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Comparison of Asymmetric Trade Costs: Estimated vs. Recovered

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Abstract

The aim of this paper is to compare trade costs which are obtained using two methods. In the first method, trade costs are recovered from bilateral trade equation, without imposing any restriction on the trade costs. In the second method, trade costs are estimated using the gravity variables. The comparison between them shows that average estimated trade costs imply higher barriers for developing countries when they are both exporting and importing compared to the developed countries. On the other hand average recovered trade costs imply higher barriers for developing countries when they are exporting and lower barriers when they are importing compared with the developed countries.

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***Keywords*:International Trade; Trade Costs**

1. Introduction

In international trade, trade costs play an important role. Trade barriers can be in the form of transportation costs, quotas, tariffs etc. Anderson and VanWincoop, 2004 point the fact that "trade costs are large even aside from trade-policy barriers and even between apparently highly integrated economies". In this paper, trade costs for the total manufactures are obtained by two methods. First, trade costs are recovered from bilateral trade equation, without imposing any restriction on trade costs. Second, trade costs are estimated using the gravity variables. The comparison between trade costs implies some interesting results. Average trade cost

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country *i* faces when importing a good and average trade cost country *i* faces when exporting a good are calculated using the trade costs obtained from the two methods. Estimated trade costs imply that less developed countries face higher barriers in both exporting and importing compared to the developed countries. Whereas recovered trade costs make a reasonable distinction between the average costs when importing and average costs when exporting. According to the recovered costs less developed countries face higher barriers when exporting and less barriers when importing compared with the developed countries.

I apply Eaton and Kortum, 2002's model with trade frictions in the form of iceberg costs to the data in 1996. The model delivers a gravity equation and I estimate trade costs from the gravity equation using the structural relationship between observed bilateral trade shares and trade costs. Following Eaton and Kortum, 2001, Eaton and Kortum, 2002, and Waugh, 2007, asymmetric trade costs are used. Trade costs are estimated using proxies for geographic barriers suggested by the gravity literature and the source of asymmetry is the importer barriers as in Eaton and Kortum, 2001, Eaton and Kortum, 2002, and Waugh, 2007 proposes asymmetric trade costs where asymmetry comes from the exporter fixed effect rather than Eaton and Kortum 's importer fixed effect. Basically, he assumes trade costs as a function of symmetric relationships and an exporter fixed effect.

Firstly, I estimate trade costs using bilateral trade data in total manufacturing sector for a cross-section of 53 countries in 1996 for which I match the data on trade, production and United Nations' International Comparison Program (ICP) (PennWorld Tables 6.1) measures of price of manufacturing goods. 1996 is the most recent year in which ICP provides price measures for 115 countries. In 1980 and 1985 ICP provides price measures for 61 and 64 countries respectively. Secondly, I recover trade costs using a specific equation from the model.

Jack et al., 2008 present a micro-founded measure of aggregate trade cost in order to depict the role of trade costs for trade booms and trade busts in the past century and a half. But they assume that trade costs are symmetric. As Waugh, 2007 argues, assuming symmetric trade costs is a strong argument. He recovers trade costs from the data and his focus is manufactures as well. Vural, 2011 recovers trade costs for investment goods sector. The focus of this paper is to compare the trade costs obtained using two different methods.

The paper proceeds as follows. Section 2 outlines the basic settings of the model. Section 3 has the empirical analysis and the data. Section 4 provides analysis about trade costs. Finally, section 5 contains some concluding remarks.

2. The Model

Following Eaton and Kortum, 2002 and Alvarez and Lucas, 2007 a multi-country Ricardian model of trade is employed. There are N countries indexed by $i = 1, 2...N$. There is a continuum of goods indexed by $x \in [0,1]$. There are trade costs for shipping goods between countries. These costs are in the form of iceberg costs denoted by $\boldsymbol{\tau}_{ij}$ (where *i* refers importer country and *j* refers exporter country). Where $\boldsymbol{\tau}_{ij} > 1$ which means $\boldsymbol{\tau}_{ij}$ of good *x* must be shipped from country *j* in order to arrive one unit in country *i*. Within country there is no trade costs; $\boldsymbol{\tau}_{ij} = 1$.

