries.

Proposition 2: For fixed industries, the cross-country trade has the following patterns, when relative factor price is controlled, the country that has cheaper cost in absolute terms export more varieties.

Proof: See appendix B

There is a bigger mass of firms in the skill-intensive industries in the skill-abundant country (home country), and unskilled labor intensive industries in the skill-scarce country (foreign country).

The asymmetry of the proportion of exporting firms across industries stems from the fact that comparative advantage industry features lower relative price. Therefore, a more fierce competition exists in the comparative advantage industry, but less fierce competition in the export market for comparative advantage industry. This fact will result in more firms entering comparative advantage industry, and thus more export varieties in this industry.

3. The Data

Our empirical framework proposed in the previous section requires data for three variables: the number of product varieties in industries in the exports of countries, production factor endowments in those countries, and input factor intensities in the industries.

For the product varieties in exports, we use the data on the U.S. imports in 1990 from Feenstra, Romalis and Schott (2002). The data contain the information on the U.S. imports of each commodities classified according to the very disaggregated 10-digit Harmonized System (HS) from each exporting country. The data also indicate product classification code according to the 4-digit U.S. Standard Industrial Classification (SIC, 1987 version) corresponding to each 10-digit HS. This enables us to count the number of product varieties in each industry in the following manner. Defining industries following the 4-digit SIC and product varieties following the 10-digit HS, we measure the number of varieties in Industry i exported from Country c, or n_{ic}, by the number of 10-digit HS commodities included in the U.S. imports from Country c in each 4-digit SIC industry. Since some 4-digit industries have more 10-digit varieties than others by nature, we adjust the number of varieties by the total number of 10-digit varieties that U.S. imports from the world in each 4-digit industry; i.e., $N_i = \sum_c n_{ic}$. Note that the imports of the same 10-digit commodity from different countries are considered as different varieties, as the theoretical model assumes that each firm produces a unique product. Table 12 provides the number of exporters, total number of varieties, and total import value in the U.S. imports, as well as those in the U.S. manufacturing imports (imports in the 4-digit SIC 2011 through 3999) in the year of 1990. Due to the availability of industry factor intensity data, we use the data on manufacturing imports, which represent 94% of the total U.S. imports in 1990 in the number of varieties, and 83% in the value of imports.

The data for factor endowment of countries are from Hall and Jones (1999). Our theoretical model is in a two-factor framework with skilled labor (S) and unskilled labor (U), and we use the data on the ratio of human capital to labor as the measure of the abundance of skilled labor relative to unskilled labor (S/U). In the source the data on human capital to labor ratio as of 1988 are available for 127 countries. Since we consider the U.S. imports from other countries, we calculate the exporters' skilled-to-unskilled labor ratios relative to the ratio of the U.S. (*i.e.*, $\frac{(S/U)_c}{(S/U)_{US}}$ for each exporter c).

Our theoretical model assumes common production technologies across countries, and we employ the data from the 1992 U.S. Census of Manufactures, which covers 458 manufacturing industries classified by the 4-digit SIC (1987 version; the codes 2011 through 3999) as the measure of the world common input factor intensity in each industry. We measure the skilled-labor intensity of each industry by the number of non-production workers as the share in the total number of employees in each 4-digit SIC; and the unskilled-labor intensity by the number of production workers as the share in the total employment.

The sample for our empirical analysis includes 115 countries, from which the U.S. imports in any one or more manufacturing industries in 1990; and 394 manufacturing industries (4-digit SIC), in which the U.S. imports from any one or more exporters in 1990. Table 13 lists these 115 countries in the sample; and Table 14 provides the summary statistics of relative factor endowment (the skilled labor-to-unskilled labor ratio, or S/U) of the sample countries, as well as the lists of ten most and least skilled labor-abundant countries. Table 15 shows the summary statistics of the intensities of the two factors (S and U) of 394 sample industries, and also lists ten most and least skilled labor-intensive industries. Figure 4 graphs the number of countries from which the U.S. imports in each 4-digit industry in 1990, on which the industries are sorted (from the left to right) in the order of skilled-labor intensity. Figure 5 and 6 plot the number of exporters and the total number of varieties that the U.S. imports in each industry, respectively, against industry skilled-labor intensity. These figures indicate that the U.S., the world second most skilled-labor abundant countries, tends to import from more exporters, and accordingly import more varieties, in unskilled labor-intensive industries than do in skilled-labor intensive industries.

4. Empirical Test

The key implication of our economic model presented in the second section is that, as indicated by Equation (2.22), with the assumption that each firm produces a unique variety of product, a country will export more varieties in industries in which the country has its comparative advantage in the Heckscher-Ohlin sense than it will in other industries. In this section we empirically test this implication using the data described in the previous section.

4.1 Measuring Exported Varieties

Our model is to explain the number of product varieties that each country exports to a common importer—the U.S. in our empirical analysis—in each industry by two elements: the exporter's relative resource abundance and the industry's relative factor use or intensity. As described in the previous section, we define varieties by the 10-digit HS commodities and industries by the 4-digit SIC, and thus measure the number of a country's exporting varieties in an industry by the number of the 10-digit HS commodities that the country exports to the U.S. in that 4-digit SIC, as follows:

$n_{ic} \equiv$ No. of 10-digit HS commodities in a 4-digit SIC i exported by country c

However, some 4-digit industries may contain by nature more 10-digit varieties in its catalogue than others, and thus the U.S. may import more 10-digit varieties in those industries than in other industries. For a proper cross-industry comparison, we use an adjusted measure of the number of varieties, which is constructed as follows[15]:

$$n\_share_{ic} = \frac{n_{ic}}{N_i}$$

where N_i is the total number of varieties that U.S. imports from the world in industry i: $N_i = \sum_c n_{ic}$

4.2 Regressions for Aggregate North and South:

We first test our two-country, two-factor and multi-industry model with the data for country aggregates. We divide our 115 sample countries into two groups and construct two country aggregates, one of which consists of countries that are relatively more skilled-labor abundant to unskilled (or with relatively high S/U), and the other consists of countries that are relatively more unskilled-labor abundant (or with low S/U). We call the former country group "North" and the latter "South." For North we select 51 countries with S/U relative to the U.S. above its sample mean, and other 64 countries for South[16]. Table 16 lists the countries constructing the aggregates North and South. Table 17 compares the within-group averages of relative factor abundance S/U.

The following equation is estimated by the OLS regression for North and South[17]:

$$log(n\_share_{i,A}) = \alpha + \beta * skill_i + \varepsilon_i \tag{2.23}$$

where $n\_share_{i,A} = \sum_{c \in A} n\_share_{i,A}$ for A =South, North, and $skill_i$ =skill intensity of industry i.[18]Our model suggests that relatively skilled-labor abundant North exports more varieties in skilled-intensive industries than in unskilled-intensive industries, and unskilled-abundant South exports more varieties in unskilled-intensive industries; thus the expected sign of β is positive for North and negative for South. The estimation results are in fact consistent with this prediction, as shown in Table 18.

4.3 Pooled Regression for Dependent Parameter Specification:

We next use the pooled data for all the individual exporters to estimate cross-industry patterns of the varieties in exports. We consider the following regression model:

$$log(n\_share_{ic}) = \alpha + \Lambda_c * skill_i + \varepsilon_{ic} \tag{2.24}$$

The slope coefficient for skilled-labor intensity, Λ_c, would differ across exporter countries. The theory predicts that the value of the slope coefficient is higher for countries with greater relative skilled-labor endowment, and lower for exporters with smaller relative skilled-labor endowment (or greater relative unskilled-labor endowment). To capture this pattern, we impose the following structure on the slope coefficient Λ_c:

$$\Lambda_c = \Lambda((S/U)_c) = \beta_1 + \beta_2 * (S/U)_c \tag{2.25}$$

where $(S/U)_c$ is the skilled- to unskilled-labor ratio in exporter c relative to the U.S. The theoretical prediction is that the sign of β_1 will be negative (since Λ_c will be negative for countries with low skilled-labor abundance) and β_2 will be positive (since Λ_c will increase to be positive for countries with high skilled-labor abundance). By substituting (2.24) into (2.25), we derive a specification for our pooled regression as follows:

$$log(n\_share_{ic}) = \beta_1 * skill_i + \beta_2 * skill_i * (S/U)_c + \mu_c + \varepsilon_{ic} \tag{2.26}$$

We include exporter-specific dummies, μ_c, to capture the effects of all other factors than the relative skilled-unskilled abundance that differ across countries, such as fixed and variable trade costs and the size of the exporter[19].

The result of the estimation of Equation (2.26) by the fixed-effect OLS is shown in Table 19. The estimates of all the coefficients show the signs as expected from the theory, and they are all highly significant. In addition, using these estimates we compute the "threshold" factor abundant $(S/U)^*$ that makes the slope coefficient for skilled intensity Λ_c turn from negative to positive (i.e., $\Lambda_c((S/U)^*) = 0$). The value of the "threshold" S/U (relative to the U.S.) is 0.66[20].

These results of the empirical tests suggest that the semi-Heckscher-Ohlin prediction of our economic model on the exported varieties is supported by the data on the U.S. imports.

5. Conclusion

In this paper, we have investigated the relationship between export variety and the exporter's comparative advantage in terms of relative resource abundance.

We generalized the model by Bernard, Redding & Schott (2006) to the case with continuum industries and derived a prediction that relates a country's export varieties in a certain industry to the industry's "degree" of relative factor intensity.

To test the prediction we have employed the disaggregated data on the U.S. imports, as well as the data on countries' human capital and labor endowments from Hall & Jones and those on the industry-wise uses of skilled- and unskilled-labor from the U.S. Census of Manufactures. The empirical tests support our semi-Heckscher-Ohlin prediction, which shows that more unskilled-labor abundant exporter tend to export more varieties of products in relatively unskilled labor-intensive industries, and more skilled-abundant exporters tend to export more varieties in relatively skill-intensive industries.

Chapter 3: Globalized but Unhealthy? Feedback on Population Health from FDI

1. Introduction:

There has been numerous theoretical and empirical studies that underscore the positive effects of Foreign Direct Investment (FDI) for economic growth. It has been established that the economic benefits of FDI come in several channels. First and foremost, FDI allows the transfer of the technology, which takes the form of new varieties of capital input that cannot be achieved by trade in goods and services (Feldstein 2000). Recipients of FDI also gain job training which helps to develop the human capital in the host countries. Additionally, profits generated by FDI contribute to corporate tax revenues in the target countries.

Since there is such widespread belief that FDI is beneficial to the host countries, FDI has become the pre-eminent source of capital flows into the developing countries, and these governments have implemented a handful initiatives to attract the foreign investment, such as tax incentives. As a result, net inflows of FDI in the group of developing countries have increased almost five fold from an average of 0.44% of GNP during the period 1970-1974 to 2.18% of GNP during the period 1993-1997.

Besides all the claims that FDI is a good thing, the hypothesis that FDI would also improve the total living standard outside of the scope of economic growth seems more controversial. Some critics demonstrate that FDI might increase wage inequality (Driffield & Taylor, 2000), generate environmental degradation, increase target countries' exposure to international financial crises and deteriorate the problem of education inequality.

In this paper, we explore whether (and how) FDI affects the population health. The population health is an important factor in achieving the long-run economic growth. Even so, the relationship between FDI and population health has received rather scarce attention, both theoretically and empirically. What makes the empirical test difficult is that a simple correlation study on FDI and health does not help to reveal the true casual effect of FDI. The endogeneity of FDI usually causes the identification problem that is hard to be addressed. The level of the government effectiveness, quality of social infrastructure or international aid programs that may attract (or discourage) more inward FDI would also influence the population health. For example, countries with less stringent policies on the epidemical diseases, such as HIV/AIDS, malaria and tuberculosis would usually bear the consequence of lower levels of human capital, labor productivity and likely higher costs of operations to cope with the health-related expenditures, therefore, less inward FDI would be a natural result. So the key question in our study would be how we can control the endogeneity and ideally, how we can find the exogenously calculated FDI level, then look at the effect of the variation of FDI on population health.

Given the backdrop, this paper is the first of its kind to examine the link between FDI and population health in a cross-country framework and untangle the problem of endogeneity. Levine and Rothman (2006) looked at a similar question whether openness of trade affects child health. They found that overall the trade does little harm. Edmonds and Pavcnik (2006) examined the trade effect on child labor and found that the openness elasticity of child labor is much smaller (-0.1) and statistically insignificant. Both papers explore the import-export effect on a country development indicator. A more related paper to ours is authored by Alsan, Bloom and Canning (2006), who investigated whether population health affects foreign direct investment inflows while we look at the causality in the reverse direction. Their panel-data analysis on 74 countries during the period of 1980-2000 showed that health has a positive and significant effect on FDI inflows for low- and middle-income countries. Though the finding is consistent with the view that health is an essential component of human capital in developing countries, their empirical testing more or less suffers from the identification problem.

Our empirical investigation on the FDI and health data suggests a negative impact of FDI on the health status, however, the association is statistically insignificant. Thus the cross-country data do not substantiate the assertions that FDI per se plays a significant role in perpetuating the low levels of health status that pervade in low-income countries. Country-level inward and outward FDI are from published and unpublished data prepared by UNCTAD. The merit of UNCTAD data is that it is not only collected directly from the member countries, but also is complemented by international organizations, such as IMF and world bank. The population health indicators, including the measures of life expectancy, mortality rates are from World Development Indicator Database. And the gravity covariates are compiled from different sources.

The endogeneity problem is addressed with a semi-IV approach. We use the framework proposed by Frankel and Romer (1999) and examine the relationship between population health and FDI based on countries' geographical characteristics[21]. The identification depends on the assumption that geographical factors do not affect population health through other channels besides FDI. Then the constructed measure of FDI volume is used to analyze the causality between globalization and population health.

The rest of the paper is organized as follows. Section 2 presents a health stock model and further discusses how FDI might affect the health outcome in theory. Section 3 presents the econometric models to identify the effect and the data used in the paper. Section 4 contains the result of empirical analysis. Section 5 concludes and provides discussions on further extension.

2. How does FDI affect health:

2.1 Theoretical Review:

There are several arguments put forth for exploring the link between FDI and health. We seek to provide a comprehensive and systematic review of the evidence concerning FDI and health service. We categorize the mechanisms through which FDI affects the health condition into five groups: (1) the income effect; (2) government policy effect; (3) labor market effect; (4) effects through joint products of economic activities and (5) direct result from higher FDI volume in medical sector.

