Marmara Üniversitesi

İ.İ.B.F. Dergisi

YIL 2011, CİLT XXXI, SAYI II, S. 165-174

TRADE BARRIERS ON CAPITAL GOODS[1]

Gülfer VURAL[2]

Abstract

Capital goods play a major role in international trade. World production of capital goods and R&D activity are highly concentrated in some developed countries. Most of the countries, especially developing countries import the most of their capital equipment from some leading capital goods exporter countries. Therefore technological advances can be transmitted across borders through trade in capital goods. In international trade countries face trade costs. Trade costs can be in the form of transportation costs, quota, tariffs etc. The focus of this study is on trade barriers on the capital goods implied by the pattern of bilateral trade. I recover trade costs from bilateral trade equation using the United Nations' International Comparison Program (ICP)'s price and bilateral trade data without imposing any restriction on the form of trade costs.

***Keywords**: International Trade, Capital Goods, Trade Costs, Ricardian Model*

SERMAYE MALLARI ÜZERİNDEKİ TİCARİ MALİYETLER

Özet

Sermaye malları uluslararası ticarette önemli bir rol oynamaktadır. Dünya sermaye malları üretimi ve Ar-Ge faaliyetleri bazı gelişmiş ülkelerde yoğunlaşmıştır. Ülkelerin pek çoğu, özellikle gelişmekte olan ülkeler, sermaye mallarını dünyanın önde gelen sermaye malı ihracatçısı bu ülkelerden ithal etmektedirler. Bu nedenle teknolojik gelişmeler sermaye malları ticaretiyle sınırlarin ötesine geçmektedir. Uluslararası ticarette ülkeler belli maliyetlerle karşı karşıyadır, örneğin, taşıma maliyetleri, kota ve gümrük vergileri. Bu calışmanın amacı sermaye malları üzerindeki ticari maliyetleri ticaret verisi ve Birleşmiş Milletler tarafından yayınlanan fiyatlar verisi kullanarak ticari maliyetler üzerinde hiçbir kısıtlama uygulamadan dogrudan elde etmektir.

***Anahtar Kelimeler**: Uluslararası Ticaret, Sermaye Malları, Ticari Maliyetler, Ricardian Model*

1 Some parts of this paper borrowed from Gulfer Cengiz (Vural)'s PhD thesis submitted to the University of Texas at Austin.

2 Bogazici University, Department of International Trade
gulfervural@gmail.com

1. Introduction

For most countries, foreign sources of technology account for 90 percent or more of domestic productivity growth. At present, only some developed countries provide most of the creation of worlds new technology (Keller (2004)). Eaton and Kortum (2001) document that a small group of R&D abundant countries are the most specialized in capital goods production and poor countries import much of their equipment from just a few large exporters (especially from the United States, Japan, Germany, the United Kingdom, France, Italy and Sweden).

According to Eaton and Kortum (2001) capital goods are defined as the output of the electrical equipment, nonelectrical equipment, and instruments industries. They focus on trade flows and price indices for capital goods in 1985. They apply the model to data on production and bilateral trade in capital equipment, and estimate the trade barriers in equipment. These estimates imply substantial differences in equipment prices across countries.

In international trade countries face trade barriers; trade costs which can be in the form of transportation costs, tariffs etc. Anderson and Van Wincoop (2004) point at the fact that trade costs are large even aside from trade-policy barriers and even between apparently highly integrated economies. As it is documented in the literature capital goods play a significant role in international trade by transmitting the benefits of technological advances across borders (Coe and Helpman, 1995). Since poor countries import the bulk of capital goods from some leading capital goods exporter countries, and they face trade barriers, trade costs on the capital goods are crucial for the developing countries. The aim of this paper is to recover trade costs from the data without imposing any functional form of trade costs and document some properties of these recovered trade costs.