Each good *x* is relabeled by its efficiency level, efficiency levels in the production of good *x* are random variables drawn from the exponential distribution with parameter λ_i: $x \sim exp(\lambda_i)$ The parameter λ_i denotes country *i*'s state of technology and governs country *i*'s absolute advantage across continuum of goods. If $\lambda_i > \lambda_j$ this means country *i* is on average more efficient in producing goods than country *j*. Each good is produced with total factor productivity levels $x_i^{-\theta}$ and labor: $y_i(x) = x_i^{-\theta} w_i l_i (x)$. Where θ reflects comparative advantage within this continuum. θ governs the amount of variation within the distribution. A bigger θ implies more variability. The production cost is the wage rate w_i which is the same as across goods but different across countries.

Country i faces the price if it buys from country j; $p_{ij}(x) = x_i^{\theta}\, w_i\, \tau_{ij}$. With perfect competition country i buys from the minimum price provider; $p_i(x) = min\ [p_{i1}(x),\ldots,p_{iN}(x)]$. Using this condition and some properties of the exponential distribution we get the price index. Equation (1) shows the price index for goods in country i where γ is a collection of constants.

Since there is a continuum of goods, probability of country j is the lowest cost supplier for the country i is equal to the trade share of country j in country i's total imports. Equation (2) below shows the expression for trade share which is abstracted from constants.

$$p_i = \gamma\left[\sum_{j=1}^{N}(w_j\tau_{ij})^{-1/\theta}\lambda_j\right]^{-\theta} \tag{1}$$

$$D_{ij} = \left(\frac{w_j\tau_{ij}}{p_i}\right)^{-1/\theta}\lambda_j \tag{2}$$

3. Empirical Analysis and Data

3.1 Estimating Trade Costs

I focus data in 1996 across 53 countries. In this paper I am interested in total manufactures trade and I aggregate all 34 Bureau of Economics Analysis (BEA) manufacturing industry codes. I follow Eaton and Kortum, 2002 to estimate trade costs. If we normalize Equation (2) by home trade share of country i, D_{ii} and take logs then the model delivers a log-linear gravity equation, Equation (3) to be estimated.

$$\overline{D}_{ij} = ln\frac{D_{ij}}{D_{ii}} = ln\lambda_j - \frac{1}{\theta}lnw_j - ln\lambda_i + \frac{1}{\theta}lnw_i - \frac{1}{\theta}ln\tau_{ij} \tag{3}$$

To specify the right hand side, S_j is defined as $S_j = ln\lambda_j - (1/\theta)lnw_j$. Here S_j reflects country j's competitiveness in producing goods and it is captured as the coefficient on export-country dummies. Then Equation (3) becomes,

$$\overline{D}_{ij} = S_j - S_i - \frac{1}{\theta}ln\tau_{ij} \tag{4}$$

Trade costs are assumed to include both policy and non-policy related costs. Trade costs are specified as a function of some gravity variables; distance, border, language and importer fixed effect. Trade costs are estimated using gravity variables; Here d^k $(k = 1,\ldots,6)$ is the effect of the distance between i and j lying in the kth interval, the six distance intervals (in miles) are: [0,375), [375,750), [750,1500), [1500,3000), [3000, 6000) and [6000, maximum]. b_{ij} is the effect of sharing a border, l_{ij} is the effect of sharing a language and m_i is the importer fixed effect (overall destination effect as Eaton and Kortum, 2001 call it). Here m_i is the source of asymmetry. The error term ε_{ij} captures all other factors affecting trade costs. Then Equation (6) below is the basis for the empirical analysis.

$$ln\tau_{ij} = d_{ij}^k + b_{ij} + l_{ij} + m_i + \varepsilon_{ij} \tag{5}$$

$$\overline{D}_{ij} = S_j - S_i - \frac{1}{\theta}lnd_{ij}^k - \frac{1}{\theta}b_{ij} - \frac{1}{\theta}l_{ij} - \frac{1}{\theta}m_i - \frac{1}{\theta}\varepsilon_{ij} \tag{6}$$

To map the trade shares into [0,1] interval, I follow Bernard et al., 2003 and calculate D_{ij} as the ratio of country i's total imports from country j to gross production in country i, plus country i's all imports from the sample countries minus country i's total exports to the whole world. I use data on total manufactures trade. Equation (7) and Equation (8) show how I calculate D_{ij} and D_{ii}.