Firstly, a higher level of FDI could overall increase the income level and economic growth, which would improve health (Pritchett & Summers,1996). It may come from several sources: improved nutrition (Fogel, 1994); improved access to health care or higher government investment in public health funded by the tax revenue. A larger income would also allow more extensive medical care: a frequency of routine checkups, doctor visits and hospital episodes. However, transitory economic growth is usually coupled with more intensive input of labor and health. As Gustmann and Windmeijer (2004) showed, there is improved health status with long-term higher income level but worse status with temporary wage raise for the Germany case. Better macroeconomic states might be coupled with reductions in the risky behaviors such as smoking (Ruhm, 2003) but in the meanwhile increases obesity-inducing behavior and alcohol use (Ruhm, 2000; Freeman, 1999). Therefore the results are rather mixed in this setting.

Secondly, a higher FDI may induce the government to provide a better safety net, better regulations, and as a result, the better infrastructure would have a positive impact on the health outcome. The data shows that there is a keen competition among developed and developing countries to attract FDI for its many economic benefits. This drive to lure investment makes different potential target countries to pursue their own strategies and assemble their own baskets of incentives to attract a larger inward FDI. Various reforms and strategies have been implemented. The improved general business environment, more skilled human capital and the infrastructure of the higher quality, which would have been on a smaller scale if it were not for the incentive of attracting more FDI, all link to a better population health condition.

Thirdly, FDI can be linked to health through the labor market dynamics. The link between FDI and labor market outcome (wage inequality and employment rate) has been previously explored. The motivation of FDI--either as horizontal for market access, or as vertical to exploit the lower input cost in target developing countries would yield different results for labor market. Though it has been shown by various authors that heterogeneity exists across countries and over time for the determinants of FDI, we contend the volatility of the workers' wage, employment status and the redistribution of wealth all have an impact on the population health. Health is considered as an input of the production of goods and services. The hazardous working conditions, the physical exertion and job-loss stress could all have negative effects, but the condition could also deteriorate when job hunting period is lengthened when market expands (Karasek & Theorell, 1990; Sokejima & Kagamimori, 1998; Liu et al., 2002). Some sectors that boast higher intensity of inward FDI, such as mining and construction also have higher accident rates as the hire of inexperienced workers increases because of the lengthened working hours to boost the production (Catalano, 1979; Robinson, 1988). In the meanwhile, the change of lifestyle during laid-off period also has impacts on the health status from a different channel. Evidence shows that there is reduction in alcohol use linked with economic downturns (O'Neill, 1984; Evans & Graham, 1988). Severe obesity, smoking, physical inactivity, consumption of fat decline as well. For a popular and widely used health indicator, mortality, a number of studies find a one percentage point increase in the unemployment rate is typically associated with a 0.3 to 0.5 percent reduction in total mortality (Johansson, 2003; Gerdthamn & Ruhm, 2004;

Tapia Granados, 2004b). And infant and neonatal mortality in US declines by 0.6 percent when unemployment rises by one point (Ruhm, 2000). The change of non-market "leisure" time, gives people more or less health-producing activities, such as exercise. To sum up, the evidence linking working hours and health is also mixed (Johansson, 2003; Ruhm, 2004a).

Fourthly, FDI influences some joint products of economic activities, such as pollution, also these present risks to health condition (Chay & Greenstone, 2003). The impacts of these may be particularly pronounced for different strata of the population –workers who are involved directly in certain sectors, such as mining, or vulnerable segments of the population, such as infants and seniors. The openness in FDI induces a more fierce competition among firms, which may lead to a "race to the bottom" that increases pollution and reduces government expenditure for investment in health.

The last momentum is from General Agreement on Trade in Services (GATS), which aims to liberalize the service sector to a greater extent, and FDI is considered as the most critical area for openness negotiation. GATS specifies "four modes of supply" : cross-border supply, consumption abroad, commercial presence and temporary movement of service providers. Among the four modes of supply, mode 3 (commercial presence) is considered as the most critical as an influence of FDI on the health sector, the benefit being especially big where investment leads to gains in basic, with additional resources and expertise improving the range, quality and efficiency of the service offered (Chanda, 2001; Zhang & Felmingham, 2002). For example, FDI could occur in building hospital facilities or be featured by more medical professionals, in such cases the increased FDI would present more opportunities and be linked with better health outcome.

2.2 A Simple Model:

To motivate the empirical specification, we use a modified version of the investment model of health with FDI built in it. Health is considered as endogenous and depends on both the time allocated to it and the medical care. And the amount of these inputs is determined by the time and budget constraint.

We denote the representative individual (both agent and principle)'s utility by U as a function of contemporaneous consumption c_t and leisure time l_t at given time period t:

$$U_t = \alpha_1 \log(c_t) + \alpha_2 \log(l_t) \tag{3.1}$$

The production of health consists of time allocated to it (h_t) and medical care expenditure (m_t). The Cobb-Douglas function would thus be:

$$Q_t = C_t + \beta_1 \log(h_t) + \beta_2 \log(m_t) \tag{3.2}$$

C_t is considered as exogenous human capital. With a depreciation rate δ, the dynamics of the health stock could be described as:

$$\dot{D}_t = C_t + \beta_1 \log(h_t) + \beta_2 \log(m_t(f_t)) - \delta D_t \tag{3.3}$$

The total medical care expenditure is funded by both the domestic government and FDI in medical health sector (the GATS channel) therefore is a function of the current period FDI (f_t). The gain from a higher health investment is represented as a longer life duration, so that more future wage and leisure time could be enjoyed. Death takes place when D_t is smaller than $D_{\min}$. Thus the duration of life depends on D_t. We normalize the length of each time period to 1, and wage rate is $w(f_t)$, a function of FDI, which could either come from the income channel or labor market channel for the reasons we previously argued. The time spent on working is $1 - h_t - l_t$ for period t, assuming away the possibility of tax, the total consumption can therefore be expressed as:

$$c_t = w_t(f_t)(1 - h_t - l_t) - p_t m_t(f_t) \tag{3.4}$$

which presents a trade-off between time for health and time for work. The dynamics of the model could be described as the current Hamiltonian H:

$$H = \alpha_1 \log(w_t(f_t)(1 - h_t - l_t) - p_t m_t(f_t)) + \alpha_2 \log(l_t) +$$

$$\lambda_t(C_t + \beta_1 \log(h_t) + \beta_2 \log(m_t) - \delta D_t) \tag{3.5}$$

The levels of control variables h_t, l_t and f_t are determined by FOC as follows:

$$h_t = \frac{\lambda_t \beta_1 (w_t(f_t)(1 - h_t - l_t) - p_t m_t(f_t))}{\alpha_1 w_t(f_t)} \tag{3.6}$$

$$l_t = \frac{\alpha_2 (w_t(f_t)(1 - h_t - l_t) - p_t m_t(f_t))}{\alpha_1 w_t(f_t)} \tag{3.7}$$

$$\frac{\alpha_1}{(w_t(f_t)(1 - h_t - l_t) - p_t m_t(f_t))}[w_t'(w_t(f_t)(1 - h_t - l_t) - p_t m_t(f_t)) - p_t m_t'] +$$

$$\lambda_t \beta_2 \frac{m_t'}{m_t} = 0 \tag{3.8}$$

$$\dot{D}_t = C_t + \beta_1 \log(h_t) + \beta_2 \log(m_t(f_t)) - \delta D_t \tag{3.9}$$

$$\dot{\lambda}_t = (\delta + \rho)\lambda_t \tag{3.10}$$

ρ is the discount rate, λ_t is the Lagrange multiplier for the shadow value of health. $m_t^{'}$ and $w_t^{'}$ are the first order condition of m_t and w_t with respect to f_t individually.

The system of the equations characterizes the change path of the health stock. By collecting terms, the total health investment can be expressed by:

$$Investment_t = C_t + \beta_1 \log(\frac{\lambda_t \beta_1 (w_t(f_t) - p_t m_t(f_t))}{w_t(f_t)(\lambda_t \beta_1 + \alpha_2 + \alpha_1)}) +$$

$$beta_2 \log(\frac{\alpha_2 (w_t(f_t) - p_t m_t(f_t))}{w_t(f_t)(\lambda_t \beta_1 + \alpha_2 + \alpha_1)}) \quad (3.11)$$

where the optimal level of f_t is determined by equations of (3.6) to (3.8).

In order to determine the impact of FDI on health, we need to further look at the marginal effect $\frac{\partial \text{Investment}_t}{\partial f_t}$, and its sign is determined by the product $(\lambda_t \beta_1 + \alpha_1) \frac{p_t}{w_t - p_t m_t} (m_t^{'} w_t - w_t^{'} m_t)$. The sign is undetermined because of the uncertainty of the part $(m_t^{'} w_t - w_t^{'} m_t)$. When FDI allows higher foreign-aided medical care expenditure without crowding out domestic share, $m_t^{'}$ is expected to be positive. The feedback from FDI on the labor market is quite mixed as we argued in the previous section. The impact from joint economic activities, such as pollution, comes into effect through the term λ_t, in that higher λ_t means a faster depreciation of the health investment stock. Therefore the impact of FDI on population health is ultimately an empirical question for us to explore.

3. Data and Specifications:

3.1 Data:

For empirical investigation, we focus on two basic measures of health: life expectancy and probability to die (mortality), both measured in aggregate and by gender, age range.

Life expectancy is the average number of years that a person can expect to live if they experience the current mortality rate of the population at each age.

Adult mortality risk is defined as the probability of dying between 15 and 59 years old per 1000 population. Under-five mortality rate is defined as the probability of a child born in a specific year or period dying before reaching the age of five, subject to age-specific mortality rates of that period.

FDI is becoming increasingly important in the global economy. According to UNCTAD (2000) statistics, FDI from developed countries to developing countries grew from 36 billion US dollars in 1992 to 155 billion US dollars in 1999, a level more than three times that of the official development aid. Several sources provide data on net and gross FDI, including IMF[22], OECD publications[23]and UNCTAD FDIStat database. We chose the data that is the closest to the empirical specification. We consider a FDI inflow (gross FDI) would influence target country population health more directly than net FDI flow. The FDI data[24]and affiliate enterprises are compiled from the unpublished data prepared by UNCTAD. The data from 2000-2004 are used and a total of eighty countries have positive inward FDI volume for any year during that period. The total FDI is the sum of three components: equity, reinvested earning and other capital (intra-company loans) on a current US dollar basis. Other gravity measures, including distance, common language, common border, landlocked dummies, sizes are from Rose (2003). The measure of medical expenditure as a share of GDP is from World Health Organization. Real GDP per capita terms are from Penn World Table 6.1.

3.2 Specification:

The empirical work is to understand whether and how the inward FDI influences the population health condition. For the regression, we first explore the cross-sectional data, and the following linear model is used:

For each country i, at given time period t,

$$health_i = \beta_1 + \beta_2 * \frac{FDI_i}{GDP_i} + \varepsilon_i \qquad (3.12)$$

where the $\frac{FDI_i}{GDP_i}$ is the volume of foreign direct investment in country i weighted by the GDP, which could be considered as a FDI-induced index of openness. The reason why we use FDI-GDP ratio instead of FDI volume is the large variations in GDPs across country incomes. A GDP-weighted FDI measure eliminates the bias induced by heterogeneity in income levels and represents better the country-level globalization degree. The dependent variable is from the series of the health indicators including life expectancy and mortality (both by sex and in total). Thus β_2 would have an interpretation of the change of health measure associated with the increase in the ratio of FDI to total GDP. However this coefficient should not be simply treated as the change of health measure induced by the change in the FDI openness index because we have not dealt with endogeneity issue yet.

Another factor we need to incorporate is the channel of per capita income level. As we previously discussed in section 2, FDI influences the health condition through the change of income. It is evident that a higher GDP per capita allows people to spend more on medical care or consume hazardous products, such as cigarettes and alcohol. To capture this effect, we also include the GDP per capital term in the estimation of equation (1). We hypothesize that the relationship between the income level and health might exhibit a non-linear property. Similar to the environmental Kuznets curve (Grossman and Krueger, 1993, 1995), higher income level might be bad for population health because it provides higher incentive for working extra hours and worsens the health status, but later on it would benefit health, as countries become rich enough to pay more attention to the health quality. Therefore we further estimate the following:

$$health_i = \beta_1 + \beta_2 * \ln(\frac{FDI_i}{GDP_i}) + \beta_3 * \ln(GDPPC) + \beta_4 * (\ln(GDPPC))^2 + \varepsilon_i \quad (3.13)$$

The term GDPPC stands for the GDP per capita. β_2 therefore tells us the degree of association between population health and FDI when controlling the income level.

FDI enters each target country in different sectors. It is natural to expect that FDI would enter different industries varying in the pollution extent in different countries, therefore the impact of FDI would have different environmental, thus health implications. Though it is impractical to fully capture all these impacts, we would add more terms besides FDI term in the regression, as a practice, we further include medical expenditure share of GDP for each country in the regression.

$$health_i = \beta_1 + \beta_2 * \ln(\frac{FDI_i}{GDP_i}) + \beta_3 * \ln(medical\_expenditure\_share_i) + \varepsilon_i \quad (3.14)$$

3.3 Control the Endogeneity and Include the Zeros:

In order to address the endogeneity issue, we construct measure of FDI-induced openness based on geography, which is proposed by the original work of Frankel and Romer (1999). In constructing these measures, we utilize a pseudo gravity model for FDI with covariates of geographical characteristics.

It yields the following regression:

$$lnFDI_{ji} = \beta_1 + \beta_2 * \ln size_i + \beta_3 * \ln size_j +$$

$$\beta_4 * \ln(distance_{ij}) + \beta_5 * \ commonlan_{ij} + \beta_6 * \ contiguity_{ij} + \beta_7 * \ landlock_{ij} + \varepsilon \quad (3.15)$$

The logarithm of inward FDI from country j to i is regressed on countries' sizes, the distance between the importer and exporter, whether they share the same language, same border and whether any of them is landlocked.

To predict FDI volume in this way has its own right. Ramondo (2006) used simulated and actual data to justify the approach of estimating multinational production function using geographical measures. The research shows that similar to international trade flows, gravity governs the volume of FDI. Not only country sizes matter, countries that are twice as distant face 56% higher cost than otherwise.

To determine the quality of instrument variables, we need to explore: whether they are correlated with the actual FDI, whether they are not affected by population health; and whether they are correlated with other factors that influence health. As we just argued, FDI can be appropriately constructed by the gravity measures and the empirical analysis also shows a high correlation between constructed measure and actual measure. On the other hand, it is hardly true that countries' geographical features could be influenced or influence the population health. Therefore it is justifiable to say that the IVs affect the dependent variable only through its effect on the endogenous variable of interest --FDI. Different from the conventional gravity model approach, we only use the country area sizes instead of population or GDP to capture the size effect. We are concerned if GDP or population is used, one might cast doubt on their suitableness as qualified instruments. The GDP itself could allow a higher proportion of income as medical expenditure thus FDI is not its only channel to influence health. The population measure is dubious as well, as population density and the initial stages of the spread of disease are highly correlated (Tarwater, 1999).