In the literature, trade costs are estimated from the gravity equation by assuming some functional forms for the trade costs. The functional form can be composed with symmetric or/and asymmetric components. Eaton and Kortum (2001, 2002) assume some symmetric components (distance between countries, whether they share a border or not, whether they share a common language or not) and asymmetric components (importer fixed effects) for the trade costs. Another recent paper by Waugh (2009) 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 similar symmetric relationships and exporter fixed effects. Waugh (2007) also recovers trade costs from the data but he focuses on the total manufactures. In this study my focus is barriers on the capital goods.

1996 is the most recent year in which United Nations' International Comparison Program (ICP) provides price measures for 115 countries. In 1980 and 1985 ICP provides price measures for 61 and 64 countries, respectively. I use data for 1996 across 53 countries for which I have data on trade, production, and ICP measures of the price of capital goods.

I employ Eaton and Kortum (2002) and Alvarez Lucas (2007) model to get an expression for the trade costs. Using the data on prices and bilateral trade shares I recover the asymmetric trade costs on the capital goods without assuming any functional form for the trade costs.

The paper proceeds as follows. Second section outlines the basic settings of the model. Third section presents data and the analysis carried out with the recovered asymmetric trade costs. Finally, fourth section contains some concluding remarks.

2. The Model

I use Eaton and Kortum (2002) and Alvarez Lucas (2007)'s multi-country Ricardian model of trade to get an expression for the trade costs. It is a perfect competition, constant returns to scale framework and incentive to trade comes from comparative advantage due to cross country technology differences. Production technologies differ across goods on the continuum only in their productivity level. Productivity levels are random variables, drawn from a parameterized distribution. The average productivity level is different across countries. The capital goods are purchased from country with the lowest price including iceberg trade costs.

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 τ_{ij} (where i refers importer country and j refers exporter country). Where $\tau_{ij} > 1$ which means τ_{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; $\tau_{ij} = 1$.

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: $y_i(x) = {x_i}^{-\theta} w_i l_i (x)$.

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 equation (1) below where γ is a collection of constants.

Trade shares are denoted by D_{ij}. Fraction D_{ij} of country i's per capita spending is spent on country j's goods. Using some properties of exponential distribution we get the expression for trade share which is abstracted from constants. Equation (2) shows the expression for trade shares.

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

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

By normalizing Equation (2) by country *j*'s home trade share D_{jj} , we get Equation (3). That will be basis for recovering trade costs. Since we have data on prices (ICP price measures) and trade shares, trade costs can be recovered from that equation without imposing any restriction on the form of these costs.

$$\left(\frac{D_{ij}}{D_{jj}}\right)^{-\theta} \left(\frac{p_i}{p_j}\right) = \tau_{ij} \qquad (3)$$

3. Data and Analysis

Following Eaton and Kortum (2001), capital goods are associated with the output of the nonelectrical equipment, electrical equipment, and instruments industries (3 digit Standard International Trade Classification (SITC) codes; 382, 383 and 385, Bureau of Economic Analysis (BEA) codes; 20-27 and 33). Table 3 presents capital goods according to this classification.

Table 4 presents some basic statistics about trade in capital goods and manufactures. The table reports both capital goods imports as a percentage of capital goods absorption and total manufactures imports as a percentage of manufactures absorption. For each country, absorption is calculated as gross production plus imports less exports. I use bilateral trade data compiled by Feenstra, Lipsey and Bowen (1997). Gross production data come from UNIDO Industrial Statistics Database (2001) or OECD Stan (2005) database. For capital goods I aggregate goods with BEA codes 20-27 and 33. For manufactures I aggregate all 34 BEA codes. This provides the aggregate value of capital goods and manufactured goods that each country purchases from each other. If we compare the first column with the second, we see that investment goods imports as a percentage of absorption exceeds the import share for total manufactures, generally by a substantial amount. Capital goods prove to be a highly traded component of manufactures.

To recover trade costs from the equation (3) we need bilateral trade shares and price data. Price data come from United Nation's International Comparison Program (ICP). I use trade and production data to construct bilateral trade shares. The details are given below.

