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Empirical Estimated of Trade Costs for Asia

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Abstract

In this paper, we determine how policy and environmental barriers affect international trade, using data at 4-digit HS. We estimate a modified gravity equation, controlling for remoteness, for eight sectors in 10 Asian countries. Looking at the impact of the 'non-price' and 'price' factors on international trade, this paper finds that country's tariff, infrastructure quality and transport costs are the main three determinants for cross-country variations of trade flows. The major findings of the paper can be summarised as follows: (i) bilateral infrastructure quality is a principal determinant of trade performance, (ii) bilateral tariffs, which are largely ignored in the empirical gravity literature in context of Asia, has an impact on trade, (iii) the bilateral transport costs strongly influence the trade flows, and (iv) except transport equipment, trade in all other manufacturing sectors, considered in this study, are influenced by tariffs, transport costs and infrastructure quality.

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1. Introduction

Trade costs have become a key area for reform in regional and multilateral context mainly due to the rise in volume and complexity of international trade. Trade costs include all costs incurred in getting a good to a final user other than the marginal cost of producing the good itself, such as transportation costs (both freight costs and time costs), policy barriers (tariffs and non-tariff barriers), information costs, contract enforcement costs, costs associated with the use of different currencies, legal and regulatory costs, and local distribution costs (wholesale and retail). Trade costs form a potentially important barrier to trade, and some of these are captured in Table 1.

Table 1: Trade Costs and Infrastructure Interventions

Type of Trade Costs	Type of Barriers	Infrastructure Intervention
Transport cost	Hard / Visible	Port, Shipping, Road, Rail, Aviation
Time in transit	Hard / Visible	Port, Shipping, Road, Rail, Aviation
Freight insurance	Soft / Invisible	Insurance regulation
Customs delays	Soft / Invisible	Harmonisation of customs procedures
Unofficial payments	Soft / Invisible	Governance reform
Information search	Soft / Invisible	Investment climate
Currency changes (cost of hedging)	Soft / Invisible	Financial sector regulation
Management of supply chain	Hard / Visible and Soft / Invisible	Telecommunications, investment climate, regulatory environment
Excess inventories	Hard / Visible and Soft / Invisible	Port, Shipping, Road, Rail, Aviation, Harmonisation of customs procedures

Source: Adopted from Khan and Weiss (2006)

Why we need to give special attention to trade costs? One compelling argument is that countries will not fully realize the gains from trade liberalisation unless they also initiate adequate infrastructure interventions in order to reduce costs of doing trade across borders. For example, reductions in tariff levels – at home and abroad – will offer fewer benefits to economies whose international trading infrastructures are ill-equipped to handle increased imports or clear exports quickly enough.

Therefore, higher trade costs is an obstacle to trade and it impedes the realization of gains from trade liberalisation.[1] Studies show that integration is the resultant of reduced costs of transportation in particular and other infrastructure services in general.[2] Direct evidence on border costs shows that tariff barriers are now low in most countries, on average (trade-

[1] A growing literature has documented the impact of trade costs on the volume of trade. Refer, Anderson and van Wincoop (2004) for the major seminal works carried out on this subject.
[2] See, for example, Khan and Weiss (2006), which explain how and why infrastructure can assist the regional cooperation process.

weighted or arithmetic) less than 5 percent for rich countries, and with a few exceptions are on average between 10 to 20 percent for developing countries (Anderson and van Wincoop, 2004). While, in one hand, the world has witnessed drastic fall in tariffs over the last two decades, a whole lot of barriers, on the other, remain and do penalising trade, among which some are seen as policy barriers, such as tariff and non-tariff barriers (NTBs), and others seen as barriers relating to environment, such as infrastructure quality.[3] In policy formulation, one set of such policy barriers (soft barriers) are dealt through measures in trade and business facilitation, whereas the set of barriers relating to environment (hard barriers) is managed through transport facilitation measures. Improvements in infrastructure can lower these barriers and thus, declines in such costs make goods more cost competitive and raise the return on investment (Khan and Weiss, 2006).

Table 2: Intra- and Inter- Regional Merchandise Trade in 2005

Origin (↓)	Destination (→)							
	North America	South & Central America	Europe	CIS*	Africa	Middle East	Asia	World
Value (US$ billion)								
Asia	608	51	498	37	54	89	1424	2779
World	2093	301	4398	224	240	321	2443	10159
Share of inter-regional trade flows in each region's total merchandise exports (%)								
Asia	21.9	1.9	17.9	1.3	1.9	3.2	51.2	100.0
World	20.6	3.0	43.3	2.2	2.4	3.2	24.0	100.0
Share of regional trade flows in world merchandise exports								
Asia	6.0	0.5	4.9	0.4	0.5	0.9	14.0	27.4
World	20.6	3.0	43.3	2.2	2.4	3.2	24.0	100.0

Notes: *Commonwealth of Independent States
Source: WTO (2006)

Therefore, today's trade strategy goes beyond the traditional mechanisms of tariffs and quotas, and includes "behind-the-border" issues, such as the role of infrastructure and governance in supporting a well-functioning trading economy. The attention is now focused to lowering trade costs through facilitation of merchandise and services trade logistics, both inbound and outbound.[4] Given this awareness, trade costs are, therefore, cited as an important determinant

[3] In literature, policy barriers are termed as 'soft' or 'invisible' barriers, while barriers relating to environment are noted as 'hard' or 'visible' barriers.
[4] Trade facilitation (TF) measures are also used differently in literature dealing with the World Trade Organisation (WTO) issues. Typical TF measures are very narrow in a sense to deal the barriers to trade in goods and services. According to the World Bank, "there is no standard definition of trade facilitation. In a narrow sense, trade facilitation simply addresses the logistics of moving goods through ports or more efficiently moving customs documentation associated with cross-border trade. In recent years, the definition has been broadened to include the environment in which trade transactions take place, including the transparency and professionalism of customs and regulatory environments, as well as harmonization of standards and conformance to international or regional regulations." (World Bank, 2006a)

of the volume of international trade, and specialisation.[5] Indeed, more the countries economically progress forward, and commit sincerely to remove barriers to trade, as the way it happened in some parts of the European Union (EU), assessing the size and shape of the trade costs will help countries to strengthen economic integration process. Therefore, trade costs indeed play a crucial role in policy formation as the optimality of preferential trade arrangements depends on the size and shape of "natural" trade barriers (Krugman, 1991).

Table 2: Merchandise Exports of Asia by Product

Product	**Share in Exports of Asia (%)**		**Share in Eorld Exports (%)**	
	2000	**2005**	**2000**	**2005**
Total merchandise exports	100.0	100.0	26.4	27.4
Agricultural products	6.1	5.6	18.3	18.1
Fuels and mining products	7.6	9.1	14.5	14.4
Manufactures	84.2	83.1	29.7	31.6
Iron and steel	2.2	3.0	24.9	26.5
Chemicals	6.1	7.4	17.3	18.5
Pharmaceuticals	0.5	0.6	8.1	6.2
Other chemicals	5.6	6.7	19.4	22.5
Other semi-manufactures	5.6	5.8	20.5	22.8
Machinery and transport equipment	51.2	48.6	32.2	35.1
Office and telecom equipment	27.5	25.2	47.2	54.9
EDP and office equipment	10.7	9.0	47.7	53.9
Telecommunications equipment	6.2	8.0	35.8	47.7
Integrated circuits	10.6	8.2	57.2	66.0
Transport equipment	10.2	10.2	20.3	21.9
Automotive products	6.9	7.0	19.8	21.3
Other transport equipment	3.3	3.2	21.3	23.2
Other machinery	13.4	13.2	26.7	28.7
Textiles	4.2	3.4	44.2	46.7
Clothing	5.5	4.7	46.4	47.7
Other manufactures	9.5	10.1	29.6	33.0
Personal and household goods	2.2	2.3	31.4	36.2
Scientific and controlling instruments	1.6	2.5	22.4	32.7
Miscellaneous manufactures	5.8	5.3	31.8	31.9

Source: WTO (2006)

Trade volume in Asia has been rising fast. To date, about 51 percent of Asia's exports are conducted within the region (Table 2), and about 27 percent of world exports come from Asia, which was about 18 percent when China started liberalising her economy in 1978 and about

[5] For example, according to Hummels *et. al* (1999), trade costs do explain the rise of vertical specialisation.