Many countries actually witness a zero inward FDI. The FDI literature suggests the underlying reason of the zero volumes is the high sunk cost of initiating such FDI in the target countries. Therefore we use a two-part model approach to account for the existence of the zeros and thus we could include them into the estimation. The choice of two-part model over sample-selection is justified by the strand of the literature on a high entry barrier for FDI thus making it a corner-solution case rather than potential missing value (Mullahy, 1997; Wooldridge, 2003).

4. **Empirical Analysis:**

The first step of the procedure is to estimate the fitted value of FDI based on the geographical variables. First we use the positive FDI volumes only with the specification of equation (3.15) and report the result in table 21. The the total fitted value of FDI is calculated by exponentiating the predicted values for each country pair then adding up for each target country. The correlation between the fitted inward FDI volume and the actual measure for year 2002 is 0.61. In order to account for the zero FDI volume, we invoke a two-part model approach so that we can include all the possible country pairs and the result is reported in table 22. A total of 170 countries are included in the large sample.

With the fitted values of FDI from both approaches, we could investigate the causal effect of FDI on population health. The main regression results indicate that after controlling the endogeneity problem, there is a significant and negative correlation between population health and inward FDI. Tables 23 and 24 contain the results of estimating equations 3.12 through 3.14 using the life expectancy as the dependent variable. Table 23 presents the result of the regression of the level variable of life expectancy on FDI measures while table 24 uses the logarithm of life expectancy. Column 2 includes the result of the association between the actual FDI/GDP ratio and health without controlling the endogeneity problem. A higher FDI seems to link to a shorter life expectancy but the coefficient size is rather smaller. Column 3 contains the result where the FDI measure is predicted from gravity covariates. It can be argued that once the endogeneity issue is controlled, the magnitude of the effect is even larger. A 1% increase in FDI/GDP ratio is associated with a 0.03 percent reduction in life expectancy. An interesting result is that there exists gender difference in the degree of the impact of FDI on the health condition. The general message is that male is more negatively influenced by the globalization.

The analysis on mortality rate yields a similar result to life expectancy. The higher FDI ratio induces higher probability to die for both adults and children below five. A coefficient of 2.5 suggests that when FDI/GDP increases by one million[25], the mortality rate would be increased by 2.5% for male infants dying before five, and 8.5% for dying between 15 to 59 years old.

Additionally, we also notice that there is difference between using fitted values from positive FDI volume only (78 country sample) and all country pairs (170 country sample). The negative impact of FDI is relatively smaller in magnitude when estimating FDI using all countries in the first step. Presumbly this is because countries with actual zero FDI have a better health status than those with positive FDI. But with an IV-approach in the first step, there might be a positive estimated FDI for these countries, thus offsetting the negative influence of FDI and making it smaller.

We also include the a log level of the GDP per capita term in the estimation, positing that it might impact health in a non-linear way. Yet the analysis shows that the income impact on health is only significant and positive in a linear way, and when income is controlled, we find no statistically significant association between FDI and health. The drive behind this negative correlation might be that lower income level countries are attractive targets therefore have higher FDI-indexed openness.

Overall, the results from the regressions show a negative feedback from FDI on population health. With the negative coefficients, one could go as far as the implication that a higher FDI-induced globalization has a negative contribution, but the coefficients are hardly indicative of the importance of each mechanism through which FDI influences health.

5. Conclusion

It is a quite *a priori* case to presume inward FDI benefits target country in many accounts. Since the later 1990s, FDI has become especially welcome across the world, in the developing countries in particular. Besides some other acclaimed economic distortions caused by FDI, in this paper we look at the linkage between population health and FDI and address the endogeneity problem in a framework proposed by Frankel and Romer (1999). Geographical vectors are used as IVs for inward FDI. The cross-country evidence shows that there is an overall negative association between population health and FDI. A 1% increase in FDI/GDP ratio is associated with a 0.03 percent reduction in life expectancy. Once the income difference is controlled, there is little evidence that FDI has impact on health.

The paper gives a systematic review on the mechanisms through which FDI might affect health. And an investment stock of health model is used to motivate the empirical specification. Though the view of positive economic benefit of FDI has been established, the paper looks at the effect of the FDI on target countries from another perspective.

The interaction of FDI and health has received considerable attention in the literature, but the empirical evidence on this topic is scarce. The main problem that limits the empirical investigation is the identification problem of FDI: the endowment and policies that influence the FDI level also have impact on the health outcome thus are difficult to fully control for in an empirical setting. In the results, although the coefficient on FDI is negative and statistically significant, its confidence interval around zero is small in magnitude. Though the results suggest a negative impact on health from FDI, we need to interpret the results cautiously.

The findings suggest that a higher volume of inward FDI because of countries' geographic features does harm to population health but its effect is not substantive when we control the income levels. It is not the foci of this paper to specifically explore through which channel (and by what extent) FDI influences the health condition though. However, it is definitely something worth investigating in the future. Also, our paper does not concern the question whether better or worse health conditions of the target country would lead to higher or lower levels of the FDI. Also the evidence of minimal effect of FDI on health on average does not imply that there are no circumstances that FDI will negatively impact health. Identifying the atypical circumstances seems to be an importance avenue for future research.

Footnote

1. Anderson (1979) was among the first to derive it from a theoretical trade model.

2. Hummels and Levinsohn (1995) also poses new puzzles beside replicating Helpman(1987)'s work and in the end, they found the empirical evidence less overwhelming.

3. Data source is World Trade Flow documented by Feenstra etc. (2005).

4. Melitz (2003) discussed the model in a general equilibrium and explicitly solved the number of firms endogenously.

5. As shown in Helpman, Melitz and Yeaple (2004), the parameter k represents the dispersion of the productivities. Lower k means higher dispersion of the firms' productivities.

6. See Duan et al. (1983, 1984, 1985) and Manning, Duan and Rogers (1987). So far they have offered the strongest criticisms against sample selection model. They argue the selection models are intrinsically flawed because they have to rely on untestable assumptions and have poor statistical and numerical properties.

7. Hay, Leu, and Rohrer (1987) showed that two part model performs at least as well as the sample selection model in terms of mean prediction bias and mean squared prediction error, and significantly outperforms it in terms of parameter squared error. In a different Monte Carlo investigation, Manning, Duan and Rogers (1987) put two-part model in a worst-case setting by assuming the true model is sample selection. When there are no exclusion restrictions, they find that the two part model outperforms in terms of mean squared prediction error and mean prediction bias.

8. Sample selection model is also called adjusted Tobit model or Tobit 2 model.

9. Linear specification of the second part would be inappropriate because it

generates large standard errors due to the non-linear property of the second part. And in order to use linear specification, we need to add unrealistic assumption of fairly limited range of x and constant partial effects.

10. D=1 does not differentiate two way trade and one way trade. However, the export from country j to i is treated differently from the export from country i to country j; which is to say, two way trade between county i and country j will correspond to two positive records.

11. 1. Probit+Lognormal 2. Logit+Lognormal 3.Probit+Exponential 4.Logit+ Exponential

12. The dummy for contiguity takes the value of one if two countries are adjacent.

13. The colonial ties are defined in the following way: two countries have had a common colonizer after 1945, have ever had a colonial link, have had a colonial relationship after 1945, or are currently in a colonial relationship.

14. The distance formula used is a generalized mean of city-to-city bilateral distances developed by Head and Mayer (2002), which takes the arithmetic mean and the harmonic means as special cases.

15. The variable to be explained in Equation (2.22) is the probability that an entree firm becomes an exporter. This can be interpreted as the adjusted number of exported varieties, in the following case: The relative number of potential entrees, or the relative size of the mass of potential entrees in each industry is the same across exporters, which is also the same as the relative number of total varieties in the U.S. imports. (For an illustrative example; the size of the potential entree mass in book publishing industry is twice as large as that in men's footwear industry in all exporters, and the U.S. imports twice more varieties in the former industry than does in the latter.

16. We also attempt two other cutoffs of S/U to divide the sample countries

into North and South; above or below the 75 percentile (29 countries for North, 86 for South), and above or below 0.7 of the value of S/U relative to the U.S. (25 for North, 90 for South). These groupings are also indicated in Table 16. The qualitative results of estimation (the sign and significance of the coefficient estimate) are the same as shown in Table 18 regardless of the cutoffs.

17. n_share is skewed in distribution, and so log-scaled in regressions to adjust for heteroskedasticity.

18. As described in Section 3, skill is measured by the share of non-production workers in the total number of employees. Unskilled-labor intensity is defined by the share of production workers in the total employment.

19. Recall that we develop the theoretical model in the two-country framework. The values of parameters in the model are likely to be different across country pairs.

20. The mean of S/U, which is used as the cutoff of North-South in the previous subsection, is 0.59, which is a little lower than this value.

21. The same approach has been used by Frankel and Rose (2003) for analysis on the effect of trade on the environment; Edmonds and Pavcnik (2006) for effect of trade on child labor.

22. Publications include International Financial Statistics and Balance of Payment Statistics.

23. Geographical Distribution of Financial Flows to Developing Countries. The data include gross FDI origninated in OECD countries into developing countries.

24. FDI inflows and outflows comprise capital provided (either directly or through other related enterprises) by a foreign direct investor to a FDI enterprise, or capital received by a foreign direct investor from a FDI enterprise. FDI includes the three following components: equity capital, reinvested earnings and intra-

company loans. - Equity capital is the foreign direct investor's purchase of shares of an enterprise in a country other than that of its residence. - Reinvested earnings comprise the direct investor's share (in proportion to direct equity participation) of earnings not distributed as dividends by affiliates or earnings not remitted to the direct investor. Such retained profits by affiliates are reinvested. - Intra-company loans or intra-company debt transactions refer to short- or long-term borrowing and lending of funds between direct investors (parent enterprises).

25. The GDP measure from Penn Table is in thousands US current dollars and FDI in million dollars, so each unit of the FDI/GDP is in thousands.

APPENDICES

Appendix A

A.1: Proof of Lemma 1

Recall that revenue term

$$r_j = Y_j \, (\frac{c_j}{\rho\varphi(l) P_j})^{1-\sigma} \tag{A.1}$$

$$r_{ij} = \tau^{1-\sigma} r_j \tag{A.2}$$

$$r_j(\varphi_j^*) = \sigma f \tag{A.3}$$

$$r_j(\varphi_{xji}^*) = \sigma f_{ji} \tag{A.4}$$

Then

$$\frac{r_j(\varphi_{xji}^*)}{r_i(\varphi_i^*)} = \frac{f_{ji}}{f} = \frac{Y_i \, (\frac{\tau c_j}{\rho\varphi_{xji}^*(l) P_i})^{1-\sigma}}{Y_j \, (\frac{c_i}{\rho\varphi_i^*(l) P_j})^{1-\sigma}} = (\frac{\varphi_i^*}{\varphi_{xji}^*})^{1-\sigma} \frac{Y_i}{Y_j} \tau^{1-\sigma} \tag{A.5}$$

$$\frac{r_i(\varphi_{xij}^*)}{r_j(\varphi_j^*)} = \frac{f_{ij}}{f} = \frac{Y_j \, (\frac{\tau c_i}{\rho\varphi_{xij}^*(l) P_j})^{1-\sigma}}{Y_i \, (\frac{c_j}{\rho\varphi_j^*(l) P_i})^{1-\sigma}} = (\frac{\varphi_j^*}{\varphi_{xij}^*})^{1-\sigma} \frac{Y_j}{Y_i} \tau^{1-\sigma} \tag{A.6}$$

Thus

$$\frac{\varphi_{xij}^*}{\varphi_j^*} = \frac{f_{ij}}{f} \tau^{\sigma-1} (\frac{c_i}{c_j})^{\sigma} \frac{Y_i}{Y_j} = \Omega_1 \tag{A.7}$$

$$\frac{\varphi_{xji}^*}{\varphi_i^*} = \frac{f_{ji}}{f} \tau^{\sigma-1} (\frac{c_j}{c_i})^{\sigma} \frac{Y_j}{Y_i} = \Omega_2 \tag{A.8}$$

A.2: Exponential Distribution

The exponential distribution may be viewed as a continuous counterpart of the geometric distribution. The log likelihood function specifications are similar to lognormal distribution.

With the first setting of probit for hurdle part and exponential distribution as the level part:

$$P(D_i = 1 | X_{1i}) = P(X_{1i}^{'}\beta_1 + \varepsilon_1 > 0) = \Phi(X_{1i}^{'}\beta_1) \tag{A.9}$$

$$E(T_i|D_i = 1, X_{2i}) = \exp(X_{2i}^{'}\beta_2) \tag{A.10}$$

The unconditional expected value is:

$$E(T_i|X_{1i}, X_{2i}) = E(T_i|D_i = 1, X_{2i})\ Pr(D_i = 1|X_{1i}) = \exp(X_{2i}^{'}\beta_2)\Phi(X_{1i}^{'}\beta_1) \tag{A.11}$$

The log-likelihood functions will change accordingly to

$$\ln(0) = ln(1 - \Phi(X_{1i}^{'}\beta_1)) \tag{A.12}$$

$$ln(T_i) = \ln(\Phi(X_{1i}^{'}\beta_1)) + \ln(X_{2i}^{'}\beta_2) - \frac{T_i}{(X_{2i}^{'}\beta_2)} \tag{A.13}$$

and marginal effect of distance is:

$$\frac{\partial E(T_i)}{\partial x_k} = \Phi(X_{1i}^{'}\beta_1)\beta_{2k}\exp(X_{2i}^{'}\beta_2) + \phi(X_{1i}^{'}\beta_1)\beta_{1k}\exp(X_{2i}^{'}\beta_2) \tag{A.14}$$

In estimation part, when we use total trade volume for level of T_i and x_k is the log form of distance, the elasticity of distance on trade volume is:

$$\frac{\partial E(\ln \text{trade})}{\partial(\ln \text{distance})} = \Phi(X_{1i}^{'}\beta_1)\beta_{2k} + \phi(X_{1i}^{'}\beta_1)\beta_{1k}(X_{2i}^{'}\beta_2) \tag{A.15}$$

$$\frac{\partial E(\ln \text{trade})}{\partial(RTA)} = \exp(X_{2i}^{'}\beta_2)\Phi(X_{1i}^{'}\beta_1)|_{RTA=1} - \exp(X_{2i}^{'}\beta_2)\Phi(X_{1i}^{'}\beta_1)|_{RTA=0} \tag{A.16}$$