Following Bernard, Eaton, Jensen and Kortum (2003) and D_{ij} 's are calculated as the ratio of country *i*'s total imports from country *j* (aggregating across BEA codes of 20-27 and 33 gives the aggregate value of capital goods that each country buys from each other) to gross production in country *i*, plus country *i*'s all imports from the sample countries minus country *i*'s total exports to whole world. Equation 4 and equation 5 show how D_{ij} and D_{ii} are calculated.

$$D_{ij} = \frac{Imports_{ij}}{GrossProduction_i + Imports_i - TotalExports_i} \qquad (4)$$

$$D_{ij} = 1 - \sum_{j \neq i} D_{ij} \qquad (5)$$

The United Nations International Comparison Program (ICP) collects prices on goods and services in various countries and benchmark years which are used in the construction of the Penn World Table. These prices are national average prices for the same or similar goods across countries (Waugh 2007). 1996 is the most recent year in which United Nations' International Comparison Program (ICP) provides price measures for 115 countries. In 1980 and 1985 ICP provides price measures for 61 and 64 countries respectively.

There are 53 × 52 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.

After having the ICP price data and calculating bilateral trade shares according to equation 3 to recover trade costs, I need to select a value for θ. Alvarez and Lucas (2007) use a value of 0.15 as a baseline. The analysis is carried out for θ = 0.10, 0.15 and 0.20.

Table 1 presents the summary statistics for θ = 0.10, 0.15 and 0.20. We see that the higher θ is the higher the trade costs are. Table 2 reports some recovered values of τ_{ij} for some country combinations. The trade costs between the United States and Canada is lower than the median 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. For the recovered values between the United States and Turkey, it is definitely more expensive for the United States to import from Turkey than it is for Turkey to import from the United States. 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. We can see this relationship from the Figure 2.

The average trade cost that country *i* faces when importing a good is denoted by $\hat{\tau}_i$ which is given in equation (6). Add-valorem tariff rate equivalent of $\hat{\tau}_i$ is calculated as ($\hat{\tau}_i$ -1) × 100. Figure 1 plots add-valorem tariff rate equivalent of $\hat{\tau}_i$ 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)

$$\hat{\tau}_i = \frac{1}{N}\sum_{j=1}^{N}\tau_{ij} \qquad (6)$$

Figure 1 illustrates that the average cost to importing a good does not vary too much with income level.

The average trade cost that countries face when importing a good from country *j* is denoted by $\hat{\tau}_j$ which is given in equation (7). Add-valorem tariff rate equivalent of $\hat{\tau}_j$ is calculated as ($\hat{\tau}_j$ -1) × 100. Figure 2 plots add-valorem tariff rate equivalent of $\hat{\tau}_j$ 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).

$$\hat{\tau}_j = \frac{1}{N}\sum_{i=1}^{N}\tau_{ij} \qquad (7)$$

From figure 2 we see that on average it is cheaper to import from a rich country than it is for a good to be imported from a poor country. This finding is in agreement with the data since developing countries import the bulk of their capital goods from some developed countries.

Table 1. Trade Costs, Summary Statistics

	θ = 0.10	θ = 0.15	θ = 0.20
τ_{ij}, Median	2.18	3.07	4.37

Table 2. Trade Costs, For Some Country Pairs

	θ = 0.10	θ = 0.15	θ = 0.20
$\tau_{US,Canada}$	1.43	1.65	1.91
$\tau_{Canada,US}$	1.01	1.02	1.05
$\tau_{US,Argentina}$	2.54	4.03	6.39
$\tau_{Argentina,US}$	1.15	1.24	1.34
$\tau_{US,Turkey}$	2.35	3.61	5.54
$\tau_{Turkey,US}$	1.35	1.57	1.82

Figure 1. Ad Valorem Tariff Rate Equivalent of $\hat{\tau}_i$ vs GDP per Worker, (Normalized with U.S. GDP per worker)