26 percent when India adopted liberal trade regime in 1991. The composition of trade in Asia is also changing fast. Asia is gradually specialising in trade in intermediate and finished products. About 54 percent of world exports of EDP and office equipment come from Asia (in 2005), which was about 48 percent in 2000, and 66 percent of world exports in integrated circuits are contributed by Asian countries (Table 3). These are the high-end products where cost of international trade is appeared to be high, if barriers at both ends are counted (De, 2007).

Considering the rise in trade interdependence in Asia, the need for a pan-Asian FTA in the region has gained high momentum in recent years. This has been reflected in a growing number of studies conduced in last few years aiming to find out the feasibility of an FTA in Asia.[6] On the demand side, the noticeable development is that, as a result of trade liberalisation, tariff level in Asia has become low. However, on the supply side, question remains whether or not the Asia as a region witnesses decline in 'trade costs'. Apparently, despite technological advancement, cost of movement of goods across countries has not fallen.[7] Venables (2006) commented: "technical change in shipping is no longer faster than technical change in goods shipped, so freight rates relative to shipment value are no longer falling".

Since the countries in Asia are planning to intensify regional cooperation through FTAs[8], these countries should display smaller trade costs. FTAs are expected to put added competitive pressure on Asian economies, particularly on trade and through which investments. To gain anything from liberalised trade regime in Asia, there is an urgent need to control trade costs. Declines in trade costs will not only multiply the welfare emanating from the liberalized trade environment but also strengthen the trade capacity of the region. Therefore, gaining a fair idea about the factors that contribute to trade costs will help Asian countries to take more accurate and appropriate infrastructure interventions.

Asian countries performance in controlling trade costs, relative to European Union (EU), has not progressed well. Despite a fall in absolute base ocean freight, auxiliary shipping charges are increasingly becoming critical to trade in Asia.[9] Table 4 indicates that while ocean freight

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[6] Refer, ADB (2005, 2006).

[7] By technological advancement, here, we mean, for example, bigger vessels plying across ports.

[8] In 2005, about 36 bilateral agreements from Asia were notified to WTO, which was only 3 involving developing Asia before 1995, whereas 46 agreements are yet to be notified to WTO, and further 42 agreements are being negotiated (ADB, 2006).

[9] According to De (2007), about 60 percent of total shipping costs for movement of a containerised cargo in Asia in 2005 was charged by shipping lines as base ocean freight; 28 percent as container

for movement of vessels from three Northeast Asian countries to selected Asian countries has been reduced during the period 2003 and 2005, auxiliary shipping charges have witnessed steep rise.

Table 4: Trends in Ocean Freight in Selected Asian Countries[1]

Origin	Destination	Base Ocean Freight		Auxiliary Charges[2]		Total	
		2003	2005	2003	2005	2003	2005
		(US$ per TEU)					
Japan	China	250	275	178	223	428	498
Japan	Korea	300	275	238	289	538	564
Japan	Hong Kong	196	200	419	425	615	625
Japan	Malaysia	366	375	244	296	610	671
Japan	Singapore	312	325	307	321	619	646
Japan	India	1546	1600	489	523	2035	2123
Japan	Thailand	312	275	232	258	544	533
China	Japan	900	800	162	366	1062	1166
China	Korea	300	500	190	240	490	740
China	Hong Kong	412	400	331	345	743	745
China	Malaysia	620	600	213	217	833	817
China	Singapore	410	400	240	241	650	641
China	India	2109	2000	288	302	2397	2302
China	Thailand	608	600	166	180	774	780
Korea	Japan	300	400	218	262	518	662
Korea	China	250	350	203	220	453	570
Korea	Hong Kong	444	450	419	422	863	872
Korea	Malaysia	388	400	267	282	655	682
Korea	Singapore	398	400	309	318	707	718
Korea	India	2010	1950	517	528	2527	2478
Korea	Thailand	395	400	251	255	646	655

Notes: 1. Rates are collected for shipment of a 20' container (TEU) among country's major ports. Rates are averaged for the year 2005. 2. Including container handling charges, documentation fees, government taxes and levies, etc. of both the trading partners.
Source: De (2007)

To a great extent, auxiliary shipping charges often overtake base ocean freight (see, Figure 1). These auxiliary charges are nothing but outcome of market imperfections, and obviously have negative effect on trade. While some auxiliary charges are market driven, such as terminal handling charges, imposition of government duties and levies on ocean freight (similar to tariffs) is very much *ad hoc* and offers less 'economic rationale'. Size and the level of duties and levies also differ across countries. On an average, 3 percent was imposed as government duties and levies on ocean freight in 2005. Apparently, the rates of government duties and levies are relatively more on the freight between Japan and countries in Northeast and Southeast Asia, where the volume of two-way trade is also high.

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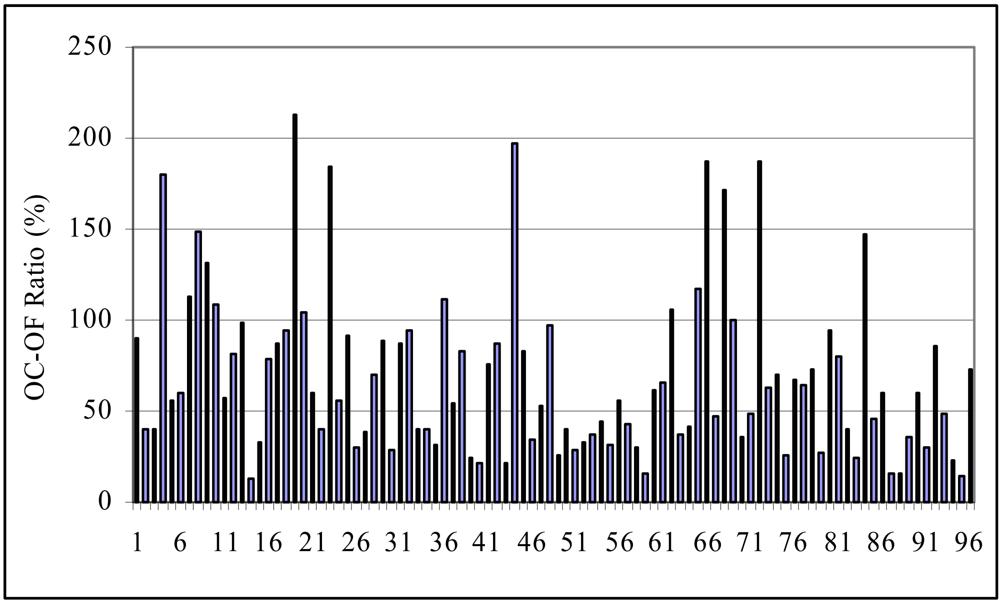
handling charges, recovered by the terminal or port operators; and about 3 percent as government duties and taxes.

Expectedly, the rise in auxiliary shipping charges is thus not only offsetting the gains arising from tariff liberalisation, but also making the entire trade costlier. A major part of these auxiliary shipping charges like documentation fees, government taxes and levies, etc. are the 'soft' barriers to trade and very much implicit in system, on which shippers (exporters and importers) have less control. Countries that cannot or will not control auxiliary shipping charges, their exports may lose markets to rivals. This provides opportunities for cross-border cooperation, which ultimately lead to a reduction in trade costs.