When part one is logit and second part lognormal, the unconditional expected value would be:

$$E(T_i|X_{1i}, X_{2i}) = E(T_i|D_i = 1, X_{2i})\ Pr(D_i = 1|X_{1i}) \tag{A.17}$$

The log-likelihood functions will change accordingly to

$$\ln(0) = ln(1 - \frac{\exp(X_{1i}^{'}\beta_1)}{\exp(X_{1i}^{'}\beta_1) + 1}) \tag{A.18}$$

$$ln(T_i) = ln(1 - \frac{\exp(X_{1i}^{'}\beta_1)}{\exp(X_{1i}^{'}\beta_1) + 1}) + \ln(X_{2i}^{'}\beta_2) - \frac{T_i}{(X_{2i}^{'}\beta_2)} \tag{A.19}$$

and marginal effect of distance is:

$$\frac{\partial E(T_i)}{\partial x_k} = \frac{\exp(X_{1i}^{'}\beta_1)}{\exp(X_{1i}^{'}\beta_1) + 1}\beta_{2k}\exp(X_{2i}^{'}\beta_2) + \frac{\exp(X_{1i}^{'}\beta_1)}{(\exp(X_{1i}^{'}\beta_1) + 1)^2}\beta_{1k}\exp(X_{2i}^{'}\beta_2) \tag{A.20}$$

The elasticity of distance on trade volume is:

$$\frac{\partial E(\ln \text{trade})}{\partial(\ln \text{distance})} = \frac{\exp(X'_{1i}\beta_1)}{\exp(X'_{1i}\beta_1)+1}\beta_{2k} + \frac{\exp(X'_{1i}\beta_1)}{(\exp(X'_{1i}\beta_1)+1)^2}\beta_{1k}(X'_{2i}\beta_2) \quad (A.21)$$

When part one is logit and second part lognormal, the unconditional expected value would be:

$$E(T_i|D_i = 1, X_{2i})\ Pr(D_i = 1|X_{1i}) = \exp(X'_{2i}\beta_2 + 0.5\sigma^2)\frac{\exp(X'_{1i}\beta_1)}{\exp(X'_{1i}\beta_1)+1} \quad (A.22)$$

The log-likelihood functions will change accordingly to

$$\ln(0) = ln(1 - \frac{\exp(X'_{1i}\beta_1)}{\exp(X'_{1i}\beta_1)+1}) \quad (A.23)$$

$$ln(T_i) = \ln(\frac{\exp(X'_{1i}\beta_1)}{\exp(X'_{1i}\beta_1)+1}) + \ln(\phi(\frac{\ln T_i - X'_{2i}\beta_2}{\sigma})) - \ln \sigma T_i \quad (A.24)$$

and marginal effect of distance is:

$$\frac{\partial E(T_i)}{\partial x_k} = \frac{\exp(X'_{1i}\beta_1)}{\exp(X'_{1i}\beta_1)+1}\beta_{2k}\exp(X'_{2i}\beta_2) + \frac{\exp(X'_{1i}\beta_1)}{(\exp(X'_{1i}\beta_1)+1)^2}\beta_{1k}\exp(X'_{2i}\beta_2) \quad (A.25)$$

The elasticity of distance on trade volume is:

$$\frac{\partial E(\ln \text{trade})}{\partial(\ln \text{distance})} = \frac{\exp(X'_{1i}\beta_1)}{\exp(X'_{1i}\beta_1)+1}\beta_{2k} + \frac{\exp(X'_{1i}\beta_1)}{(\exp(X'_{1i}\beta_1)+1)^2}\beta_{1k}(X'_{2i}\beta_2) \quad (A.26)$$

$$\frac{\partial E(\ln \text{trade})}{\partial(RTA)} =$$

$$\exp(X'_{2i}\beta_2)\frac{\exp(X'_{1i}\beta_1)}{\exp(X'_{1i}\beta_1)+1}|_{RTA=1} - \exp(X'_{2i}\beta_2)\frac{\exp(X'_{1i}\beta_1)}{\exp(X'_{1i}\beta_1)+1}|_{RTA=0} \quad (A.27)$$

A.3: Vuong's Test:

For the first part of the estimation, we choose from Probit vs. Logit estimations, then exponential vs. Lognormal for the second part. These two sets of models are strictly non-nested because we cannot get one model by putting restrictions on the other model. Our Vuong's test statistic is

$$T_{LR,NN} = \frac{1}{\sqrt{n}} \sum_{i=1}^{n} \ln \frac{f(y_i|x_i,\widehat{\theta})}{g(y_i|x_i,\widehat{\gamma})} \div \{\frac{1}{n} \sum_{i=1}^{n} (\ln \frac{f(y_i|x_i,\widehat{\theta})}{g(y_i|x_i,\widehat{\gamma})})^2 - (\frac{1}{n} \sum_{i=1}^{n} \ln \frac{f(y_i|x_i,\widehat{\theta})}{g(y_i|x_i,\widehat{\gamma})})^2\} \tag{A.28}$$

We specify log likelihood functions for exponential and lognormal distribution individually by $f(y_i|x_i,\widehat{\theta})$ and $g(y_i|x_i,\widehat{\gamma})$. For $\widehat{\omega}^2$, we use

$$\widehat{\omega}^2 = \{\frac{1}{n} \sum_{i=1}^{n} (\ln \frac{f(y_i|x_i,\widehat{\theta})}{g(y_i|x_i,\widehat{\gamma})})^2 - (\frac{1}{n} \sum_{i=1}^{n} \ln \frac{f(y_i|x_i,\widehat{\theta})}{g(y_i|x_i,\widehat{\gamma})})^2\} \tag{A.29}$$

as an estimate of the variance of $\frac{1}{\sqrt{n}} LR(\widehat{\theta},\widehat{\gamma})$.

The hypothesis is:

$$H_0 : E_h[\frac{f(y_i|x_i,\theta)}{g(y_i|x_i,\gamma)}] = 0 \tag{A.30}$$

E_h denotes the expectation with respect to the density of the true data-generating process, $h(y_i|x_i)$. We reject at the significance level 5% the null hypothesis of equivalence of the model in favor of F_θ being better (or worse) than G_γ if $T_{LR,NN} > z_{0.05}$ (or if $T_{LR,NN} < -z_{0.05}$). The null hypothesis is not rejected if $|T_{LR,NN}| \leq z_{0.025}$.

The Vuong's test is applied on the full sample for the first part while only sub-sample with positive values for the second part. The test output is shown in Table 11.

Appendix B

B.1. Derivation of equations (2.17),(2.18):
Use equations 2.6, 2.15 and 2.16, we can get

$$\sigma f_i A^H = \alpha_i Y^H (\frac{A^H}{\rho \phi_i^{*H} P_i^H})^{1-\sigma} \tag{B.1}$$

$$\sigma f_i A^F = \alpha_i Y^F (\frac{A^F}{\rho \phi_i^{*F} P_i^F})^{1-\sigma} \tag{B.2}$$

$$\sigma f_{ix} A^H = \alpha_i Y^F (\frac{\tau A^H}{\rho \phi_i^{*H} P_i^F})^{1-\sigma} \tag{B.3}$$

$$\sigma f_{ix} A^F = \alpha_i Y^H (\frac{\tau A^F}{\rho \phi_i^{*F} P_i^H})^{1-\sigma} \tag{B.4}$$

and $A^\lambda = (s^\lambda)^{\beta_i} (w^\lambda)^{1-\beta_i}$

Divide (B.1) by (B.4), and (B.2) by (B.3),

$$(\frac{\phi_i^H}{\phi_{ix}^F})^{\sigma-1} = \frac{f_i}{f_{ix}} \cdot (\frac{A^H}{A^F})^{\sigma} \cdot \tau^{1-\sigma} \tag{B.5}$$

$$(\frac{\phi_i^F}{\phi_{ix}^H})^{\sigma-1} = \frac{f_i}{f_{ix}} \cdot (\frac{A^F}{A^H})^{\sigma} \cdot \tau^{1-\sigma} \tag{B.6}$$

B.2. Derivation of equations (2.20), (2.21)
We can write

$$Q(\phi_i^{*\lambda}) = [1 - G(\phi_i^{*\lambda})][(\frac{\widetilde{\phi}(\phi_i^{*\lambda})}{\phi_i^{*\lambda}})^{\sigma-1} - 1] \tag{B.7}$$

and $\widetilde{\phi}(\phi_i^{*\lambda})$ is the weighted average productivity which is expressed as:

$$\widetilde{\phi}(\phi_i^{*\lambda}) = \frac{1}{[1 - G(\phi_i^{*\lambda})]} [\int_{\phi_i^{*\lambda}}^{\infty} \phi^{\sigma-1} g(\phi) d\phi]^{\frac{1}{\sigma-1}} \tag{B.8}$$

In Pareto specification,

$$Q(\phi_i^{*\lambda}) = [1-G(\phi_i^{*\lambda})][(\frac{\widetilde{\phi}(\phi_i^{*\lambda})}{\phi_i^{*\lambda}})^{\sigma-1} - 1] = [1-G(\phi_i^{*\lambda})][K-1] = (K-1)(\frac{\phi_{\min}}{\phi_i^{*\lambda}})^k \tag{B.9}$$

Therefore, the free entry conditions under costly trade would become:

$$f_i(K-1)\varphi_{\min}^k(\varphi_i^H)^{-k} + f_{ix}(K-1)\varphi_{\min}^k(\phi_{ix}^H)^{-k} = f_{ie}\delta \tag{B.10}$$

$$f_i(K-1)\varphi_{\min}^k(\varphi_i^F)^{-k} + f_{ix}(K-1)\phi_{\min}^k(\phi_{ix}^F)^{-k} = f_{ie}\delta \tag{B.11}$$

Combining (B.10), (B.11) with equations (2.17), (2.18), we can derive a system of two equations for two unknowns: $(\phi_i^H)^{-k}$ and $(\phi_i^F)^{-k}$. Both equations are linear in these two variables.

$$f_i(K-1)\phi_{\min}^k\Lambda_i^H(\phi_{ix}^F)^{-k} + f_{ix}(K-1)\phi_L^k(\phi_{ix}^H)^{-k} = f_{ie}\delta \tag{B.12}$$

$$f_i(K-1)\phi_{\min}^k\Lambda_i^F(\phi_{ix}^H)^{-k} + f_{ix}(K-1)\phi_L^k(\phi_{ix}^F)^{-k} = f_{ie}\delta \tag{B.13}$$

B.3. Proof of proposition 1:

$$1 - G(\phi_{ix}^{*H}) = \left(\frac{\phi_{\min}}{\phi_{ix}^{*H}}\right)^k = \frac{f_{ie}\delta(\Lambda_i^H - \frac{f_{ix}}{f_i})}{(K-1)(\Lambda_i^F\Lambda_i^H f_i - \frac{f_{ix}^2}{f_i})} \tag{B.14}$$

Then

$$\frac{\partial[1-G(\phi_{ix}^{*H})]}{\partial(\frac{A^H}{A^F})} = \frac{f_{ie}\delta\tau^k(\frac{f_i}{f_{ix}})^{\frac{-k}{\sigma-1}}(\frac{-k\sigma}{\sigma-1})(\frac{A^H}{A^F})^{\frac{1-k\sigma-\sigma}{\sigma-1}}}{(K-1)[\tau^{2k}(\frac{f_{ix}}{f_i})^{\frac{2k}{\sigma-1}}f_i - \frac{f_{ix}^2}{f_i})]} \tag{B.15}$$

By assumption 2, the sign of $\frac{\partial[1-G(\phi_{ix}^{*H})]}{\partial(\frac{A^H}{A^F})}$ =the sign of $(\frac{-k\sigma}{\sigma-1})$, which is negative.

Therefore,

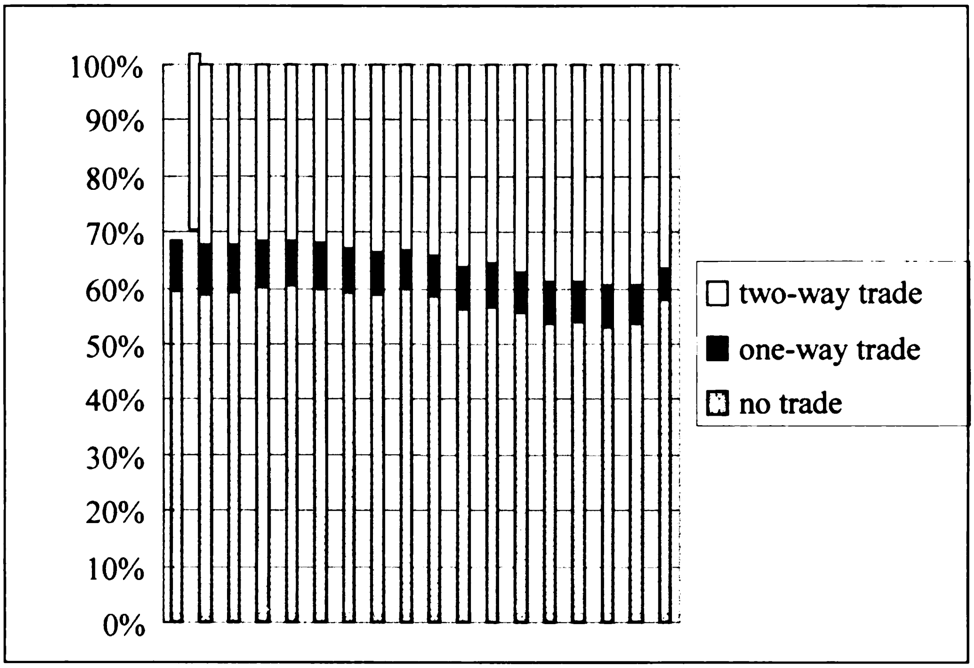
$$\frac{\partial[1-G(\phi_{ix}^{*H})]}{\partial\left(\frac{s_H^{\beta_i}w_H^{1-\beta_i}}{s_F^{\beta_i}w_F^{1-\beta_i}}\right)} = \frac{\partial[1-G(\phi_{ix}^{*H})]}{\partial\left((\frac{\frac{s_H}{w_H}}{\frac{s_F}{w_F}})^{\beta_i}\frac{w_H}{w_F}\right)} < 0 \tag{B.16}$$

This means when $\frac{w_H}{w_F}$ is fixed, we can inspect the effect of change of $\left(\frac{\frac{s_H}{w_H}}{\frac{s_F}{w_F}}\right)^{\beta_i}$ on $1 - G(\phi_{Hix}^*)$.

When exporter is more skill abundant than the importer, $\frac{s_H}{w_H} > \frac{s_F}{w_F}$, then the increase of β (more skill intensive industry) would result in smaller export varieties. When home country is more skilled labor intensive than the foreign country, $\frac{s_H}{w_H} < \frac{s_F}{w_F}$, then the increase of β (more skill-intensive industry) would result in larger export varieties.