I use bilateral trade data compiled by Feenstra et al., 1997. Actually I face the tradeoff between trade data for a large sample of countries and price data for some countries. Since I need prices to recover trade costs I chose those countries that ICP price data is available.

Gross production data come from UNIDO Industrial Statistics Database or OECD Stan database. Gravity variables come from the CEPII Database. There are 53x52 possible combinations but almost 25 percent of the trade combinations have zero trade. This can be either zero trade or falling below some threshold level so that it is not reported. In the model this can be interpreted as the result of infinite trade costs.

$$D_{ij} = \frac{Imports_{ij}}{GrossProduction_i + Imports_i - TotalExports_i} \tag{7}$$

$$D_{ii} = 1 - \sum_{j \neq i} D_{ij} \tag{8}$$

I need to take a stand on the parameter θ and the baseline value of 0.15 in Alvarez and Lucas, 2007 is chosen. The Equation (6) is estimated using OLS. Table 1 presents the estimated gravity variables. Table 2 provides estimated exporter barriers ($\widehat{S}_i$) and Table 3 presents the estimated importer barriers ($\widehat{m}_i$).

Table 1. Bilateral trade equation, gravity variables

	EST	S.E.	%EffectOnCost
[0,375)	-4.59	0.22	98.92
[375,750)	-5.57	0.13	130.65
[750,1500)	-5.99	0.09	145.74
[1500,3000)	-6.76	0.08	175.64
[3000, 6000)	-8.05	0.05	234.34
[6000, maximum)	-8.76	0.05	272.27
Shared Border	0.04	0.19	-0.53
Shared Language	1.18	0.09	-16.23
R-squared	0.85		

Table 2. Bilateral trade equation , exporter competitiveness

	$\widehat{S}_i$	S.E.		$\widehat{S}_i$	S.E.
SouthAfrica	0.98	0.17	Korea	3.70	0.17
Morocco	-1.66	0.18	Nepal	-3.72	0.21
Tunisia	-1.92	0.19	Pakistan	0.44	0.17
Egypt	-2.37	0.18	China	3.16	0.17
Cameroon	-3.90	0.22	Denmark	1.61	0.17
Kenya	-3.31	0.20	France	3.44	0.17
Malawi	-5.43	0.23	Germany	4.22	0.17
Mauritius	-2.49	0.20	Greece	-0.32	0.17

Senegal	-3.96	0.22	Ireland	1.14	0.17
Zimbabwe	-2.77	0.21	Italy	3.66	0.17
Canada	2.21	0.17	Netherlands	2.68	0.17
Argentina	1.54	0.18	Portugal	0.51	0.17
Chile	0.78	0.18	Spain	2.37	0.17
Colombia	-1.17	0.18	UK	3.35	0.17
Ecuador	-2.22	0.19	Austria	1.59	0.17
Mexico	1.04	0.18	Finland	1.67	0.17
Uruguay	-1.33	0.18	Iceland	-2.51	0.20
Venezuela	-1.59	0.21	Norway	0.40	0.17
CostaRica	-2.64	0.19	Sweden	2.26	0.17
ElSalvador	-4.76	0.23	Switzerland	2.10	0.17
Honduras	-4.51	0.25	Bulgaria	-1.26	0.18
Japan	4.80	0.17	Hungary	-0.80	0.17
Jordan	-3.43	0.20	Poland	0.35	0.18
Kuwait	-4.03	0.19	Australia	1.66	0.18
Turkey	0.49	0.17	NewZealand	1.02	0.18
India	1.86	0.17	USA	4.93	0.14
Indonesia	2.16	0.18			