Figure 1: Variations in Shipping Rates in Selected Asian Countries in 2005



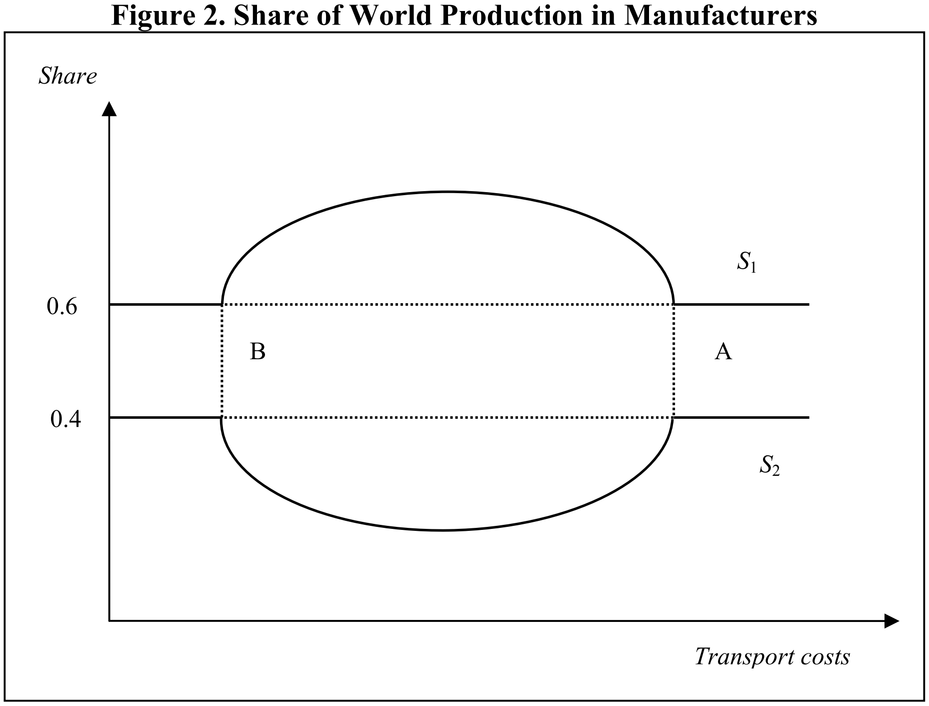
Note: Total number of observations is 97, taken in bilateral pairs. OF and OC refer ocean freight (base) and other charges (auxiliary), respectively, for a shipment of a container (TEU) in bilateral trading pair in 10 selected Asian countries for the year 2005.
Source: Calculated based on freight rates, provided by Maersk Sealand (2006)

In view of above, this paper attempts to assess the relative importance of trade costs in context of selected Asian countries. The remainder the paper is organised as follows. Section 2 offers a quick overview of theoretical discourse on trade costs, particularly in context of new trade theory. This discussion is relevant here since we attempt to assess the impact of trade barriers on trade flows. Data and Methodology are briefed in Section 3. An assessment of the relative importance of trade costs is done in Section 4. Finally, conclusions are briefed in Section 5.

2. Trade Costs and New Trade Theory

In traditional trade theory, it is customarily assumed that trade takes place between countries which have no spatial dimensions.[10] The *neo-classical trade theory* completely ignores the transport costs, and considers some assumptions which have comparatively less relevance in today's complex trade issues. For example, in the *factor abundance model*, which is popularly known as Heckscher, Ohlin and Samuelson (HOS) model, comparative advantage is determined by cross-country differences in relative abundance of factor endowments. HOS model uses some assumptions such as perfect competition, homogeneous goods, production with constant returns to scale, no transport costs, and mobility of factors between industries and not between countries. In *new trade theory*, transport cost is incorporated as a factor of determinant, where trade is analyzed in models in a world of increasing returns to scale, and monopolistic competition (Dixit and Stiglitz, 1977).[11] Therefore, one of the implications of the new trade theory is growing interdependence between countries through increased trade and/or increased factor mobility where transport costs play a pivotal role in integrating the countries and/or factors.

Figure 2. Share of World Production in Manufacturers



Source: Krugman and Venables (1990)

[10] Correspondingly, locational problems have also been neglected in the theory of customs unions (see, Balassa, 1961).
[11] Refer, Krugman (1979, 1980); Bhagwati, Panagariya and Srinivasan (1998)

However, to a great extent, foundation of new trade theory was laid down by Samuelson (1952) when he introduced the concept of *iceberg* transport costs.[12] The whole set of literature on new trade theory introduces the importance of transport costs in explaining cross-country trade and movement of factors, the notable of which are Krugman and Venables (1990) and Krugman (1991). They show how an increase in the degree of economic integration (using a fall in transport costs as a proxy) affects the countries engaged in trade. Figure 2 shows how it occurs. In a two-country model, Krugman and Venables show that in autarky (when high transportation costs prohibit trade) both countries have a share in the manufacturing sector equal to their share in world endowments.[13] The difference in endowments is given in segments A and B in Figure 2. It turns out that for an intermediate range of transport costs, economic integration strengthens the country 1. As shown in Figure 2, country 1's share of world industry S_1 gets larger than its share of world endowments and vice versa for country 2 ($S_2 < 0.4$). As a result, given the larger market size and minimisation of transport costs, new firms prefer country 1 even though wages are higher. As transport costs continue to fall, country 1's share of world industry eventually starts to decrease again. At very low transport costs, the advantage of producing in the country with the larger market (here, country 1) becomes small, which combined with the stiffer labour market competition in country 1 implies that new firms find it profitable to start production in country 2 where wages are lower. At the extreme zero transport costs, wages will be equal and each country's share of manufactures will return to its share in world endowments. There is thus a non-linear relationship between a country's share in world industry and transport costs in which the shares always sum to one.

Trade costs are reported in terms of their ad-valorem tax equivalent. In Anderson and van Wincoop's (2004) term: the 170 percent 'representative' trade costs in industrialized countries breaks down into 21 percent transportation costs, 44 percent border related trade barriers and 55 percent retail and wholesale distribution costs (Figure 3).

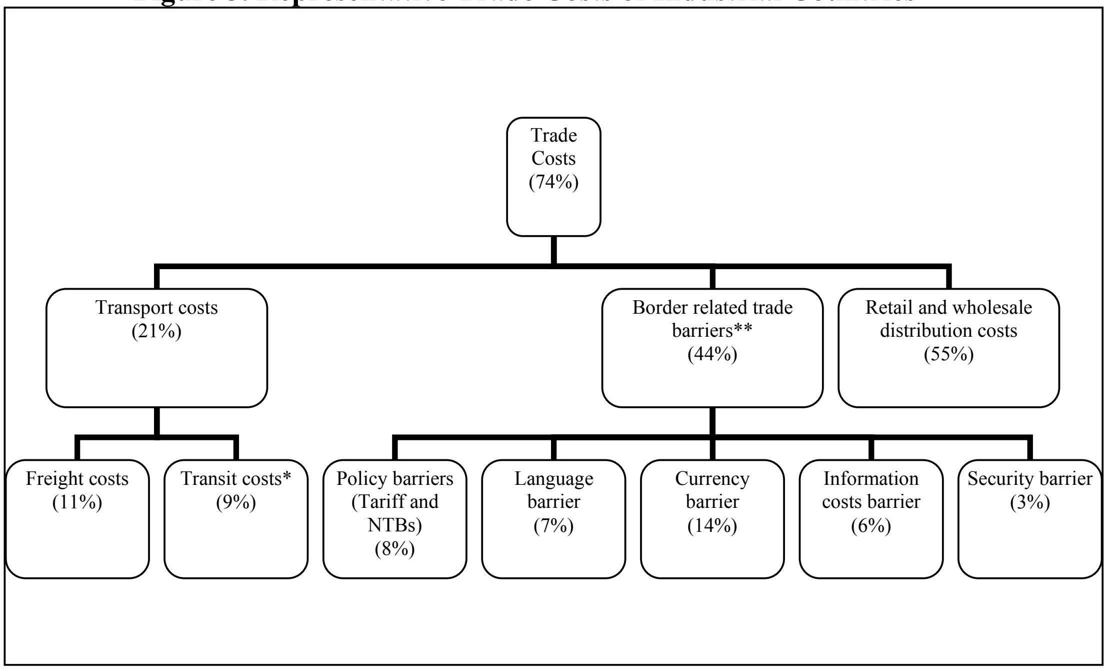
In general, an exporter or importer incurs trade costs in all the phases of the export or import process starting from obtaining information about market conditions in any given foreign

[12] Samuelson's *iceberg* transport cost implies that a fraction of the manufactured goods does not arrive at the destination when goods are shipped between the regions. The fraction does not arrive represents the costs of transportation.

[13] Basic assumptions of Krugman and Venables (1990) are as follows: country 1 is larger than country 2 in terms of factor endowments (capital and labour) and market size. In both countries, there are two sectors, both producing tradable goods, one perfectly competitive and the other, producing manufactures, imperfectly competitive. Country 1 has larger number of firms in the manufacturing sector. This sector produces differentiated products under increasing returns to scale and monopolistic competition. The relative factor endowments are same for both the countries, so there is no comparative advantage and trade is of the intra-industry type.

market and ending with receipt of final payment. One part of the trade cost is trader specific and depends upon his/her operational efficiency. The magnitude of this trade cost diminishes with an increase in the efficiency level of the trader, under the prevailing framework of any economy.