B.4. Proof of propostion 2: When we fixed $(\frac{\frac{s_H}{w_H}}{\frac{s_F}{w_F}})^{\beta_i}$ term, the negative derivative of equation A.15 would simply mean higher unskilled-labor cost in home country result in smaller export variety.

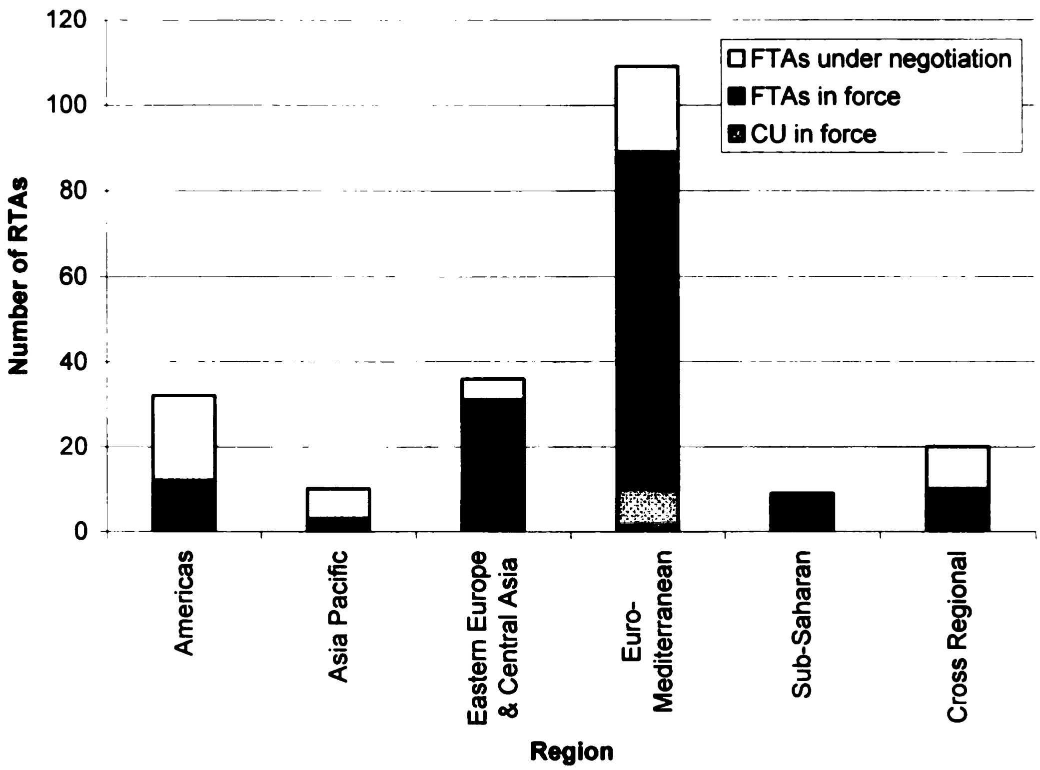
Figure 1: Cross-Country Distribution of Trade



Years 1980-1997

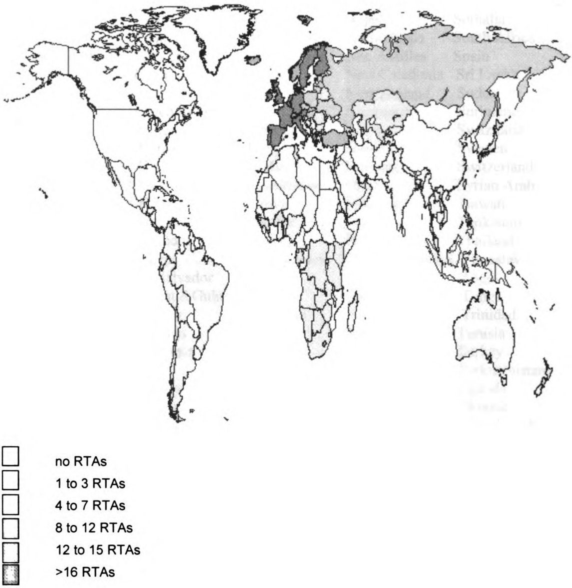
Note: Years are graphed on x-axis from 1980-1997
All possible country pairs are 36290
Data is from World trade flow, by Feenstra ect. (1995)

Figure 2: Geographical Distribution of RTA (Both in force or under negotiation)



Source: World Trade Organization 2000 report

Figure 3: Geographical Distribution of RTA as of year 2000



Source: World Trade Organization year 2000 Report

Table 3: List of Countries:

Afghanistan	China	Hungary	Morocco	Slovakia
Albania	Colombia	Iceland	Mozambique	Slovenia
Algeria	Comoros	India	Namibia	Solomon Islands
Amer. samoa	Congo	Indonesia	Nepal	Somalia
Angola	Costa Rica	Iran	Netherlands	South Africa
Antigua&Barbuda	Croatia	Iraq	Net. Antilles	Spain
Argentina	Cuba	Ireland	New Caledonia	Sri Lanka
Armenia	Cyprus	Israel	New Zealand	Sudan
Aruba	Czech Republic	Italy	Nicaragua	Suriname
Australia	Korea	Jamaica	Niger	Swaziland
Austria	Congo	Japan	Nigeria	Sweden
Azerbaijan	Denmark	Jordan	Norway	Switzerland
Bahamas	Djibouti	Kazakhstan	Oman	Syrian Arab
Bahrain	Dominica	Kenya	Pakistan	Taiwan
Bangladesh	Dominican Rep.	Kiribati	Palau	Tajikistan
Barbados	Ecuador	Kuwait	Panama	Thailand
Belarus	Egypt	Kyrgyzstan	Papua N.Guinea	Yugoslav
Belgium	El Salvador	Lao	Paraguay	Togo
Belize	Equat.&Guinea	Latvia	Peru	Tonga
Benin	Eritrea	Lebanon	Philippines	Trinidad
Bermuda	Estonia	Lesotho	Poland	Tunisia
Bhutan	Ethiopia	Liberia	Portugal	Turkey
Bolivia	Fiji	Libyan Arab	Puerto Rico	Turkmenistan
Bosnia&Herzego.	Finland	Lithuania	Qatar	Uganda
Botswana	France	Luxembourg	Korea	Ukraine
Brazil	French Polynesia	Macao	Moldova	United Arab
Brunei Darussalam	Gabon	Madagascar	Romania	UK
Bulgaria	Gambia	Malawi	Russian Fed.	Tanzania
Burkina Faso	Georgia	Malaysia	Rwanda	US
Burundi	Germany	Maldives	St. Kitts&Nevis	Uruguay
Cote d'Ivoire	Ghana	Mali	Saint Lucia	Uzbekistan
Cambodia	Greece	Malta	St Vt.&Grenadines	Vanuatu
Cameroon	Grenada	Marshall Is.	Sao tome&principe	Venezuela
Canada	Guatemala	Mauritania	Saudi Arabia	Viet Nam
Cape Verde	Guinea	Mauritius	Senegal	Yemen
Central African	Guinea-Bissau	Mexico	Seychelles	Zambia
Chad	Guyana	Micronesia	Sierra Leone	Zimbabwe
Chile	Haiti	Mongolia	Singapore	
	Honduras	HongKong		

Table 4: Summary Statistics

Variable	Full Mean	sample Std.Dev.	Export>0 Mean	Std.
Trade	165511	2534012	562450	4647484
Log of trade	-----	------	9.52777	2.75813
Log of importer GDP	10.1249	2.2714	11.6104	1.90957
Log of exporter GDP	10.1249	2.2714	11.7063	1.81652
Log of distances	8.77504	0.77531	8.60933	0.83267
Contiguity	0.01565	0.12413	0.02585	0.15868
Common Language	0.16269	0.36909	0.1222	0.32753
Colonial Ties	0.0108	0.10337	0.02837	0.16605
Landlocked Exporter	0.18848	0.3911	0.13981	0.3468
Landlocked Importer	0.18848	0.3911	0.1355	0.34227
Major cities in exporter	21.8684	6.34529	23.825	4.3851
Major cites in importer	21.8684	6.34529	23.825	4.3851
RTA	0.0652	0.24688	0.06742	0.25076

Table 5: Estimation of Gravity Equations by Conventional Methods

Estimator	**OLS**	**OLS**	**PML**	**PML**
Dependent variable	**ln(Tij)**	**ln(1+Tij)**	**Tij>0**	**Tij**
Log exporter GDP	1.001***	1.030***	.102***	.360***
	(0.011)	(0.009)	(0.001)	(0.004)
Log importer GDP	.910***	.965***	.092***	.334***
	(0.010)	(0.009)	(0.001)	(0.004)
Log distance	-1.019***	-.647***	-.104***	-.262***
	(0.022)	(0.024)	(0.002)	(0.008)
Contiguity	.473***	.343**	0.01	-.290***
	(0.116)	(0.151)	(0.009)	(0.048)
Common-language	.565***	.196***	.056***	-0.001
	(0.054)	(0.049)	(0.005)	(0.024)
Colonial-tie	1.141***	2.866***	.099***	.232***
	(0.106)	(0.173)	(0.008)	(0.050)
Landlocked-exporter	-.376***	-.642***	-.038***	-.096***
	(0.051)	(0.046)	(0.005)	(0.020)
Landlocked-importer	-.677***	-.788***	-.072***	-.193***
	(0.051)	(0.046)	(0.005)	(0.020)
Num. of cities in expor	-.052***	-.057***	-.005***	0.002
	(0.004)	(0.003)	0.000	(0.002)
Num. of cities in impor	-.057***	-.052***	-.005***	0
	(0.003)	(0.003)	0.000	(0.001)
RTA	0.61***	-0.031	0.593***	0.654***
	(0.147)	(0.081)	0.000	0.000
Observations	10607	36290	10607	36290

Note: ***, **, * each indicates significance at the level of 99%, 95%,90%
OLS stands for ordinary least squares estimation
PML stands for Poisson Maximum Likelihood estimation

Table 6: Estimation Result: Two-Part Model Without Sampling Weight

	Probit Lnormal Part 1	Probit Lnormal Part 2	Logit Lnormal Part 1	Logit Lnormal Part 2	Probit Exp. Part 1	Probit Exp. Part 2	Logit Exp. Part 1	Logit Exp. Part 2
Log (ex_GDP)	.45***	1.00***	.82***	1.00***	.45***	.74***	.82***	.74***
	(0.010)	(0.010)	(0.010)	0.000	(0.005)	(0.004)	(0.010)	(0.004)
Log (im_GDP)	.42***	.91***	.76***	.91***	.42***	.73***	.76***	.73***
	(0.010)	(0.010)	(0.010)	(0.010)	(0.005)	(0.005)	(0.010)	(0.004)
Ln(dist.)	-.25***	-.97***	-.47***	-.97***	-.25***	-.70***	-.47***	-.70***
	(0.010)	(0.020)	(0.020)	(0.020)	(0.010)	(0.010)	(0.020)	(0.010)
RTA	-0.04	.48***	-0.09	.48***	-0.04	-.41***	-0.08	.41***
	(0.040)	(0.070)	(0.070)	(0.070)	(0.040)	(0.040)	(0.070)	(0.040)
Colonial Tie	.46***	1.23***	.80***	1.24***	0.46***	1.17***	.80***	1.17***
	(0.080)	(0.100)	(0.150)	(0.100)	(0.080)	(0.060)	(0.150)	(0.060)
Common Language	0.001	.45***	0.01	.45***	0.001	.33***	0.01	0.33***
	(0.030)	(0.050)	(0.050)	(0.060)	(0.020)	(0.030)	(0.050)	(0.030)
Contiguity	-.38***	0.39***	-.71***	0.40***	-.38***	0.70***	-.71***	0.70***
	(0.070)	(0.110)	(0.130)	(0.110)	(0.070)	(0.060)	(0.130)	(0.060)
landlocked exporter	-.12***	-.35***	-.18***	-.35***	-.12***	-.54***	-.18***	-.54***
	(0.020)	(0.050)	(0.040)	(0.050)	(0.020)	(0.020)	(0.140)	(0.520)
Landlocked importer	-.21***	-.65***	-.35***	.65***	-.20***	-.82***	-.35***	-.86***
	(0.020)	(0.050)	(0.040)	(0.050)	(0.020)	(0.020)	(0.040)	(0.020)
Exporter City number	-.004**	-.05***	-.01**	-.05***	-.004**	-.05***	-.01**	-.05***
	(0.001)	(0.004)	(0.003)	(0.010)	0.000	(0.002)	(0.003)	(0.002)
Importer City number	-.006**	-.06***	-.01***	-.05***	-.006***	-.08***	-.01***	-.08***
	(0.002)	(0.003)	(0.003)	(0.003)	(0.002)	(0.002)	(0.003)	(0.002)
Log Likelihood	-134563.2		-134519.4		-139782.14		-139738.33	

Table 7: Estimation Result: 2-part Model With Sampling Weight

	Probit Lnormal P1	**Probit Lnormal P2**	**Logit Lnormal P1**	**Logit Lnormal P2**	**Probit Exp. P1**	**Probit Exp. P2**	**Logit Exp. P1**	**Logit Exp. P2**
Log (ex GDP)	.10**	1.13***	.17***	1.13***	.19**	.93***	.17*	.93***
	(0.040)	(0.040)	(0.100)	(0.010)	(0.040)	(0.030)	(0.090)	(0.030)
Log (im GDP)	.18***	1.12***	.32***	1.12***	.18***	1.03***	.32***	1.03***
	(0.030)	(0.040)	(0.010)	(0.010)	(0.030)	(0.040)	(0.060)	(0.040)
Ln(dist.)	-0.07	-.81***	-.15***	-.81***	-0.07	-.65***	-0.15	-.65***
	(0.070)	(0.060)	(0.260)	(0.010)	(0.070)	(0.040)	(0.140)	(0.040)
RTA	1.05***	1.32***	1.96***	1.32***	1.05***	.87***	1.96**	.87***
	(0.370)	(0.270)	(0.130)	(0.040)	(0.370)	(0.190)	(0.740)	(0.890)
Colonial	0.64	.43**	1.27***	.43***	0.64	0.17	1.26	0.17
	(0.400)	(0.180)	(0.090)	(0.030)	(0.400)	(0.150)	(1.790)	(0.150)
Common	-.85**	0.29	-1.5***	.29***	-.85**	0.23	-1.53**	0.23
	(0.360)	(0.230)	(0.460)	(0.020)	(0.360)	(0.190)	(0.640)	(0.190)
Contiguity	-0.56	-0.52	-.99***	-.52***	-0.56	0.09	-0.98	0.09
	(0.600)	(0.480)	(0.080)	(0.030)	(0.600)	(0.290)	(1.180)	(0.290)
landlocked	-0.11	-0.12	-.23**	-.12**	-0.11	-.22**	-0.23	-.22**
	(0.120)	(0.860)	(0.080)	(0.040)	(0.120)	(0.120)	(0.230)	(0.120)
landlocked	0.01	-0.04	0	-0.04	0.01	-0.06	0.001	-0.06
	(0.100)	(0.130)	(0.070)	(0.040)	(0.100)	(0.120)	(0.180)	(0.120)
Exporter	-0.01*	-.07***	-.03***	-.07***	-.02**	-.06***	-0.02	-.06***
	(0.010)	(0.010)	(0.010)	0.000	(0.010)	(0.010)	(0.010)	(0.010)
Importer	-0.03**	-.11***	-.06***	-.11***	-.03***	-.09***	-.06**	-.10***
	(0.010)	(0.010)	(0.010)	0.000	(0.010)	(0.010)	(0.020)	(0.010)