Table 3. Bilateral trade equation, importer barriers

	$\widehat{m}_i$	S.E.	%EffectOnCost		$\widehat{m}_i$	S.E.	%EffectOnCost
SouthAfrica	1.02	0.25	-14.18	Korea	3.24	0.25	-38.48
Morocco	-2.15	0.26	37.95	Nepal	-3.50	0.31	68.92
Tunisia	-2.57	0.28	47.01	Pakistan	1.05	0.26	-14.51
Egypt	-2.49	0.26	45.28	China	1.90	0.25	-24.77
Cameroon	-3.64	0.30	72.67	Denmark	1.63	0.25	-21.70
Kenya	-3.99	0.27	81.95	France	3.53	0.25	-41.09
Malawi	-4.60	0.32	99.39	Germany	4.40	0.25	-48.31
Mauritius	-1.21	0.28	19.91	Greece	0.05	0.25	-0.74
Senegal	-3.21	0.29	61.82	Ireland	1.55	0.25	-20.71
Zimbabwe	-2.47	0.28	44.73	Italy	3.90	0.25	-44.27
Canada	1.95	0.25	-25.31	Netherlands	4.59	0.25	-49.78
Argentina	1.14	0.26	-15.70	Portugal	0.44	0.25	-6.35
Chile	1.54	0.26	-20.60	Spain	2.25	0.25	-28.60
Colombia	-1.35	0.26	22.36	UK	3.43	0.25	-40.18
Ecuador	-2.02	0.28	35.38	Austria	1.27	0.25	-17.32
Mexico	0.51	0.26	-7.37	Finland	1.06	0.25	-14.72
Uruguay	-0.77	0.27	12.18	Iceland	-1.94	0.29	33.81
Venezuela	-2.03	0.28	35.60	Norway	0.01	0.25	-0.16
CostaRica	-2.60	0.27	47.65	Sweden	2.19	0.25	-27.96
ElSalvador	-3.86	0.31	78.36	Switzerland	1.77	0.25	-23.28
Honduras	-4.22	0.32	88.41	Bulgaria	-1.90	0.27	33.00

Japan	3.87	0.25	-44.03	Hungary	-1.67	0.26	28.36
Jordan	-2.83	0.28	52.90	Poland	-0.72	0.26	11.35
Kuwait	-4.03	0.27	82.99	Australia	1.75	0.26	-23.05
Turkey	0.03	0.25	-0.51	NewZealand	1.48	0.27	-19.95
India	1.09	0.25	-15.11	USA	4.53	0.20	-49.32
Indonesia	2.60	0.26	-32.30				

3.2 Recovering Trade Costs

Since we have data on prices (ICP price measures) and trade shares, trade costs can be recovered from Equation (9). ICP provides price measures for disaggregate categories of manufactured goods. Waugh, 2007 provides the details about how aggregate price index for total manufactures are obtained.

$$\left(\frac{D_{ij}}{D_{jj}}\right)^{-\theta}\left(\frac{p_i}{p_j}\right) = \tau_{ij} \tag{9}$$

Table 4 presents the summary statistics for $\theta = 0.15$. The median value of estimated trade costs is very close to the one for the recovered trade costs. Table 5 shows some estimated and recovered values of τ_{ij} for the United States and some other country combinations. The trade costs between the United States and Canada is lower than the median values. If we look at the recovered values, we see that it is slightly more expensive for the United States to import from Canada, than it is for Canada to import from the United States. We observe this pattern for the trade costs between the US and Mexico, Turkey, South Africa, China, India, Mauritus.

But if we look at the recovered trade costs between the US and Germany, it is less expensive for the US to import from Germany than it is for Germany to import from the US. This pattern is also valid for Japan, France. Generally, it is more expensive for a developed country to import from a less developed country, than it is for a less developed country to import from a developed country. On the other hand, for the estimated trade costs, it is less expensive for the US to import from a country than it is for a country to import from the US.