Figure 3. Representative Trade Costs of Industrial Countries



Notes: *Tax equivalent of the time value of goods in transit. Both are based on estimates for US data. ** The combination of direct observation and inferred costs, which, according to author, is an extremely rough breakdown.
Source: Drawn from Anderson and van Wincoop (2004)

The other part of trade costs is specific to the trading environment and is incurred by the traders due to in-built inefficiencies in the trading environment. It includes institutional bottlenecks (transport, regulatory and other logistics infrastructure), information asymmetry and administrative power that give rise to rent seeking activities by government officials at various steps of transaction. This may cost traders (or country) time and money including demurrage charges, making transactions more expensive.

Trade costs are large, even aside from trade policy barriers and even between apparently highly integrated economies. In explaining trade costs, Anderson and van Wincoop (2004) referred the example of Mattel's Barbie doll, discussed in Feenstra (1998), indicated that the production costs for the doll were US$ 1, while it sold for about US$ 10 in the United States. The cost of transportation, marketing, wholesaling and retailing represent an ad-valorem tax equivalent of 900 percent. Anderson and van Wincoop (2004) commented: "Tax equivalent of representative trade costs for rich countries is 170 percent. This includes all transport, border-related and local distribution costs from foreign producer to final user in the domestic country. Trade costs are richly linked to economic policy. Direct policy instruments (tariffs, the tariff equivalents of quotas and trade barriers associated with the exchange rate system) are less important than other policies (transport infrastructure investment, law enforcement and related property rights institutions, informational institutions, regulation, language)."

Direct transport costs include freight charges and insurance, which is customarily to the freight charge. Indirect transport user costs include holding cost for the goods in transit, inventory cost due to buffering the variability of delivery dates, preparation costs associated with shipment size (full container load vs. partial loads) and the like. Indirect costs must be inferred. Alongside tariffs and NTB's, transport costs look to be comparable in average magnitude and in variability across countries, commodities and time.

Trade costs have large welfare implications. Current policy related costs are often worth more than 10 percent of national income (Anderson and van Wincoop, 2002). Obstfeld and Rogoff (2000) commented that all the major puzzles of international macroeconomics hang on trade costs. Some of the studies, for example, APEC (2002), OECD (2003), and Francois *et al*. (2005), estimate that for each 1 percent reduction of trade transaction costs, world income could increase by US$ 30 to 40 billion.

Some studies have indicated that the cost of trade, specifically trade documentation and procedures, is high, between 4 to 7 percent of the value of goods shipped. In 1996, APEC conducted a study that highlighted the gain from effective trade facilitation. For example, the gains from streamlining customs procedures exceeded those resulting from trade liberalization, such as tariff reduction. Gains from effective trade facilitation accounted for about 0.26 percent of real GDP of APEC members (about US$ 45 billion), while the gains from trade liberalization would be 0.14 percent of real GDP (about US$ 23 billion).[14] According to the World Bank, raising performance across the region to halfway up to the level of the APEC average could result in a 10 percent increase in intra-APEC exports, worth roughly US$ 280 billion (World Bank, 2002).

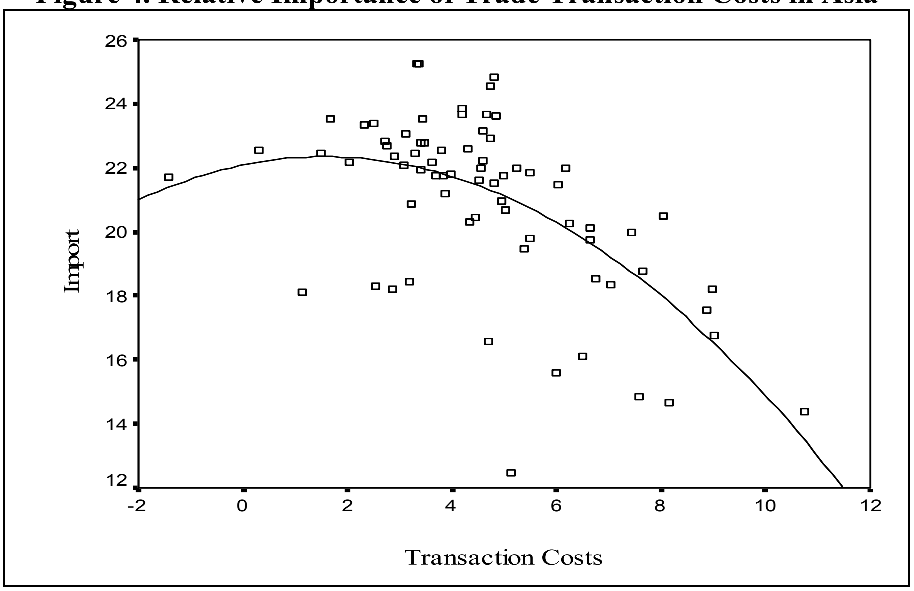
Details of trade costs also matter to economic geography. For example, the home market effect hypothesis (big countries produce more of goods with scale economies) hangs on differentiated goods with scale economies having greater trade costs than homogeneous goods

[14] Similar indications were obtained for countries in APEC (Cernat, 2001; World Bank, 2002; Wilson *et al*, 2003).

(Davis, 1998). The cross-commodity structure of policy barriers is important to welfare (e.g., Anderson, 1994).

In dealing with cross-country trade, influenced by *new trade theory*, several studies have explicitly considered transport costs such as Bergstrand (1985, 1989), Krugman (1991), Davis (1998), Deardorff (1998), Limao and Venables (2001), Fink *et al*., (2002), Clark, Dollar and Miucco (2004), Redding and Venables (2004), Hummels (1999a, 1999b, 2000), Wilson *et al*, (2003), De (2006a, 2006b, 2007), to mention a few.

Figure 4. Relative Importance of Trade Transaction Costs in Asia



Note: Import and transaction costs are based on pooled bilateral trading pairs for 15 Asian economies for the year 2004.
Source: De (2006b)

Poor institutions and poor infrastructure penalize trade, differentially across countries. While dealing barriers to trade, there are some studies which have explicitly emphasised quality of infrastructure (as a proxy of trade costs), associated with cross-country trade. Country's infrastructure plays vital role in carrying trade. For example, by incorporating transport infrastructure in a two-country Ricardian framework, Bougheas *et al.* (1999) have shown the circumstances under which it affects trade volumes. According to Francois and Manchin (2006), transport and communication infrastructure and institutional quality are significant determinant not only for country's export levels but also for the likelihood exports. Nordås and Piermartini (2004) shown that quality of infrastructure is an important determinant of trade performance wherein port efficiency alone has the largest impact on trade among all indicators of infrastructure. De (2005) provided evidence that transaction cost is an important determinant in explaining variation in trade in Asia. In addition, this author also found that port efficiency and infrastructure quality are two important determinants of trade costs in context of selected Asian countries. De (2006b) found a negative non-linear relationship between transaction costs and imports in context of 15 Asian economies for the year 2004 (see, Figure 4). This relationship clearly points to the fact that transaction costs do influence trade. In another study, De (2007) also showed that the propensity to increase the trade in context of selected Asian countries is higher with reduction of transport costs, rather than tariff reduction.[15]

The infrastructure variables have explanatory power in predicting trade volume. Limao and Venables (2001) emphasized the dependence of trade costs on infrastructure, where infrastructure is measured as an average of the density of the road network, the paved road network, the rail network and the number of telephone main lines per person. A deterioration of infrastructure from the median to the 75th percentile of destinations raises transport costs by 12 percent. The median landlocked country has transport costs which are 55 percent higher than the median coastal economy.[16] Inescapably, understanding trade costs and their role in determining international trade volumes must incorporate the internal geography of countries and the associated interior trade costs.

Many commentators indicate that the success of trade liberalisation will always be suboptimal if transport cost is not controlled. The World Trade Organisation (WTO, 2004) commented: "the effective rate of protection provided by transport costs in many cases higher than that provided by tariffs". According to the World Bank (2001), for 168 out of 216 trading partners of the United States, transport costs barriers outweighed tariff barriers. It is estimated by Hummels (1999b) that doubling distance increases overall freight rates by between 20 to 30 percent. Djankov *et al*. (2006) showed that on average each additional day that a product is delayed prior to being shipped reduces trade by at least 1 percent.[17] Therefore, what follows is that countries will not fully realise the gains from trade unless they also prioritize facilitation of trade and transport.