Table 8: Marginal Effect Derived From Other Methods

Estimation	Dependant Variable	Mar. effect of ln(dist.)	Mar. effect of RTA
OLS positive trade only	ln(Tij)	-1.019*** (.022)	0.61*** (0.147)
OLS all possible country pairs	ln(1+Tij)	-.647*** (.024)	-0.031 (0.081)
PML positive trade only	Tij>0	-.104*** (.002)	0.593*** (0.000)
PML all possible country pairs	Tij	-.262*** (0.008)	0.654*** (0.000)

Note: ***, **, * each indicates significance at the level of 99%, 95%, 90%
OLS stands for ordinary least squares estimation
PML stands for Poisson Maximum Likelihood estimation

Table 9: Marginal Effect of log(distance) and RTA on log(trade volume)(with the Trading Partner's Sizes as Weight Factor)

	Marginal effect of Log(distance)	Marginal effect of RTA
P1: Probit	-1.05***	1.61***
P2: Lognormal	(0.24)	(0.04)
P1: Logit	-0.85***	1.61***
P2: Lognormal	(0.01)	(0.32)
P1: Probit	-0.88***	1.21***
P2: Exponential	(0.24)	(0.22)
P1: Logit	-.69***	1.16***
P2: Exponential	(0.08)	(0.25)

Table 10: Marginal effect of log(distance) and RTA on log(trade volume)(without any Weight Factor)

	Marginal effect of Log(distance)	Marginal effect of RTA
P1: Probit	-1.20***	0.26***
P2: Lognormal	(0.025)	(0.098)
P1: Logit	-1.34***	0.35***
P2: Lognormal	(0.089)	(0.096)
P1: Probit	-0.92***	0.18***
P2: Exponential	(0.016)	(0.075)
P1:Logit	-1.07***	0.28***
P2: Exponential	(0.022)	(0.074)

Table 11: Vuong (1989)'s Test for Model Selection

	LR Test Statistics	Result
Probit (Model f) Vs. Logit (Model g)	-4.193e-07	H_0 is not rejected
Exponential (Model f) Vs. Lognormal (Model g)	-8.32e-10	H_0 is not rejected

Table 12: U.S. Import and Varieties in 1990

	Total Import	Manufacturing Import
Number of Exporting Countries	153	153
Number of Varieties	182,230	171,322
Total Import Value (in million $)	495,260	409,953

Notes:

1. The data are from Feenstra, Romalis, and Schott (2002).
2. Manufacturing import is the import in the industries classified as the 4-digit U.S. SIC (1987 version) 2011 through 3999.
3. Exporters in this table include overseas territories of countries.
4. The number of varieties is defined as the number of commodities classified by the 10-digit Harmonization System (HS) that the U.S. imports *from each exporter*. (i.e., the same 10-digit HS commodities imported from different exporters are counted as different varieties.)
5. Import value is the customs value of general imports. General Imports measure the total physical arrivals of merchandise from foreign countries, whether such merchandise enters consumption channels immediately or is entered into bonded warehouses or Foreign Trade Zones under Customs custody.

Table 13: Country List (as of 1990, 115 countries)

Algeria
Angola
Argentina
Australia
Austria
Bangladesh
Barbados
Belgium
Benin
Bolivia
Brazil
Burkina Faso
Burundi
Cameroon
Canada
Central African Republic
Chad
Chile
China
Colombia
Congo
Costa Rica
Cote d'Ivoire
Cyprus
Czechoslovakia
Denmark
Dominican Republic
Ecuador
Egypt
El Salvador
Fiji
Finland
France
Gabon
Gambia
Germany
Ghana
Greece
Guatemala
Guinea
Guinea-Bissau
Guyana
Haiti
Honduras
Hong Kong
Hungary
Iceland
India
Indonesia
Iran
Ireland
Israel
Italy
Jamaica
Japan
Jordan
Kenya
Madagascar
Malawi
Malaysia
Mali
Malta
Mauritania
Mauritius
Mexico
Morocco
Mozambique
Netherlands
New Zealand
Nicaragua
Niger
Nigeria
Norway
Oman
Pakistan
Panama
Papua New Guinea
Paraguay
Peru
Philippines
Poland
Portugal
Reunion
Rwanda
Saudi Arabia
Senegal
Seychelles
Sierra Leone
Singapore
Somalia
South Africa
South Korea
Spain
Sri Lanka
Sudan
Suriname
Sweden
Switzerland
Syria
Taiwan
Tanzania
Thailand
Togo
Trinidad and Tobago
Tunisia
Turkey
U.S.S.R.
Uganda
United Kingdom
Uruguay
Venezuela
Yugoslavia
Zaire
Zambia
Zimbabwe

Table 14: Factor Abundance of Countries: Skilled Labor (*S*) to Unskilled Labor (*U*)

Variables	Mean	Std. Dev.	Min.	Max.
S/U ratio	1.879	0.553	1.075	3.369
S/U ratio relative to US	0.567	0.167	0.325	1.017

Number of countries: 115

10 most skilled labor-abundant countries:

Country	S/U ratio	S/U relative to U.SA
New Zealand	3.369	1.017
Hungary	3.086	0.932
Norway	3.010	0.909
Canada	3.008	0.908
Denmark	2.999	0.905
Australia	2.981	0.900
Finland	2.833	0.855
Sweden	2.825	0.853
Israel	2.818	0.851
Belgium	2.768	0.836

10 most unskilled labor-abundant countries:

Country Name	S/U ratio	S/U relative to U.S.A
Niger	1.075	0.325
Guinea-Bissau	1.078	0.325
Benin	1.098	0.332
Mali	1.116	0.337
Rwanda	1.119	0.338
Gambia	1.119	0.338
Sudan	1.130	0.341
Mozambique	1.156	0.349
Central African Republic	1.184	0.357
Nigeria	1.217	0.367

Note: The relative skilled-labor abundance to unskilled labor (S/U) is measured by the human capital-to-labor ratio provided by Hall and Jones (1999).

Table 15: Input Factor Intensity of Industries: Skilled-labor (*S*) to Unskilled-labor (*U*)

Variables	Mean	Std. Dev.	Min.	Max.
S-intensity	0.296	0.124	0.078	0.827
U-intensity	0.704	0.124	0.173	0.922

10 Most Skilled-labor intensive industries

SIC	Industry Description	*S*-intensity	*U*-intensity
2721	Periodicals	0.827	0.173
2731	Book Publishing	0.766	0.234
3571	Electronic Computers	0.718	0.282
3761	Guided Missiles & Space Vehicles	0.685	0.315
2711	Newspapers	0.676	0.324
2741	Miscellaneous Publishing	0.638	0.362
2835	Diagnostic Substances	0.633	0.367
3572	Computer Storage Devices	0.627	0.373
3826	Analytical Instruments	0.617	0.383
2086	Bottled and Canned Soft Drinks	0.604	0.396

10 Most Unskilled-labor intensive industries

SIC	Industry Description	*S*-intensity	*U*-intensity
2322	Men's & Boys' Underwear & Nightwear	0.078	0.922
2281	Yarn Spinning Mills	0.089	0.911
2284	Thread Mills	0.097	0.903
2211	Weaving Mills, Cotton	0.102	0.898
2436	Softwood Veneer and Plywood	0.105	0.895
2015	Poultry and Egg Processing	0.108	0.892
3263	Fine Earthenware Food Utensils	0.111	0.889
2325	Men's & Boys' Trousers & Slacks	0.116	0.884
2321	Shirts, Men's and Boys'	0.120	0.880
3144	Women's Footwear, Except Athletic	0.120	0.880

Notes:

1. The source of the data for factor intensity is 1992 U.S. Census of Manufactures.
2. Industries are classified according to the 4-digit U.S. Standard Industrial Classification (SIC; 1987 version).
3. Skilled-labor (*S*) intensity is defined as the share of non-production workers in the total number of employees; and unskilled-worker (*U*) intensity is defined as the share of production workers. The sum of S-intensity and U-intensity is thus one for each industry.

Table 16: List of Countries in Aggregate North and South

North (51 countries)		South (64 Countries)	
Argentina	Sri Lanka	Algeria	Oman
Australia	Sweden	Angola	Pakistan
Austria	Switzerland	Bangladesh	Papua New Guinea
Barbados	Taiwan	Benin	Paraguay
Belgium	Thailan	Bolivia	Portugal
Canada	Trinidad and Tobago	Brazil	Reunion
Chile	United Kingdom	Burkina Faso	Rwanda
China	Uruguay	Burundi	Saudi Arabia
Costa Rica	U.S.S.R.	Cote d'Ivoire	Senegal
Cyprus	Venezuela	Cameroon	Seychelles
Czechoslovakia	Yugoslavia	Central African Republic	Sierra Leone
Denmark	Malaysia	Chad	Singapore
Ecuador	Malta	Colombia	Somalia
Egypt	Morocco	Congo	Sudan
Fiji	Netherlands	Dominican Republic	Suriname
Finland	New Zealand	El Salvador	Syria
France	Norway	Gabon	Togo
Germany	Panama	Gambia	Tunisia
Greece	Peru	Ghana	Turkey
Guyana	Philippines	Guatemala	Uganda
Hong Kong	Poland	Guinea	Tanzania
Hungary	South Korea	Guinea-Bissau	Zaire
Iceland	South Africa	Haiti	Zambia
Ireland	Spain	Honduras	Zimbabwe
Israel	Japan	India	Mauritania
Italy		Indonesia	Mauritius
		Iran	Mexico
		Jamaica	Mozambique
		Jordan	Nicaragua
		Kenya	Niger
		Madagascar	Nigeria
		Malawi	Mali
		Mali	

Table 17: Skilled-to-Unskilled Labor Ratios (*S*/*U*) of North and South

	S/*U* (group average)	*S*/*U* relative to U.S. (group average)
North	2.4	0.72
South	1.47	0.44

Note: The relative factor abundance (*S*/*U*) is measured by the human capital to labor ratio in Hall & Jones (1999).

Table 18: Regressions for Aggregate North and South

Dependent Variable: Log of aggregate no. of varieties as the share in the total no. of varieties imported by the U.S.

	North	South
skill	0.256***	-1.21***
	-0.041	-0.208
constant	-0.256***	-1.54***
	-0.014	-0.063
Observations	394	385
R^2	0.1	0.12

Notes:

1. Regression equation is (4.1).
2. *skill* is skilled-labor intensity of each industry.
3. Robust standard errors are in parentheses.
4. *, **, and *** indicate that the coefficient estimate is significant at the 1%-level, 5%-level, and 10%-level, respectively.

Table 19: Pooled Regression for Individual Exporters

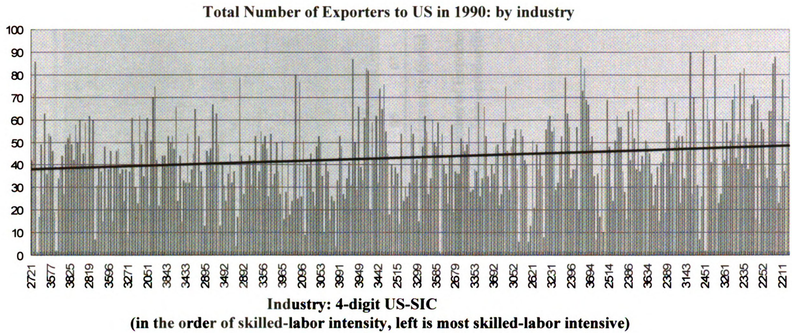
Dependent Variable: Log of no. of exported varieties in each industry as the share in the total no. of varieties imported by the U.S.

skill_i	-2.72***
	-0.566
*skill_i * (S/U)_c*	4.14***
	-0.802
Observations	17,050
R^2	0.13

Notes:

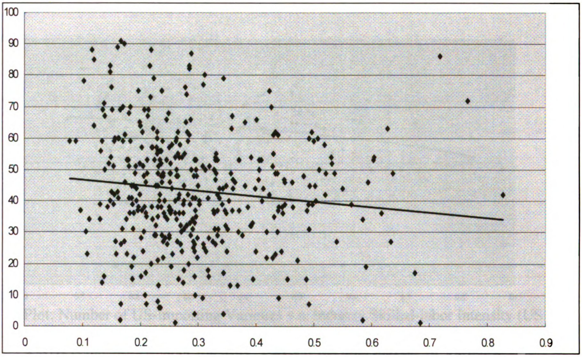
1. Regression equation is (4.4). Country-specific dummies are included.
2. *skill_i* is skilled-labor intensity of each industry; and *(S/U)_c* is skilled-to-unskilled labor endowment ratio in each exporter, relative to the U.S.
3. Standard errors in parentheses are clustered by country.
4. *, **, and *** indicate that the coefficient estimate is significant at the 1%-level, 5%-level, and 10%-level, respectively.

Figure 4: Number of Exporters to the U.S. in each manufacturing industry; in 1990



Notes:
1. Industries are listed in order of skilled-labor intensity. The left is the most skilled-labor intensive, and the right is the least.
2. Skilled-labor intensity is defined as the share of non-production workers in the total number of employees.

Figure 5: Scatterplot of Number of Exporters v.s. Industry Skilled-labor Intensity
(U.S. Manufacturing Imports in 1990)

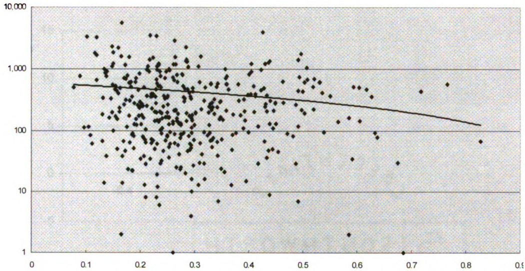


Plot: Number of Exporters vs Industry Skilled-labor Intensity (Solid Line=trend line)

x-axis is the Skilled-labor Intensity; y-axis is the number of Exporters

Note: Skilled-labor intensity is defined as the share of non-production workers in the total number of employees in each industry.