The average trade costs when a country imports and exports are calculated for both recovered and estimated trade costs. Equation (10) gives $\hat{\tau}_i$ that is the average trade cost country i faces when importing a good. Figure (1) plots add-valorem tariff rate equivalent of $\hat{\tau}_i$:($\hat{\tau}_i$ -1) x 100 versus income level (income levels are the Purchasing Power Parity (PPP) adjusted GDP per worker which comes from the Penn World Table version 6.1). Equation (11) gives $\hat{\tau}_j$ which is the average trade cost countries face when importing a good from country j. Figure (2) plots add-valorem tariff rate equivalent of $\hat{\tau}_j$: ($\hat{\tau}_j$ -1) x 100 versus income level. As illustrated in Figures (1) and (2), recovered trade costs make a strict distinction between the average costs when importing and average costs when exporting. According to the recovered trade costs, less developed countries face higher barriers when exporting and less barriers when importing compared with the developed countries. On the other hand, as Figures (3) and (4) show, estimated trade costs imply that less developed countries face higher barriers in both exporting and importing compared to the developed countries.

$$\hat{\tau}_i = \frac{1}{N}\sum_{j=1}^{N}\tau_{ij} \tag{10}$$

$$\hat{\tau}_j = \frac{1}{N}\sum_{i=1}^{N}\tau_{ij} \tag{11}$$

Table 4. Trade costs, summary statistics

Recovered Trade Costs, Median τ_{ij}	2.90
Estimated Trade Costs, Median τ_{ij}	2.98

Table 5. Trade costs for some country pairs

	Recovered	Estimated
$\tau_{US,Canada}$	1.34	0.97
$\tau_{Canada,US}$	1.27	1.44
$\tau_{US,Mexico}$	2.46	1.39
$\tau_{Mexico,US}$	0.80	2.54
$\tau_{US,Turkey}$	3.22	1.69
$\tau_{Turkey,US}$	1.69	3.33
$\tau_{US,SouthAfrica}$	2.70	1.58
$\tau_{SouthAfrica,US}$	1.95	2.68
$\tau_{US,China}$	3.43	1.89
$\tau_{China,US}$	1.07	2.80
$\tau_{US,India}$	4.20	1.58
$\tau_{India,US}$	1.12	2.65
$\tau_{US,Mauritus}$	7.61	1.58
$\tau_{Mauritus,US}$	0.95	3.74
$\tau_{US,Germany}$	1.25	1.69
$\tau_{Germany,US}$	2.52	1.73
$\tau_{US,Japan}$	0.83	1.89
$\tau_{Japan,US}$	3.48	2.08
$\tau_{US,France}$	1.43	1.69
$\tau_{France,US}$	2.47	1.97

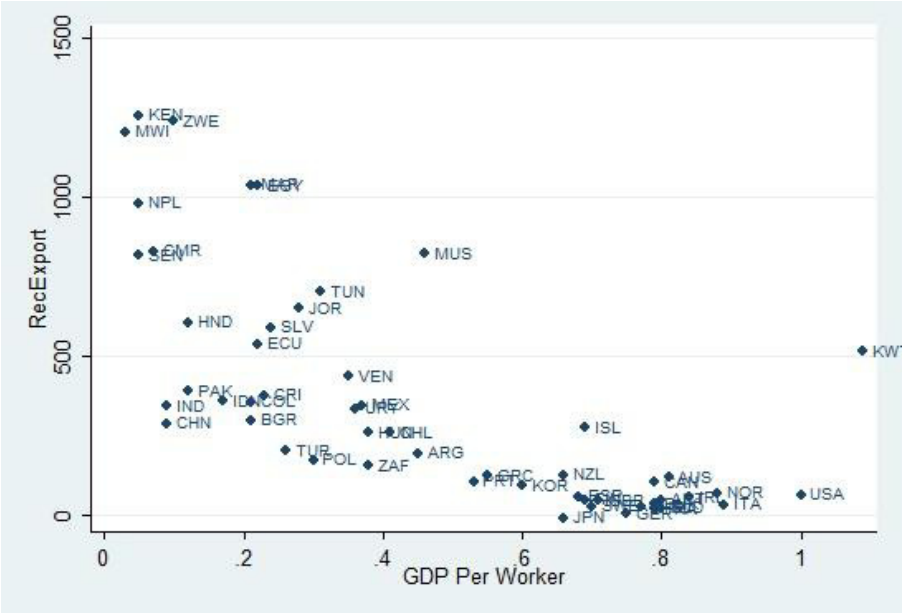

Fig. 1. Average Export Trade Costs (Recovered) vs Purchasing Power Parity (PPP) Adjusted GDP/worker