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[15] By estimating an augmented gravity model at 4-digit HS level for the year 2004, De (2007) found that a number of trade costs components, namely, infrastructure quality, tariffs, and transport costs affect international trade patterns significantly. This study shows, *inter alia*, that a reduction in tariffs and transport costs by 10 percent, each would increase bilateral trade by about 2 and 6 percents, respectively, in Asia.

[16] Bougheas *et al.* (1999) estimated gravity equations for a sample limited to nine European countries. They included the product of partner's kilometres of motorway in one specification and that of public capital stock in another and found that these have a positive particle correlation with bilateral exports.

[17] This was estimated by the authors through a structured Gravity model using newly constructed *Doing Business* Database of the World Bank on shipment of cargo from the factory gate to the ship (vessel) in 126 countries.

3. Data and Methodology

This study is undertaken in two stages. First, we provide some estimates of sector-wise trade costs for 10 Asian countries at disaggregated (4-digit HS) level.[18] We stress that the specification of the gravity equation, together with the choice of the distance measure, is crucial for evaluating the size of the barriers. Second, we estimate the impact of trade costs on selected sectors, following which, policy conclusions are drawn. In this study, we deal with selected components of trade costs which are imposed by both policy (tariff) as well as environment (transport and others). In particular, we consider tariffs, transport costs, and infrastructure quality in bilateral pairs in this paper thereby including barriers relating to both policy as well as country's environment in the model.

Measuring Sector-wise Transport Costs

Importing countries report the value of imports from partner countries inclusive of transportation charges, and exporting countries report their value exclusive of transportation charges, which measures the cost of the imports and all charges incurred in placing the merchandise aboard a carrier in the exporting port. The ratio of import and export prices provides the measure of transport costs on trade between each pair of countries. As an alternative, using the freight rate, we arrive at variation in transport costs across countries.

In this paper, to estimate bilateral transport costs two methods have been used interchangeably: (i) the difference of ad-valorem trade-weighted freight rate,[19] and (ii) the differences of inter-country costs of transportation using shipping rate, collected from shipping companies.[20]

[18] Author has created the database with the help of ARTNeT. Interested researchers may contact ARTNeT Secretariat or this author for further use of this database.

[19] Many measures have been constructed to measure transport cost. The most straightforward measure in international trade is the difference between the *cif* (cost, insurance and freight) and *fob* (free on board) quotations of trade. The difference between these two values is a measure of the cost of getting an item from the exporting country to the importing country. There is another source to obtain data for transport costs from industry or shipping firms. Limao and Venables (2001) obtained quotes from shipping firms for a standard container shipped from Baltimore to various destinations. Hummels (1999a) obtained indices of ocean shipping and air freight rates from trade journals which presumably are averages of such quotes. The most widely available (many countries and years are covered) is average ad-valorem transport costs are the aggregate bilateral *cif/fob* ratios from UN's COMTRADE database, supplemented in some cases with national data sources. Nevertheless, because of their availability and the difficulty of obtaining better estimates for a wide range of countries and years, apparently careful work such as Harrigan (1993) and Baier and Bergstrand (2001) used the IMF (COMTRADE) database.

[20] We use ocean freight rates, collected from Maersk Sealand, a shipping company which has presence across the world.

Let, t_{ij} represent costs of transportation between country *i* and *j*. We use two separate methods to estimate t_{ij}.[21] *Method I* is trade-weighted transport costs, derived from using export and import prices, whereas the *Method II* represents trade-weighted costs of transportation, estimated using cross-country shipping rates. While both the methods have been widely used to estimate transport costs, there is an explicit methodological difference between the two. The trade-weighted transport cost in *Method I* for commodity *k* is as follows.

$$t_{ij}^{k} = \left(\frac{IM_{ij}^{\;k}}{EX_{ji}^{k}} - 1 \right) S_i^{\;k} \quad (1)$$

where IM^k_{ij} stands for import price of country *i* from country *j* for the commodity *k*, EX^k_{ji} denotes export price of country *j* to country *i* for the commodity *k*, and S_i^k is the value-share of commodity *k* in country *i* in the bilateral trade (here at the 4-digit HS). In terms of the data, we use *cif* values to represent IM^k_{ij}, and *fob* values for EX^k_{ji}. As pointed out by Limao and Venables (2001), *cif/fob* data does contain information about the cross sectional variation in transport costs, and that results from using this data are quite consistent with those obtained from the shipping costs data.[22]

The trade-weighted transport costs in *Method II* is derived using

$$t_{ij}^{k} = \frac{Q_{ij}^{k} f_{ji}^{k}}{Q_{ij}} \quad (2)$$

where, Q^k_{ij} stands for import in quantity of country *i* from country *j* for the commodity *k*, f_{ji}^k stands for shipping costs of per unit of import of commodity *k* by country *i* from country *j*, and Q_{ij} is country *i*'s total import from country *j*.

[21] Here, methodology follows Limao and Venables (2001), which was adopted from Hummels (1999a).
[22] However, *cif/fob* ratio has several drawbacks. The first is measurement error; the *cif/fob* factor is calculated for those countries that report the total value of imports at *cif* and *fob* values, both of which involve some measurement error. The second concern is that the measure aggregates over all commodities imported, so it is biased if high transport cost countries systematically import lower transport cost goods. This would be particularly important if we were using exports, which tend to be concentrated in a few specific goods. It is less so for imports which are generally more diversified and vary less in composition across countries (Limao and Venables, 2001)

Measuring Quality of Infrastructure[23]

For country characteristics, we have focused on infrastructure measures – the country's ability to enhance the movement of merchandise. Here we treat infrastructure as a proxy of those costs, which are equally responsible for movement of goods across and within countries. Infrastructure facilities, arising from differential factor endowments within a country, are responsible for movement of goods. To assess impact of infrastructure facilities on bilateral trade, we have constructed an Infrastructure Index (II), comprising nine infrastructure variables for each individual country. II is designed to measure the costs of travel across a country. In theory, the export and import prices are border prices and thus it would seem that own and trading partner infrastructures as defined here should not affect these rates. It is possible that there are interactions between the variables. The simplest example is that an increase in land distance should increase the cost of going through a given infrastructure. The II was constructed based on Principal Component Analysis (PCA),[24] and it measures the relative position of a country considering a set of observables. Briefly, the II is a linear combination of the unit free values of the individual facilities such that

$$II_{ij} = \sum W_{kj} X_{kij} \quad (3)$$

where II_{ij} is infrastructure development index of the i-th country in j-th time, W_{kj} is weight of the k-th facility in j-th time, and X_{kij} = unit free value of the k-th facility for the i-th country in j-th time point.

While indexing the infrastructure stocks of the countries, we have considered following nine variables which are directly involved in moving the merchandise among countries: (i) railway length density (km per 1000 sq. km of surface area), (ii) road length density (km per 1000 sq. km of surface area), (iii) air transport freight (million tons per km), (iv) air transport, passengers carried (percentage of population), (v) aircraft departures (percentage of population), (vi) country's percentage share in world fleet (percent), (vii) container port traffic (TEUs per terminal) (viii) fixed line and mobile phone subscribers (per 1,000 people), and (ix) electric power consumption (kwh per capita). The weights of these variables, and the index, derived from the PCA, are given in Appendix 1.

[23] This sub-section is borrowed from De (2007).
[24] Refer, Fructure (1967) to know further details of PCA.

The Augmented Gravity Model

In order to explore the impact of trade costs on sector-wise trade flows, our empirical analysis has considered an augmented gravity model, since it is one of the popular partial equilibrium models known in explaining the variation of trade flows. The gravity model provides the main link between trade barriers and trade flows. The gravity equation proposed here is a sort of reduced form of an intra-industry trade model. Following Anderson and van Wincoop (2003), the baseline equation is as follows.

$$X_{ij} = \frac{Y_i Y_j}{Y_w} \left(\frac{T_{ij}}{P_i P_j} \right)^{1-\sigma} \quad (4)$$

where, Y_i Y_j and Y_w denote the aggregate size of countries *i*, *j* and the world, respectively; T_{ij} accounts for trade costs and other trade barriers; P_i and P_j reflect the implicit aggregate equilibrium prices; and σ is the constant elasticity of substitution (CES) between all goods in the consumption utility function.[25]

We assume from equation (4) that T_{ij} may be divided into several components, namely, infrastructure quality, tariff barriers, transport costs, distance, difference in language, and other border effects. Assuming monopolistically competitive market, the term (1- σ) should be negatively related to volume of trade.