Figure 6: Scatterplot of Number of Varieties v.s. Industry Skilled-labor Intensity (U.S. Manufacturing Imports in 1990)



Plot: Number of US-Importing Varieties v.s. Industry Skilled-labor Intensity (US Manufacturing Imports in 1990)
X-axis is the Skilled-labor Intensity; y-axis is the total number of Varieties.

Notes:
1. The number of varieties in each industry is defined as the number of 10-digit HS commodities that the U.S. imports *from each exporter* in each 4-digit SIC industry (i.e., the same HS commodity imported from different countries are counted as different varieties). The mapping between the 10-digit HTS and the 4-digit SIC is according to Feenstra, Romalis, and Schott (2002).
2. Skilled-labor intensity is defined as the share of non-production workers in the total number of employees in each industry.

Figure 7: Individual Exporter Regression:
Scatterplot of Slope Coefficient v.s. Skill Abundance of the Country

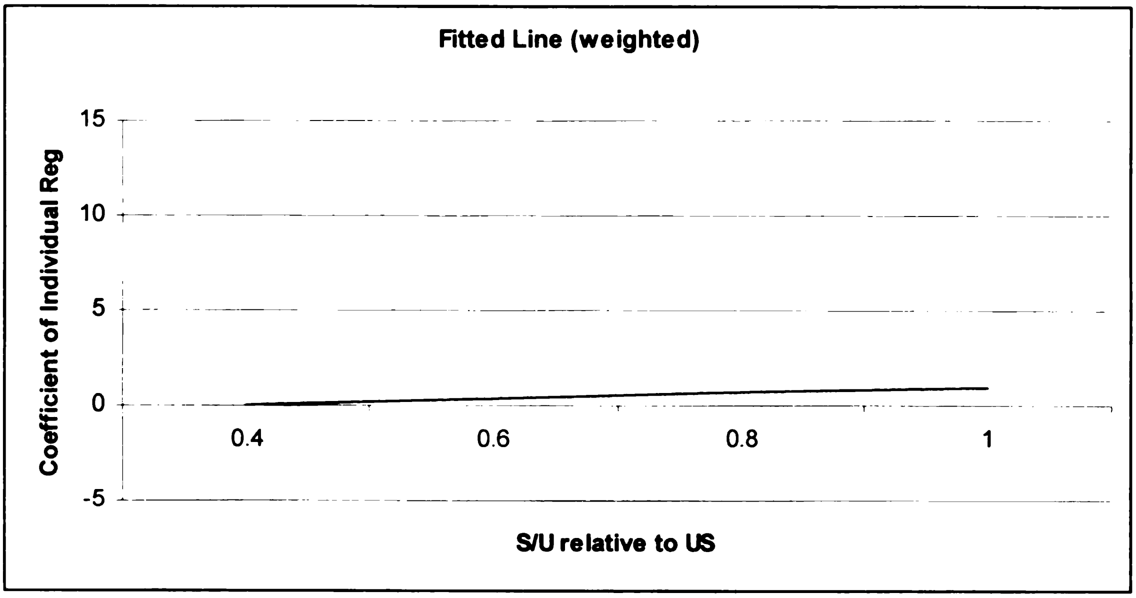
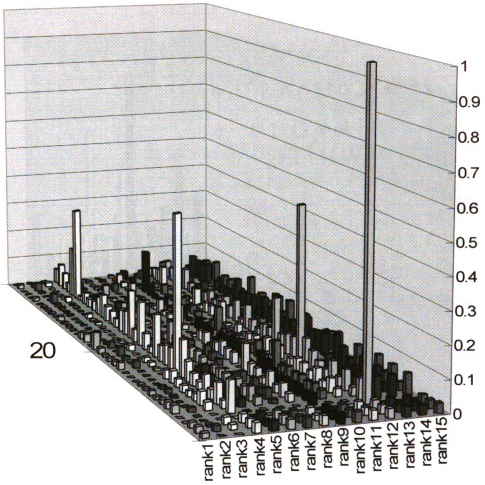
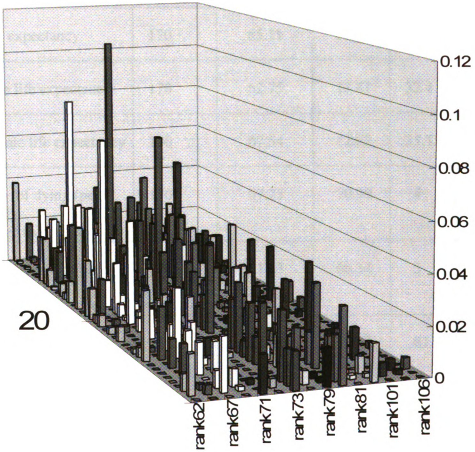


Figure 8: Exporter's Relative Factor Abundance, Industry Factor Intensity, and Number of Varieties in U.S. Manufacturing Imports in 1990 (1): Selected Skilled Labor-abundant Countries (relative to unskilled: *S*/*U*)



Rank in *S*/*U* ratio	Exporter	Average variety number share in 20 most skill-intensive industries	Average variety number share in 20 most unskill-intensive industries
1	New Zealand	0.0113	0.0084
2	Hungary	0.0065	0.0076
3	Norway	0.0161	0.0046
4	Canada	0.0758	0.0780
5	Denmark	0.0226	0.0099
6	Australia	0.0259	0.0139
7	Finland	0.0160	0.0057
8	Sweden	0.0308	0.0176
9	Israel	0.0273	0.0205
10	Belgium	0.0249	0.0200

Figure 9: Exporter's Relative Factor Abundance, Industry Factor Intensity, and Number of Varieties in U.S. Manufacturing Imports in 1990 (2): Selected Unskilled Labor-abundant Countries (relative to skilled: *U*/*S*)



Rank in *S*/*U* ratio	Exporter	Average variety number share in 20 most skill-intensive industries	Average variety number share in 20 most unskill-intensive industries
106	Nigeria	0.0006	0.0011
105	Haiti	0.0014	0.0042
101	Pakistan	0.0033	0.0090
84	Guatemala	0.0028	0.0101
81	Cote d'Ivoire	0.0010	0.0014
80	India	0.0085	0.0155
79	Kenya	0.0017	0.0015
74	Turkey	0.0035	0.0078
73	Brazil	0.0147	0.0244
72	Honduras	0.0012	0.0057
71	El Salvador	0.0022	0.0051

Table 20: Summary Statistics:

Variable	N	Mean	Standard Deviation	Min.	Max.
Life expectancy	170	65.11	11.96	34	81.9
Male life expectancy	170	62.75	11.41	32.4	78.4
Female life expectancy	170	67.54	12.62	35.7	85.3
Prob. of dying (per 1000) Under five, male	170	67.25	70.99	4	332
Prob. of dying (per 1000) Under five, female	170	61.13	66.54	3	303
Prob. of dying (per 1000) 15-59, male	170	288.67	172.52	81	902
Prob. of dying (per 1000) 15-59, female	170	208.54	166.95	46	789
General medical expenditure as % of GDP	170	1.73	0.39	.40	2.68
GDP per capita	170	9153.43	9607.07	515.50	49367.77

Table 21: Countries List (78 member countries reporting positive inward FDI during 2000-2004, UNCTAD)

ARE	United Arab Emirates	LTU	Lithuania
ARG	Argentina	LUX	Luxembourg
ARM	Armenia	LVA	Latvia
AUS	Australia	MAR	Morocco
AUT	Austria	MDG	Madagascar
AZE	Azerbaijan	MYS	Malaysia
BGD	Bangladesh	NGA	Nigeria
BGR	Bulgaria	NLD	Netherlands
BOL	Bolivia	NOR	Norway
BRA	Brazil	NZL	New Zealand
BWA	Botswana	OMN	Oman
CAN	Canada	PAK	Pakistan
CHE	Switzerland	PER	Peru
CHL	Chile	PHL	Philippines
CHN	China	PNG	Papua New Guinea
COL	Colombia	POL	Poland
CPV	Cape Verde	PRT	Portugal
CYP	Cyprus	PRY	Paraguay
CZE	Czech Republic	QAT	Qatar
DNK	Denmark	RUS	Russian Federation
EST	Estonia	SAU	Saudi Arabia
ETH	Ethiopia	SGP	Singapore
FIN	Finland	SLV	El Salvador
FRA	France	SVK	Slovakia
GBR	United Kingdom	SVN	Slovenia
GEO	Georgia	SWE	Sweden
HRV	Croatia	SWZ	Swaziland
HUN	Hungary	SYR	Syrian Arab Republic
IDN	Indonesia	THA	Thailand
IND	India	TUN	Tunisia
IRL	Ireland	TUR	Turkey
IRN	Iran, Islamic Republic of	TZA	United Republic of Tanzania
ISL	Iceland	UGA	Uganda
ITA	Italy	USA	United States
JPN	Japan	VEN	Venezuela
KAZ	Kazakhstan	VNM	Viet Nam
KHM	Cambodia	YEM	Yemen
KOR	Republic of Korea	ZAF	South Africa
LBN	Lebanon	ZMB	Zambia

Table 22: Predicting FDI: Positive Volume Only

Dependent Variable: inward FDI	
ln(distance)	-.46*** (0.06)
ln(target country size)	0.02 (0.02)
ln(investing country size)	0.04* (0.02)
Landlocked, target country	-0.25* (0.15)
Landlocked, investing country	-0.27* (0.16)
Common language	0.82*** (0.16)
Common Border	0.17 (0.26)
Colonial-tie	0.99*** (0.26)
Observations	3189
R-squared	0.04

Table 23: Predicting FDI: Using Two-part Model Approach to Account for the Zeros

Dependent Variable: inward FDI	
ln(distance)	-3.95*** (0.21)
ln(target country size)	1.06*** (0.07)
ln(investing country size)	1.06*** (0.07)
Landlocked, target country	-0.99*** (0.39)
Landlocked, investing country	-3.35*** (0.45)
Common language	-.53 (0.42)
Common Border	-.15 (0.82)
Colonial-tie	8.85*** (0.88)
Observations	35532

Table 24: Life Expectancy (level) and FDI Ratio (log), Year 2002

Dependent Variable	lexp	lexp	lexpm	lexpf	lexp	lexp	lexp
ln(ActualFDI/GDP)	-0.33** (0.14)						
ln(fittedFDI/GDP)		-1.90*** (0.63)	-1.98*** (0.59)	-1.85*** (0.67)	-0.32 (0.47)	-0.36 (0.48)	-1.66*** (0.62)
ln(GDPPC)					6.85*** (0.76)	14.7 (10.37)	
[ln(GDPPC)]_sq						-0.45 (0.59)	
ln(med_exp_ratio)							6.84** (2.81)
Expenditure indicator	no	no	no	no	no	no	yes
Income indicators	no	no	no	no	no	yes	yes
Constructed FDI	no	yes	yes	yes	yes	yes	yes
Observations	78	78	78	78	78	78	78
R-squared	0.06	0.1	0.12	0.09	0.56	0.56	0.17

Robust standard errors in brackets.
GDPPC is log PPP GDP per capita.
The instruments for constructed FDI measure are the geographical variables.
Lexp: life expectancy at birth
Lexpm: life expectancy at birth for male
Lexpf: life expectancy at birth for female

Table 25: Life Expectancy (log) and FDI Ratio (log), Year 2002

Dependent Variable	lexp	lexp	lexpm	lexpf	lexp	lexp	lexp
ln(ActualFDI/GDP)	-0.005•• (0.00)						
ln(fittedFDI/GDP)		-0.03••• (0.01)	-0.03••• (0.01)	-0.02••• (0.01)	-0.006 (0.01)	-0.007 (0.01)	-0.03•• (0.01)
ln(GDPPC)					0.11••• (0.01)	-0.32• (0.18)	
[ln(GDPPC)]_sq						-0.01 (0.01)	
ln(med_exp_ratio)							0.09•• (0.04)
Expenditure indicator	no	no	no	no	no	no	yes
Income indicators	no	no	no	no	no	yes	yes
Constructed FDI	no	yes	yes	yes	yes	yes	yes
Observations	78	78	78	78	78	78	78
R-squared	0.05	0.1	0.1	0.09	0.49	0.5	0.14

Robust standard errors in brackets.
GDPPC is log PPP GDP per capita.
The instruments for constructed FDI measure are the geographical variables.
Lexp: life expectancy at birth
Lexpm: life expectancy at birth for male
Lexpf: life expectancy at birth for female

Table26: Mortality (level) and FDI ratio (log), Year 2002

Dependent Variable	Mortality _young male	Mortality _young male	Mortality _young female	Mortality _adult male	Mortality _adult female	Mortality_ young male	Mortality_ young male	Mortality _young male
ln(ActualFDI/GDP)	1.49**							
	(0.72)							
ln(fittedFDI/GDP)		7.90**	6.46***	29.66***	22.01***	0.08	0.37	1.13
		(3.13)	(2.97)	(9.70)	(9.44)	(0.44)	(0.39)	(0.73)
ln(GDPPC)						-37.46***	-218.72***	
						(3.08)	(38.13)	
ln(GDPPC_sq)							10.43***	
							(2.19)	
ln(med_exp_ratio)								-28.37**
								(14.55)
Expenditure indicator	no	no	no	no	no	no	yes	yes
Income indicators	no	no	no	no	no	yes	yes	yes
Constructed FDI	no	yes	yes	yes	yes	yes	yes	yes
Observations	78	78	78	78	78	78	78	78
R-squared	0.06	0.07	0.06	0.1	0.07	0.68	0.17	0.1

Robust standard errors in brackets.
GDPPC is log PPP GDP per capita.
The instruments for constructed FDI measure are the geographical variables.
Mortality_young: the probability of a child born in a specific year or period dying before reaching the age of five.
Mortality_adult: the probability of dying between 15 and 59 years.
ln(med_exp_ratio): log level of the total expenditure on health as % of gross domestic product.