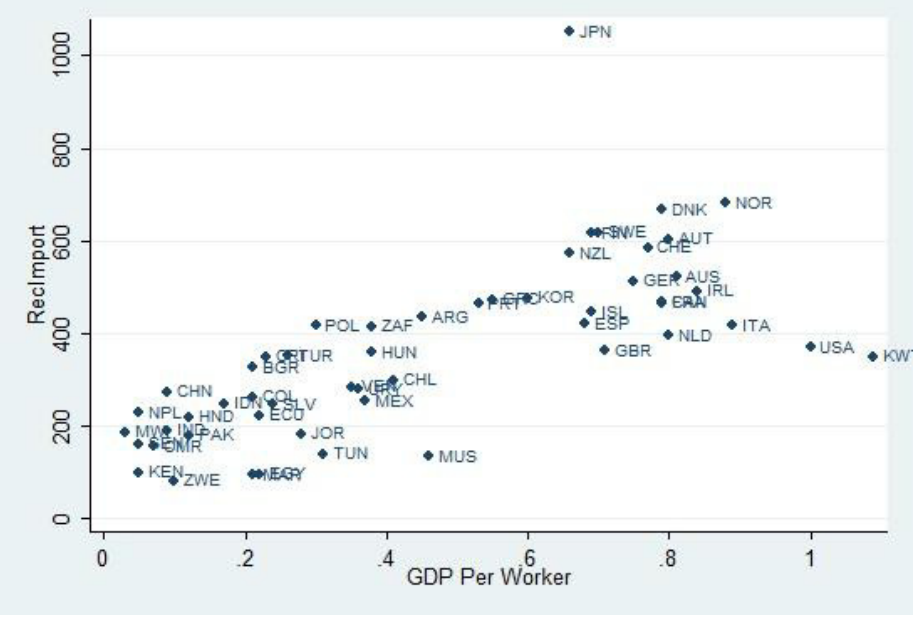

Fig. 2. Average Import Trade Costs (Recovered) vs Purchasing Power Parity (PPP) Adjusted GDP/worker

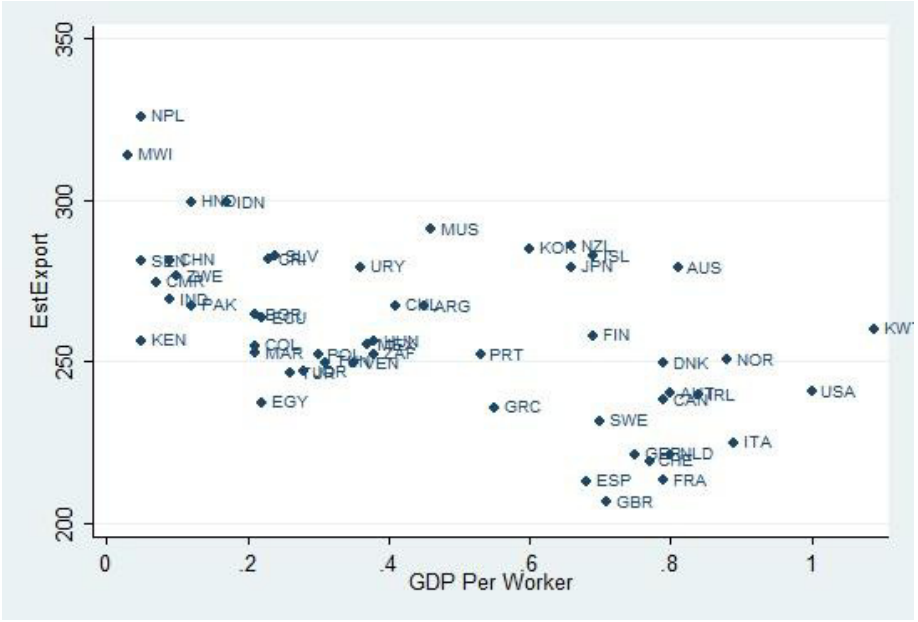

Fig. 3. Average Export Trade Costs (Estimated) vs Purchasing Power Parity (PPP) Adjusted GDP/worker