In order to carry out the estimations, following Head (2003), and Anderson and van Wincoop (2003), we assume the implicit aggregate equilibrium prices P_i and P_j are basically resistance term or remoteness (trade weighted average distances from rest of the world).[26] Here, we derive remoteness (R_i), as a proxy of implicit aggregate equilibrium prices, through following equation.

$$R_i = \sum_{m \neq j} \left(\frac{d_{im}}{Y_m} \right) \quad (5)$$

[25] See, Anderson and van Wincoop (2003) for compete derivation of the model. We assume, as shown in Anderson (1979) and Anderson and van Wincoop (2003), all goods are differentiated by place of origin and each country is specialized in the production of only one good. Therefore, supply of each good is fixed (n_i = 1), but it allows preferences to vary across countries subject to the constraint of market clearing (CES).

[26] In fact, some authors tentatively estimated model with price index variables (Baier and Bergstrand, 2001).

where R_i reflects the average distance of country i from all trading partners other than j, d_{im} is the distance between countries i and m, Y_m is the GDP of country m.

Therefore, final estimable gravity equation takes following shape.

$$\begin{aligned} \ln IM^k_{ij} = \; & \alpha_0 + \alpha_i + \beta_1 \ln Y_iY_j + \beta_2 \ln II_i + \beta_3 \ln II_j + \beta_4 \ln TC^k_{ij} + \beta_5 \ln T^k_{ij} \\ & + \beta_6 \ln R_i + \beta_7 \ln R_j + \beta_8 \ln D_{ij} + \beta_9 d_1 + \beta_{10} d_2 + \beta_{11} d_3 + \varepsilon_{ij} \qquad (6) \end{aligned}$$

where i and j are importing and exporting country respectively, and k is trade sector. IM_{ij} represents import by country i from country j, taken at constant US$, Y_i and Y_j denote gross domestic products, taken at constant US$, of countries i and j, respectively, II represents country's infrastructure quality, measured through an index, TC_{ij} stands for transport costs for bilateral trade between countries i and j for sector k, T_{ij} stands for bilateral tariff (weighted average) between country i and j for sector k, R_i and R_j denote average remoteness of countries i and j, D_{ij} is the distance between countries i and j. Dummies 1, 2 and 3 in Equation (6) refer to PTA/FTA in force, adjacency, and language, respectively. To capture country effects, we use country specific dummy, α_i. The parameters to be estimated are denoted by β, and ε_{ij} is the error term.

The augmented gravity model explains bilateral trade flows as a function of the trading partners' market sizes and their bilateral barriers to trade. As indicated in Nordås and Piermartini (2004), a number of them are standard variables in the empirical literature to capture trade barriers: (i) transport costs are generally captured by distance and island, landlocked and border dummies to reflect that transport costs increase with distance. They are higher for landlocked countries and islands and are lower for neighbouring countries; (ii) information costs are generally captured by a dummy for common language; (iii) tariff barriers are generally neglected. However, data on tariff barriers show that there is a high degree of variability in cross-country bilateral applied tariffs. Since neglecting tariffs may be a source of an omitted variable bias, we, therefore, include bilateral tariffs in our estimations.

The augmented gravity model considered here uses data for the year 2004 for 10 Asian countries, namely, China, Hong Kong, India, Indonesia, Japan, Korea, Malaysia, Singapore, Taiwan and Thailand for eight commodity groups (sectors) such as food, chemical, textile and clothing, machinery, electronics, auto components, steel and metal, and transport equipment. The corresponding codes of these commodity groups at HS 2 are provided in Appendix 2. By taken tariffs, transport costs and infrastructure quality, we cover a major portion of trade costs. Trade, transportation costs, and tariffs are taken at HS 4 level for the year 2004.[27]

The major sources of secondary data are collected from International Monetary Fund (IMF), United Nations Statistical Division (UNSD), and United Nations Conference on Trade and Development (UNCTAD). Appendix 4 provides the data specific sources.

4. Relative Importance of Trade Costs: Estimation Results

In this paper we have considered eight sectors, among which six sectors, namely, electronics, automobile, machinery, textile and clothing, steel and metal, and chemicals, share the larger pie in trade of Asia. These six industries constitute 3/4th of Korea's and Japan's exports, and 2/3rd of China's exports in intraregional trade. Except in food, China (including Hong Kong and Taiwan) has higher share in intra-regional imports of remaining seven sectors, compared to others (Table 5). To a great extent, Asia's trade is not evenly distributed and mostly driven by China.

The barriers to trade in eight sectors, namely, food, chemical, textile and clothing, machinery, electronics, auto components, steel and metal, and transport equipment, are estimated through equation (6). Tables 6 to 13 show the estimation results of equation (6) for two scenarios: one using equation (1) and another using equation (2). The explanatory variables of interest are II, TC and T in equation (6). We expect that the TC, T and II are negatively correlated with the volume of imports, respectively.[28]

The gravity model performs well as most of the variables do have expected signs. Variables being in natural logarithms, estimated coefficients show elasticity. Given large cross-section nature of the data at 4-digit HS for the year 2004, estimated gravity model explains 52 to 80 percent of the variations in direction of trade flows. The volume of imports is increasing in GDP and deceasing in the distance. The most interesting result is the strong influence that transport costs had on trade in all the sectors: the higher the transport costs between each pair of partners, the less they trade. Significance of transport costs using equation (2) always found to be higher than that estimated by equation (1) for most of the sectors. It also indicates that

[27] The model also suffers from data limitation when we consider equation (1) to estimate transport costs. On average 56 percent of total observations for all sectors are found to be either zero or negative or missing. Theoretically t_{ij} can not be negative or zero. This happened more due to discrepancy in data compilation. However, we get better results when we consider equation (2) and use shipping rates. Appendix 3 shows the country-wise observations collected and those are with errors.

[28] The usual caveat is that in our particular case, we took an inverse measure of II in the regression so that an increase in II is expected to be associated with an increase in the TC, and vice versa.

trade-weighted transport costs using ocean freight through equation (2) seems to be a better method compared to conventional way to estimate transport costs using equation (1) in our case. The results also indicate that the exporting countries infrastructure is more important than the importing countries. As seen from the Tables 6 to 13, coefficients of transport costs in most of the cases are statistically significant at 1 percent level and always negative. The sign of country effects is a reflection of current trade situation. In many cases country effects have also appeared significantly.

Table 5. Country-wise Shares in Intra-regional Imports in 2005

Country	Auto Components	Chemical	Electronics	Food
	(%)			
China, Mainland	28.17	35.71	25.66	3.54
China, Hong Kong	5.75	11.34	22.48	11.48
India	2.09	2.92	1.39	0.43
Indonesia	8.58	4.05	0.45	5.23
Japan	10.43	10.12	13.27	50.49
Korea	5.13	9.68	7.93	8.77
Malaysia	9.00	5.14	5.92	6.68
Singapore	9.49	4.56	11.68	6.20
China, Taiwan	9.74	10.36	7.60	4.20
Thailand	11.62	6.12	3.63	2.99
Total	100.00	100.00	100.00	100.00
Country	**Machinery**	**Steel & Metal**	**Textile & Clothing**	**Transport Equipment**
	(%)			
China, Mainland	34.08	28.63	17.24	14.51
China, Hong Kong	8.39	9.09	34.88	6.12
India	2.47	1.88	1.72	18.87
Indonesia	4.36	3.03	1.12	5.30
Japan	7.77	12.53	28.02	2.59
Korea	10.66	15.38	6.16	12.23
Malaysia	4.92	6.24	2.05	18.27
Singapore	6.44	5.35	3.28	6.82
China, Taiwan	13.29	9.52	3.12	10.86
Thailand	7.63	8.35	2.40	4.43
Total	100.00	100.00	100.00	100.00

Note: Intra-regional sector-wise imports consider trade at HS 4 among 10 countries in Asia.
Source: Calculated based on IMF (2006)

Food

With 1609 observations at 4-figit HS in food sector, we found variables representing trade costs like, tariff, infrastructure, and transport costs are significant in both the models in Table 6. The estimated coefficients indicate that a reduction in tariff and transport costs by 10 percent each would increase bilateral trade in food sector by about 3.2 and 1.2 percent respectively (in Model 2). The significant and negative signs of exporting countries' infrastructure quality indicate that the present state of infrastructure facilities is penalising trade in food sector. In other words, an improvement of current state of infrastructure by 10 percent in exporting countries will lead to rise in exports by 2.4 percent.