Table 27: Life Expectancy (level) and FDI Ratio (log), Year 2002, With Two-part Model Including All 170 Countries

Dependent Variable	lexp	lexp	lexpm	lexpf	lexp	lexp	lexp
ln(ActualFDI/GDP)	-0.58***						
	(0.12)						
ln(fittedFDI/GDP)		-0.46**	-0.53***	-0.38***	-0.21	-0.11	-0.46**
		(0.23)	(0.22)	(0.24)	(0.20)	(0.16)	(0.62)
ln(GDPPC)					3.41***	-6.56***	
					(0.42)	(1.01)	
ln(GDPPC_sq)						-.84***	
						(0.08)	

Robust standard errors in brackets.
GDPPC is log PPP GDP per capita.
The instruments for constructed FDI measure are the geographical variables.
Lexp: life expectancy at birth
Lexpm: life expectancy at birth for male
Lexpf: life expectancy at birth for female

Table28: Mortality (level) and FDI Ratio (log), Year 2002, 170 Countries

Dependent Variable	Mortality_young male	Mortality_young male	Mortality_young female	Mortality_adult male	Mortality_adult female	Mortality_young male	Mortality_young male	Mortality_young male
ln(ActualFDI/GDP)	3.11***							
	(0.76)							
ln(fittedFDI/GDP)		2.50**	2.24**	8.05**	3.69	0.96	0.41	-0.46**
		(1.39)	(1.30)	(3.36)	(3.30)	(1.19)	(0.96)	(0.62)
ln(GDPPC)						-20.69***	35.21***	
						(2.50)	(6.16)	
ln(GDPPC_sq)							-4.71***	
							(0.49)	
ln(med_exp_ratio)								-52.94***
								(13.08)
Expenditure indicator	no	no	no	no	no	no	yes	yes
Income indicators	no	no	no	no	no	yes	yes	yes
Constructed FDI	no	yes	yes	yes	yes	yes	yes	yes
Observations	170	170	170	170	170	170	170	170
R-squared	0.1	0.02	0.02	0.03	0.01	0.3	0.55	0.1

GDPPC is log PPP GDP per capita. The instruments for constructed FDI measure are the geographical variables. Mortality_young: the probability of a child born in a specific year or period dying before reaching the age of five. Mortality_adult: the probability of dying between 15 and 59 years. ln(med_exp_ratio): log level of the total expenditure on health as % of gross domestic product.

BIBLIOGRAPHY

BIBLIOGRAPHY

Alsan, M., Bloom, D. & Canning, D.: The Effect of Population Health on Foreign Direct Investment", NBER Working Papers 10596

Anderson, J. and Marcouiller, D.: "Insecurity and the Pattern of Trade: An Empirical Investigation", Review of Economics and Statistics, Vol. 84, 2002, pp.345-352

Anderson, J. and van Wincoop, E.: "Gravity with Gravitas: A solution to the Border Puzzle", American Economic Review, Vol. 93, 2003, pp.170-192

Anderstan, J. and van Wincoop, E.: "Trade Costs", Journal of Economic Literature, Vol. 42, 2004, pp.691-751

Arrellano, M. and Bond, S.: "Some Tests of Specification for Panel Data: Monte Carlo Evidence and an Application to Employment Equations", Review of Economic Studies, Vol. 58, 1991, pp.277-297

Arrellano, M. and Bover, O.: "Another Look at the Instrumental Variable Estimation of Error-Components Models", Journal of Econometrics, 68, 1995, pp. 29-51

Baier, S. and Bergstrand, J: "Do Free Trade Agreements Actually Increase Members' International Trade?", Journal of International Economics, forthcoming

Baltgagi, B. H.: Econometric Analysis of Panel Data, Second Edition, New York, John Wiley

Bernard, A.B., Eaton, J., Bradford, Jensen J., and Kortum, S.: "Plants and Productivity in International Trade", American Economic Review, Vol. 93, 2003, pp.1268-1290

Bernard, A.B., Redding, S and Schott, P.: Comparative advantage and heterogeneous firms, NBER working paper 10668

Biddle, Jeff E. and Hamermesh, D.: "Sleep and the Allocation of Time", Journal of political Economy, Vol. 95, 1990, pp.922-943

Blundell, R. and Bond, S.: "Initial Conditions and Moment Restrictions in Dynamic panel data models", Journal of Econometrics, Vol. 87, 1998, pp. 115-143

Borensztein, E., De Gregorio, J. and Lee, J.: "How does Foreign Direct Investment affect economic growth?", Journal of International Economics, Vol. 45, 1998, pp. 115-135

Broda, C. and Weinstein, D: "Variety Growth and World Welfare", American Economic Review, Vol. 94, 2004, pp. 139-144

Chaney, T.: "Distorted Gravity: Heterogeneous Firms, Market Structure and Geography of International Trade", working paper, MIT, 2004

Choi, Y.C., Hummels, D. and Xiang, C: "Explaining import variety and Quality: the Role of the Income Distribution", working paper, Purdue University, 2006

Davis, D.R. and Weinstein, D.E.: An Account of Global Factor Trade, American Economic Review, Vol. 91, 2001, pp. 1423-1453

Davis, D.R. and Weinstein, D.E.: "Market Access, Economic Geography and Comparative Advantage: An Empirical Test", Journal of International Economics, Vol. 59. 2003, pp.1-23

Deardorff, A.: "Determinants of Bilateral Trade: Does Gravity Work in a Neoclassical World?", in Jeffrey A. Frankel, ed., The Regionalization of the World Economy, University of Chicago Press, 1998

Dehejia, R. and Lleras-Muney, A.: "Booms, Busts, and Babies' Health", Quarterly Journal of Economics, Vol. 119, 2004, pp.1091-1130

Dixit, A. K. and Norman, V.: "Theory of International Trade", Cambridge University Press, Cambridge, U.K.

Dornbusch, R., Fisher, S. and Samuelson, P.: "Comparative advantage, Trade, and Payments in a Ricardian Model with a Continuum of Goods", American Economic Review, Vol. 67, 1997, pp. 823-839

Dow, W. and Norton, E.C.: "Choosing Between and Interpreting the Heckit and Two-Part Models for Corner Solutions", Health Services & Outcomes Research Methodology, Vol. 4, 2003, pp.5-18

Duan, N., Manning, W.G., Morris, C.N. and Newhouse, J.P.: "Choosing Between the Sample-Selection Model and the Multi-Part Model", Journal of Business and Economic Statistics, Vol. 2, 1984, pp.283-289

Eaton, J. and Kortum, S.: "Technology, Geography and Trade", Econometrica, Vol. 70, 2002, pp.1741-1779

Economou, A., Nikolau, A. and Theodossiou, I.: "Are Recessions Harmful to Health After All? Evidence from the European Union", working paper, University of Macedonia, 2004

Edmonds, E. and Pavcnik, N.: "International Trade and Child Labor: Cross-Country Evidence", Journal of International Economics, Vol. 68, 2006, pp.115-140

Edmonds, E. and Pavcnik, N.: "The Effect of Trade Liberalization on Child Labor", Journal of International Economics, Vol. 65, 2005, pp.401-419

Ettner, S. L.: "Measuring the Human Cost of a Weak Economy: Does Unemployment Lead to Alcohol Abuse?", Social Science and Medicine, Vol. 44, 1997, pp.251-260

Falvey, R. E. and Kierzkowski, H: "Product Quality, Intra-industry Trade and imperfect Competition", in Kierzkowski, H. (ed.), Protection and Competition in International Trade: Essays in Honor of W. M. Corden, Basil Blackwell, Oxford and London

Feenstra, R. and Kee, H.L.: "Export Variety and Country Productivity", World Bank Policy Research Working Paper 3412, 2004

Feenstra, R., Romalis, J. and Schott, P.K.: "U.S. Imports, Exports, and Tariff Data, 1989-2001", NBER Working Paper No. 9387, 2002

Feenstra, R., Yang, T. and Hamilton, G.: "Business groups and product variety in trade: evidence from South Korea, Taiwan and Japan", Journal of International Economics, Vol. 48, 1999, pp.71-100

Feenstra, R.: "Advanced International Trade: Theory and Evidence", The MIT Press, 2003

Fobes, J. F. and McGregor, A.: "Unemployment and Mortality in Post-War Scotland", Journal of Health Economics, Vol. 3, 1984, pp.239-257

Fogel, R.: "The Relevance of Malthus for the Study of Mortality Today: Long-run Influences on Health, Mortality, Labor Force Participation, and Population Growth. NBER Working Paper 54, 1994

Frankel, J. and Romer, D.: "Does Trade Cause Growth?", American Economic Review, Vol. 89, 1999, pp.279-399

Frankel, J. and Rose, A. : "Is Trade Good or Bad For the Environment? Sorting Out the Causality", the Review of Economics and Statistics, Vol. 87, 2005, pp. 85-91

Frankel, J. and Romer, D.: "Does Trade Cause Growth?", American Economic Review, Vol. 89, 1999, pp. 379-399
Funke, M. and Ruwedel, R.: Product Variety and Economic Growth: Empirical Evidence for the OECD Countries, IMF Staff Papers, Vol. 48, 2001

Gerdtham, U. and Johannesson, M.: "A Note on the Effect of Unemployment on Mortality", Journal of Health Economics, Vol. 22, 2003, pp.505-518

Hall, R. and Jones, C.: "Why Do Some Countries Produce So Much More Output Per Worker Than Others?", Quarterly Journal of Economics, Vol.114, 1999, pp. 83-116

Hallak, J. C.: "Product Quality and the Direction of Trade", Journal of International Economics, Vol. 68, 2006, pp. 238-265

Hallak, J. C.: "A Product-Quality View of the Linder Hypothesis", working paper, 2005

Harrison, A.: "Openness and growth: a time series, cross-country analysis for developing countries", Journal of Development Economics, Vol. 48, 1996, pp. 419-447.

Helpman, E. and Krugman, P.: Market Structure and Foreign Trade, MIT Press, Cambridge, 1985

Helpman, E, Melitz, M.J., and Rubinstein, Y.: "Trading Partners and Trading Volumes", working paper, 2006

Helpman, E, Melitz, M.J., and Yeaple, S.R.: "Export versus FDI with Heterogeneous Firms", American Economic Review, Vol. 94, 2004, pp.300-316

Holtz-Eakin, D., Newey, W. and Rosen, H. S.: "Estimating Vector Autoregressions with Panel Data" Econometrica, Vol. 56, 1986, pp.1371-95

Hsiao, C. & Shen, Y.: "Foreign Direct Investment and Economic Growth: The Importance of Institutions and Urbanization", Economic Development and Cultural Change, Vol. 51, 2003, pp.883—896

Hummels, D. and Klenow, P. J.: "The variety and Quality of a Nation's Trade", American Economics Review Vol. 95, 2005, p. 704-723

Hummels, D. and Levinsohn, J.: "Monopolistic Competition and International Trade: Reconsidering the Evidence", the Quarterly Journal of Economics, Vol. 110, 1995, pp.799-836

Krugman, P. R.: "Increasing Returns, Monoplistic Competition, and International Trade", Journal of International Economics, Vol. 7, 1979, pp. 469-479
Krugman, P: "Scale Economics, Product Differentiation, and the Pattern of Trade", American Economic Review, Vol. 70, 1980, pp.950-959

Krugman, P.: "Increasing Returns and Economic Geography," Journal of Political Economy, Vol. 99, 1991, pp.483-99,

Leamer, E.E.: "The Commodity Composition of International Trade in Manufactures: An Empirical Analysis", Oxford Economic Papers, Vol. 26, 1974, pp.350-374

Leung S.F. and Yu S.: "On the Choice between Sample Selection and two-part Model", Journal of Econometrics, Vol. 72, 1996, pp.197-229

Levine, D. and Rothman, D.: "Does Trade Affect Child Health?", Journal of Health Economics, Vol. 25, 2006, pp. 538-554.

Liu, Z., Dow, W. and Norton, E.: "Effects of Drive-through Delivery Laws on Postpartum Length of Stay and Hospital Charges", Journal of Health Economics, Vol. 23, 2004, pp.129-155

Manning, W.G., Duan, N. and Rogers, W.H.: "Monte Carlo Evidence on the Choice between Sample Selection and Two-Part Model", Journal of Econometrics, Vol. 35, 1987, pp.59-82

Melitz, M.J.: "The impact of Trade on Intra-Industry Reallocations and Aggregate Industry Productivity", Econometrica, Vol. 71, 2003, pp.1695-2003

Mullahy, J.: "Much ado about two: Reconsidering retransformation and the two-part model in health econometrics", Journal of Health Economics, Vol. 17, 1998, pp.247-282

Olsen M.K. and Schafer J.L.: "A Two-Part Random-Effects Model for Semicontinuous Longitudinal Data", Journal of the American Statistical Association, Vol. 96, 2001, pp.730-743

Rauch, J.: "Networks Versus Markets in International Markets", Journal of International Economics, Vol. 48, 1999, pp.7-35

Rose, A.: "Do We Really Know that the WTO Increases Trade?" American Economic Review, , Vol. 94, 2004, pp.98-114

Ramondo, N.: "Size, Geography, and Multinational Production", working paper, University of Texas, 2006

Romalis, J.: "Factor Proportions and the Structure of Commodity Trade, American Economic Review, Vol. 94, 2004, pp. 67-97
Rose, A.: "Do We Really Know That the WTO Increases Trade?", American Economic Review, Vol. 94, 2004, pp. 98-114

Ruhm, C.: "Economic Conditions and Alcohol Problems", Journal of Health Economics, Vol. 14, 1995, pp. 583-603

Ruhm, C.: "Are Recessions Good for Your Health?", Quarterly Journal of Economics, Vol. 115, 2000, pp. 617-650

Ruhm, C.: "Good Times Make You Sick", Journal of Health Economics, Vol. 24, 2003, pp. 637-658

Ruhm, C.: "Healthy Living in Hard Times", Journal of Health Economics, forthcoming

Schott, P.K.: "One size fits all? Heckscher-Olin Specialization in Global Production", American Economic Review, Vol. 93, 2003, pp. 686-708

Schott, P.K.: "Across-Product versus Within-Product Specialization in International Trade", Quarterly Journal of Economics, Vol. 119, 2004, pp. 647—678

Smith, J.P.: "Healthy Bodies and Thick Wallets: the Dual Relationship Between Health and Economic Status", Journal of Economic Perspectives, Vol. 13, 1999, pp. 145-166

Smith, R. D.: "Foreign direct investment and trade in health services: a review of the literature", Social Science & Medicine, Vol. 59, 2004, pp. 2313-2323

Stewart, J. M.: "The Impact of Health Status on the Duration of Unemployment Spells and the Implications for Studies of the Impact of Unemployment on Health Status", Journal of Health Economics, Vol. 20, 2001, pp. 781-796

Soloaga, I.and Winters L. A.: "Regionalism in the nineties. What effect of trade?" The North American Journal of Economics and Finance, Vol. 12, 2001, pp.1-29

Tinbergen, J.: "Shaping the world economy: Suggestions for an international economic policy", The Twentieth Century Fund, 1962

Wooldridge, J.M.: "Econometric Analysis of Cross-Section and Panel Data", MIT press, Cambridge, MA, 2002