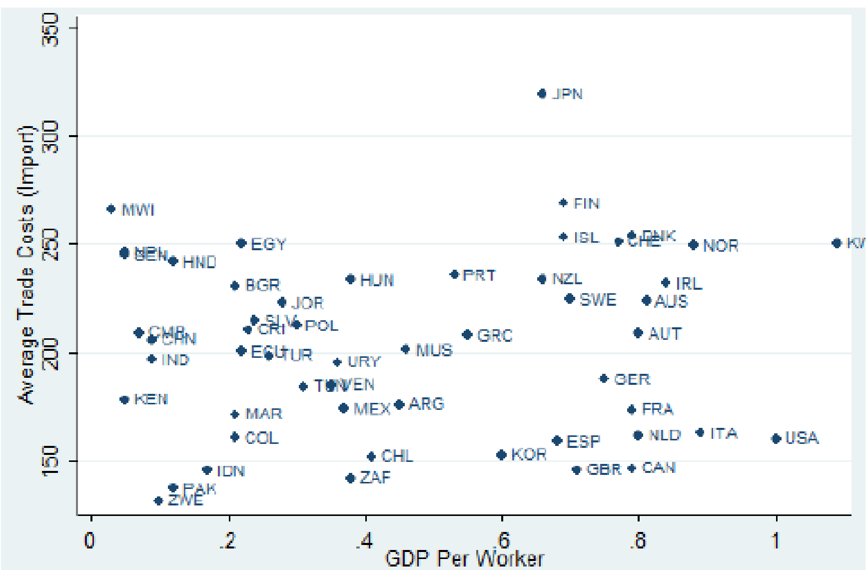
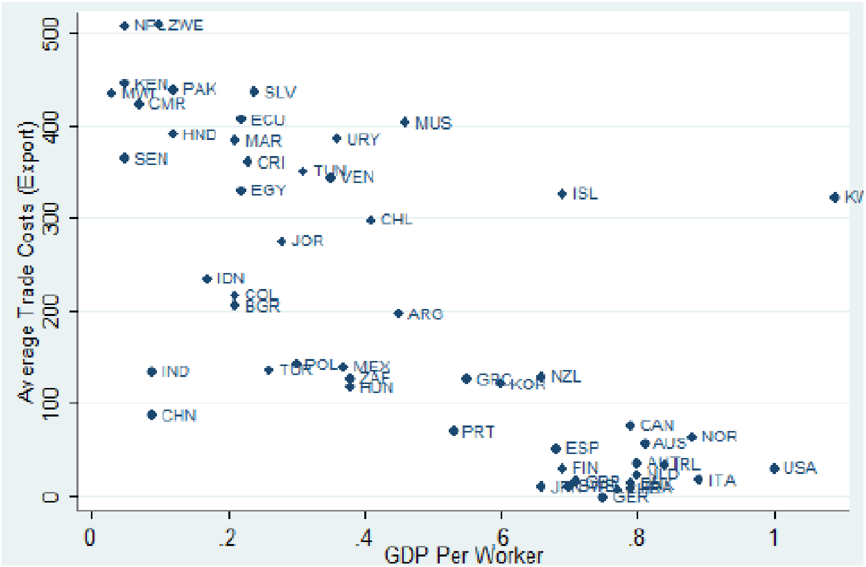


Figure 2. Ad Valorem Tariff Rate Equivalent of $\hat{\tau}_j$ vs GDP per Worker, (Normalized with U.S. GDP per worker)



4. Conclusion

In the literature it is pointed out that developing countries purchase a bulk of equipment from the leading R&D intensive capital goods exporter countries. Countries face barriers in the form of trade costs. These costs incorporate both policy related costs for example tariffs and non-policy related costs for example transportation costs.

I employ Multi-Country Ricardian Model of Eaton and Kortum (2002) and Alvarez Lucas (2007) to derive a close form for the asymmetric bilateral trade costs. I derive asymmetric bilateral trade costs for a cross section of 53 countries in 1996 using bilateral trade data and ICP prices.

The analysis with the recovered trade costs suggests that, on average 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. This is consistent with the fact that developing countries import the bulk of their capital goods from the major exporter countries.