Table 6: OLS Results at 4-digit HS for the Year 2004: Food

	Model 1		Model 2	
	Coefficients	**t-values**	**Coefficients**	**t-values**
GDP of importing countries	0.054	0.496	0.011	0.111
GDP of exporting countries	0.088	1.009	0.074	0.903
Infrastructure of importing countries	0.213*	1.294	0.221*	1.448
Infrastructure of exporting countries	-0.372***	-4.142	-0.241**	-2.886
Tariff	-0.257***	-5.604	-0.318***	-7.458
Trade-weighted transport costs$	-0.026	-1.031		
Trade-weighted transport costs#			-0.116***	-12.811
Remoteness of importing countries	-0.093	-0.806	-0.050	-0.470
Remoteness of exporting countries	-0.188*	-2.037	-0.136*	-1.586
Distance	-0.545***	-6.511	-0.467***	-6.011
FTA Dummy	0.459***	3.781	0.281**	2.483
Adjacency Dummy	0.230*	1.367	0.199*	1.273
Language Dummy	0.222*	1.497	0.246*	1.784
Country effect				
China	-0.973**	-3.484	-0.607**	-2.337
Hong Kong	0.983**	3.542	1.045***	4.056
India	-2.183***	-9.136	-2.104***	-9.506
Indonesia	-0.457**	-2.218	-0.403*	-2.132
Japan	1.270**	3.508	0.914**	2.714
Korea	-0.190	-0.794	-0.405*	-1.870
Malaysia	-0.087	-0.413	-0.194	-1.014
Singapore	0.194	0.643	0.379*	1.359
Thailand	-2.018***	-9.689	-1.899***	-9.851
No of observations	1609		1609	
Adjusted R^2	0.568		0.752	

Notes: $ Estimated following equation (1). # Estimated following equation (2). * Significant at the 10 percent level. ** Significant at the 5 percent level. ***Significant at the 1 percent level. OLS regressions excluding all missing or negative or zero transport costs.

The interesting result is that the FTA among the countries considered in this study has positively influenced the trade in food products. Countries like Hong Kong and Japan show positive and significant country effect, whereas China, India, Indonesia and Thailand have negative but significant country effect in the food sector. The reason is small countries do import large food products (due to domestic resource constraints), and, thus, they show comparatively lower trade frictions as they are equipped with improved infrastructure. With about 50 percent share in total imports, Japan is the largest importer of food and food products in Asia (see, Table 5). Hong Kong shares about 12 percent of total imports of food and food products in Asia. These countries have fairly improved infrastructure facilities, and offer negligible tariffs. Singapore has also shown a positive country effect but statistically insignificant. Larger or medium sized countries, which are producers/exporters of food items, like China, India, Indonesia, and Thailand, are still not been able to get much benefits due to presence of comparatively higher trade barriers such as higher tariffs and transport costs. Interestingly, both the coefficients are statistically significant and carry negative signs. Since exporters of food products are large in the group, exporting countries infrastructure quality does matter in raising trade in food products in Asia.

Estimated coefficients of all the three dummies are significant in both the models. We can conclude that FTA environment among the countries in Asia has positively influenced the trade in food products. In present context, trade in food products is also influenced by geographical contiguity as adjacency dummy carries positive sign and statistically significant. Language similarity does influence trade in food products as reflected in estimated positive and statistically significant coefficient.

Chemical

Table 7 reports the estimated results for the chemical sector. Except China, rest Asian countries share about 2 to 12 percent of intra-regional trade in chemical sector (Table 5). However, China alone shares 36 percent of trade conducted in the chemical sector. Hong Kong, Japan and Taiwan come next. With observations of 7907, the Model 2 in Table 7 explains about 69 percent of the variations in direction of trade flows in chemical sector. At the same time, we observe variations in the significance level of transport costs. The transport cost in Model 1 shows positive sign but statistically insignificant, while the same, calculated using equation (2) in Model 2, has appeared as highly significant (at 1 percent level) and also carries correct (negative) sign.

Estimated coefficients in Model 2 indicate that tariff, transport costs, and quality of exporting countries infrastructure are significant barriers to trade. However, infrastructure quality as barrier to trade has appeared to be less significant except in Model 1 for exporting countries. Estimated coefficients show that a reduction in tariff and transport costs by 10 percent each would increase bilateral trade in chemical sector by about 3.4 and 1.2 percent respectively (in Model 2), and an improvement of current state of infrastructure by 10 percent in exporting countries will lead to rise in exports by about 1 percent.

Table 7: OLS Results at 4-digit HS for the Year 2004: Chemical

	Model 1		Model 2	
	Coefficients	**t-values**	**Coefficients**	**t-values**
GDP of importing countries	0.320***	11.683	0.222***	8.758
GDP of exporting countries	0.397**	2.529	0.503***	3.472
Infrastructure of importing countries	-0.058	-1.019	0.058	1.100
Infrastructure of exporting countries	-0.159***	-3.893	-0.075*	-1.981
Tariff	-0.323***	-11.457	-0.338***	-12.996
Trade-weighted transport costs$	0.002	0.111		
Trade-weighted transport costs#			-0.119***	-11.634
Remoteness of importing countries	*Insignificant*			
Remoteness of exporting countries	-0.279*	-1.682	-0.088	-0.579
Distance	-0.534***	-12.781	-0.435***	-11.258
FTA Dummy	0.144**	2.408	0.090*	1.637
Adjacency Dummy	0.141*	1.699	0.074	0.973
Language Dummy	0.205**	2.880	0.243***	3.698
Country effect				
China	0.279**	2.631	0.054	0.551
Hong Kong	0.686***	7.046	0.527***	5.870
India	-1.338***	-11.183	-1.169***	-10.582
Indonesia	-0.400***	-4.295	-0.363***	-4.228
Japan	*Insignificant*			
Korea	-0.527***	-5.684	-0.564***	-6.593
Malaysia	-0.082	-0.915	-0.282***	-3.414
Singapore	*Insignificant*			
Thailand	-0.653***	-7.035	-0.682***	-7.954
No of observations	7907		7907	
Adjusted R^2	0.521		0.686	

Notes: $ Estimated following equation (1). # Estimated following equation (2). * Significant at the 10 percent level. ** Significant at the 5 percent level. ***Significant at the 1 percent level. OLS regressions excluding all missing or negative or zero transport costs.

From the country effects, it may be said that China being largest importer in chemical sector does play an influential role in trade in chemical sector, and thus its effect is correctly captured in country specific dummy. All the three dummies are significant in Model 1, while except the adjacency dummy, other two dummies are found as significant in Model 2. Significant coefficient of FTA dummy tells that trade in chemical sector has been benefited from FTA in Asia. Language similarity is found to be an important determinant of trade in chemical sector, whereas adjacency of countries does not have much influence. In general, developing countries in the region show negative and significant country effect thereby indicating low exploitation of trade potentiality and high presence of trade barriers. Nevertheless, findings provide sufficient indications of presence of trade barriers in chemical sector in Asia.

Textile and Clothing

Asian countries are major exporters in textile and clothing sector. Within Asia, shares of Japan, Hong Kong, and China in intra-regional imports of textile and clothing are on the higher side. The results in Table 8 indicate that trade in textile and clothing is too associated with considerably high trade costs. All the trade costs components do have expected signs, and also statistically significant.

Table 8: OLS Results at 4-digit HS for the Year 2004: Textile and Clothing

	Model 2	
	Coefficients	**t-values**
GDP of importing countries	0.313***	12.840
GDP of exporting countries	-1.462***	-10.380
Infrastructure of importing countries	0.327***	6.320
Infrastructure of exporting countries	-0.402***	-10.360
Tariff	-0.295***	-13.290
Trade-weighted transport costs#	-0.148***	-12.650
Remoteness of importing countries	*Insignificant*	
Remoteness of exporting countries	-2.072***	-14.000
Distance	-0.453***	-11.850
FTA Dummy	0.094*	1.720
Adjacency Dummy	0.191**	2.540
Language Dummy	0.078*	1.220
Country effect		
China	-0.272**	-2.970
Hong Kong	0.799***	9.630
India	-1.515***	-15.640
Indonesia	-0.596***	-6.720
Japan	*Insignificant*	
Korea	-0.717***	-9.190
Malaysia	-0.438***	-5.160
Singapore	*Insignificant*	
Thailand	-1.166***	-13.360
No of observations	8370	
Adjusted R^2	0.725	

Notes: Model 1 is omitted due to insignificant results. # Estimated following equation (2). *,**,and *** imply estimated coefficients are significant at 10, 5, and 1 percent level, respectively. OLS regressions exclude all missing or negative or zero transport costs.