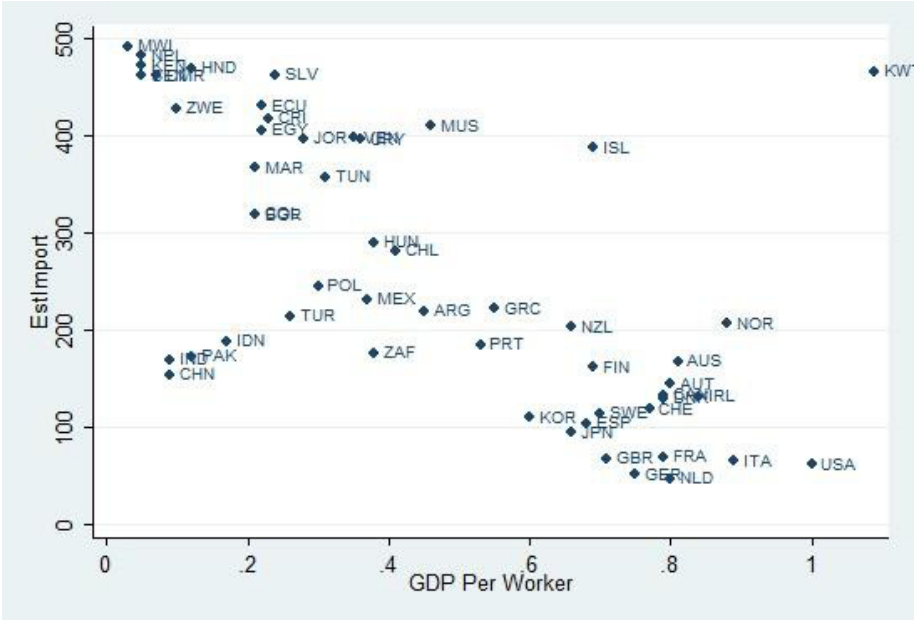

Fig. 4. Average Import Trade Costs (Estimated) vs Purchasing Power Parity (PPP) Adjusted GDP/worker

4. Concluding Remarks

I apply Multi-Country Ricardian Model of trade of Eaton and Kortum, 2002 to the data on bilateral trade and geographic barriers for a cross section of 53 countries in 1996. I used importer barriers as a source of asymmetry in trade costs besides some symmetric proxies (distance, common border, sharing a language) to estimate trade costs.

I also recovered trade costs using bilateral trade data and International Comparison Program (ICP) prices. Average trade costs when a country imports and exports are calculated. There are some differences between recovered and estimated trade costs. Recovered trade costs imply that developing countries face higher barriers when exporting and less barriers when importing than developed countries. However, according to the estimated values, developing countries face higher barriers in both exporting and importing than developed countries.

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Appendix A. List of The Countries and Country Codes:

South Africa (ZAF),Morocco (MAR), Tunisia (TUN), Egypt (EGY), Cameroon (CMR), Kenya (KEN), Malawi (MWI), Mauritius (MUS), Senegal (SEN), Zimbabwe (ZWE), Canada (CAN), Argentina (ARG), Chile (CHL), Colombia (COL), Ecuador (ECU), Mexico (MEX), Uruguay (URY), Venezuela (VEN), Costa Rica (CRI), El Salvador (SLV), Honduras (HND), Japan (JPN), Jordan (JOR), Kuwait(KWT), Turkey (TUR), India (IND), Indonesia (IDN), Korea (KOR), Nepal (NPL), Pakistan (PAK), China (CHN), Denmark (DNK), France (FRA), Germany (GER), Greece (GRC), Ireland (IRL), Italy (ITA), Netherlands (NLD), Portugal (PRT), Spain (ESP), United Kingdom (GBR), Austria (AUT), Finland (FIN), Iceland (ISL), Norway (NOR), Sweden (SWE), Switzerland (CHE), Bulgaria (BGR) Hungary (HUN), Poland (POL), Australia (AUS), New Zealand (NZL), USA (USA)