List of 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)

Table 3. Investment Goods

BEA	Industry	ISIC, Rev.2
20	Farm and garden machinery	382
21	Construction, mining, etc machinery	382
22	Computer and office equipment	382
23	Other non-electric machinery	382
24	Household appliances	383
25	Household audio and video, etc	383
26	Electronic components	383
27	Other electrical machinery	383
33	Instruments and apparatus	385

Table 4. Imports as a Percentage of Absorption

Country	**Capital Goods**	Manufactures	Country	**Capital** Goods	Manufactures
South	61.88	23.69	Korea	34.05	19.37
Morocco	**75.94**	33.64	Nepal	80.57	37.10
Tunisia	**77.48**	36.23	Pakistan	65.63	36.27
Egypt	**63.79**	30.05	China	25.48	11.65
Cameroon	**97.81**	40.39	Denmark	73.32	49.17
Kenya	40.54	17.83	France	60.16	33.83
Malawi	92.79	58.12	Germany	51.89	34.36
Mauritius	93.40	52.74	Greece	77.57	45.87
Senegal	95.48	45.82	Ireland	84.45	69.50
Zimbabwe	84.50	40.99	Italy	53.32	30.41
Canada	63.97	45.90	Netherlands	79.23	76.00
Argentina	49.26	15.28	Portugal	64.59	36.01
Chile	82.81	31.71	Spain	55.55	28.29
Colombia	79.92	27.38	UK	59.30	34.70
Ecuador	84.05	37.29	Austria	66.32	50.86
Mexico	86.07	39.16	Finland	62.66	32.67
Uruguay	80.51	28.06	Iceland	83.01	57.70
Venezuela	76.40	25.44	Norway	66.36	40.72
CostaRica	73.97	45.74	Sweden	66.76	47.34
ElSalvador	83.43	53.81	Switzerland	48.96	45.44
Honduras	94.90	50.82	Bulgaria	53.75	32.00
Japan	7.37	6.61	Hungary	62.98	43.79
Jordan	89.37	44.49	Poland	52.78	29.00
Kuwait	93.24	45.43	Australia	61.60	25.19
Turkey	60.62	27.77	NewZealand	67.25	34.64
India	23.00	10.02	USA	15.06	14.10
Indonesia	69.77	27.76			

References

ALVAREZ, F., and R. J. LUCAS (2007) "General equilibrium analysis of the Eaton- Kortum model of international trade," **Journal of Monetary Economics**, 54 (6) pp. 1726-1768.

ANDERSON, J., and E. van WINCOOP (2004) "Trade Costs," **Journal of Economic Literature**, pp. 691-751.

BERNARD, A., J. EATON, J. B. JENSEN, and S. KORTUM (2003) "Plants and Productivity and International Trade," **American Economic Review**, 93, 1268-1290.

COE, D., and E. HELPMAN (1995) "International R&D Spillovers," **European Economic Review**, 39 pp. 859-887.

EATON, J., and S. KORTUM (2001) "Trade in Capital Goods", **European Economic Review**, 45, 1195-1235.

EATON, J., and S. KORTUM (2002) "Technology, Geography, and Trade," **Econometrica**, 70, 1741-1779.

FEENSTRA, R., R. LIPSEY, and H. BOWEN(1997) "World Trade Flows, 1970-1992, with Production and Tariff Data," Working Paper No. 5910, NBER.

HESTON, A., R. SUMMERS, and B. ATEN (2002) "Penn World Table Version 6.1," Discussion paper, Center for International Comparisons at the University of Pennsylvania (CICUP).

KELLER, W. (2004) "Technology Diffusion", **Journal of Economic Literature**, 42 (3) 752-782.

OECD (2005) Structural Analysis Database (STAN).

UNIDO (2001): Industrial Statistics Database. United Nations Industrial Development Organization.

United Nations International Comparison Programme (2003): ICP 2003-2006 Handbook.

WAUGH, M. (2007) "Bilateral Trade, Relative Prices, and Trade Costs", Working Paper. University of Iowa.

WAUGH, M. (2009) "Trade and Income Differences", Working Paper. University of Iowa.