With 8370 observations at HS 4 level, Model 2 in Table 8 confirms that 10 percent savings in tariff and transport costs each will lead to 3 and 1.5 percent rise in trade in textile and clothing sector when geographical contiguity (significant adjacency dummy) positively influences the trade. Estimated coefficients in Model 2 in textile and clothing sector indicate that tariff, transport costs, and quality of exporting countries infrastructure are significant barriers to trade. Exporting country's infrastructure quality is appeared as most significant determinant;

an improvement of current state of infrastructure quality by 10 percent in exporting countries will lead to rise in exports by about 4 percent. Unlike previous cases, here except Hong Kong, remaining countries show significant negative country effect. This is likely the result of multicolinearity. Language and FTA dummies are also significant and carry positive signs.

Machinery

Import of machinery sector (as indicated in Table 5) is most unevenly distributed across the countries selected in this study. China has the highest share in total imports in machinery sector (about 34 percent). Expectedly, its dummy effect on import is positive and significant (at 1 percent level). Imports and exports in machinery sector are dominated by developing countries, and, unlike previous cases, developed countries have relatively less influence (e.g. Japan with insignificant dummy effect). Model 2 in Table 9 explains about 79 percent of the variations in direction of trade flows, whereas the estimated coefficients show that tariff and transport costs have negative effect on trade in machinery sector.

Table 9: OLS Results at 4-digit HS for the Year 2004: Machinery

	Model 2	
	Coefficients	**t-values**
GDP of importing countries	0.092*	1.307
GDP of exporting countries	0.393***	6.885
Infrastructure of importing countries	0.262*	2.412
Infrastructure of exporting countries	0.050	0.923
Tariff	-0.171***	-3.938
Trade-weighted transport costs#	-0.101***	-14.299
Remoteness of importing countries	-0.092*	-1.240
Remoteness of exporting countries	-0.511***	-8.457
Distance	-0.757***	-13.814
FTA Dummy	-0.103*	-1.345
Adjacency Dummy	-0.009	-0.081
Language Dummy	0.198*	2.107
Country effect		
China	1.004***	5.621
Hong Kong	0.197	1.072
India	-0.253*	-1.603
Indonesia	0.447**	3.520
Japan	0.229	0.953
Korea	-0.745***	-4.856
Malaysia	0.396**	2.934
Singapore	0.059	0.297
Thailand	0.044	0.326
No of observations	1965	
Adjusted R^2	0.789	

Notes: Model 1 is omitted due to insignificant results. # Estimated following equation (2). *,**, and *** imply estimated coefficients are significant at 10, 5, and 1 percent level, respectively. OLS regressions exclude all missing / negative / zero transport costs.

Electronics

In trade in electronics sector, China and Hong Kong have above 20 percent shares in intra-regional imports. With about 13 percent share, Japan comes next (see, Table 5). In general, China relies on Japan for intermediate goods in electronics sector (and for raw materials and technology) and also for market of their finished products. This has been reflected in positive country effect for China and Hong Kong in both the models in Table 10. Geographical adjacency has played a positive role in enhancing regional trade in electronics (t = 4.065 in Model 1 and t = 3.893 in Model 2). Both the models explain about 56 – 76 percent of the variations in direction of trade flows.

Table 10: OLS Results at 4-digit HS for the Year 2004: Electronics

	Model 1		Model 2	
	Coefficients	**t-values**	**Coefficients**	**t-values**
GDP of importing countries	0.127*	1.850	0.120*	1.781
GDP of exporting countries	0.189**	3.311	0.174**	3.100
Infrastructure of importing countries	-0.295**	-2.811	-0.269**	-2.618
Infrastructure of exporting countries	-0.256***	-4.740	-0.297***	-5.601
Tariff	-0.308***	-8.810	-0.310***	-9.051
Trade-weighted transport costs$	-0.031	-1.013		
Trade-weighted transport costs#			-0.125***	-14.125
Remoteness of importing countries	-0.147*	-2.018	-0.141*	-1.972
Remoteness of exporting countries	-0.548***	-9.081	-0.505***	-8.522
Distance	-0.669***	-12.260	-0.622***	-11.612
FTA Dummy	0.016	0.210	-0.041	-0.549
Adjacency Dummy	0.444***	4.065	0.417**	3.893
Language Dummy	0.020	0.214	0.061	0.665
Country effect				
China	0.778***	4.429	0.846***	4.913
Hong Kong	0.381*	2.139	0.383*	2.192
India	0.179*	1.212	0.214*	1.486
Indonesia	-0.934***	-7.300	-0.954***	-7.631
Japan	0.156	0.680	0.058	0.259
Korea	-0.121	-0.828	-0.111	-0.772
Malaysia	0.223*	1.652	0.206*	1.557
Singapore	0.018	0.094	-0.007	-0.035
Thailand	-0.066	-0.480	-0.010	-0.074
No of observations	3059		3059	
Adjusted R^2	0.563		0.764	

Notes: $ Estimated following equation (1). # Estimated following equation (2). * Significant at the 10 percent level. ** Significant at the 5 percent level. ***Significant at the 1 percent level. OLS regressions excluding all missing or negative or zero transport costs.

Nevertheless, trade in electronics sector is highly influenced by trade costs components. Estimated coefficients in both the models indicate that tariff, transport costs, and quality of infrastructure (of both the countries) are significant barriers to trade. Estimated elasticities in Model 2 show that an improvement of current state of infrastructure by 10 percent will lead to rise in trade in electronics sector by about 3 percent in both importing and exporting countries. Along with it, 10 percent savings in tariff and transport costs each will likely to increase trade in electronics sector by 3 and 1.3 percent respectively, when we found significant adjacency dummy (geographical contiguity).

Table 11: OLS Results at 4-digit HS for the Year 2004: Auto Component

	Model 1		Model 2	
	Coefficients	**t-values**	**Coefficients**	**t-values**
GDP of importing countries	0.069	0.310	0.056	0.271
GDP of exporting countries	0.346*	1.968	0.263*	1.614
Infrastructure of importing countries	0.491*	1.414	0.439*	1.362
Infrastructure of exporting countries	-0.035	-0.193	-0.032	-0.194
Tariff	-0.460***	-4.927	-0.410***	-4.723
Trade-weighted transport costs[$]	0.034*	1.948		
Trade-weighted transport costs[#]			-0.138***	-12.007
Remoteness of importing countries	-0.084	-0.357	-0.073	-0.335
Remoteness of exporting countries	-0.479**	-2.581	-0.383*	-2.222
Distance	-0.374*	-2.197	-0.328*	-2.078
FTA Dummy	0.214	0.884	0.068	0.301
Adjacency Dummy	-0.273	-0.797	-0.179	-0.562
Language Dummy	-0.227	-0.723	-0.269	-0.923
Country effect				
China	-0.087	-0.146	0.067	0.121
Hong Kong	0.814*	1.397	0.843*	1.558
India	-1.743***	-3.640	-1.556***	-3.499
Indonesia	0.465*	1.166	0.234	0.633
Japan	1.219*	1.603	1.011*	1.433
Korea	-1.012*	-2.073	-0.972*	-2.145
Malaysia	0.028	0.067	0.131	0.338
Singapore	0.556	0.908	0.499	0.878
Thailand	-1.128**	-2.702	-1.111*	-2.867
No of observations	339		339	
Adjusted R^2	0.711		0.806	

Notes: Model 1 is omitted due to insignificant results. # Estimated following equation (2). *,**,and *** imply estimated coefficients are significant at 10, 5, and 1 percent level, respectively. OLS regressions exclude all missing or negative or zero transport costs.

Auto Component

Estimated results in case of auto components (Table 11) go in the same direction. China contributes 28 percent in intra-regional imports of auto components. Thailand and Japan come next to it (Table 5). Except India, remaining countries, considered in this study, have at least above 5 percent shares in intra-regional trade of auto components thereby showing a greater interdependence and production network. Both the models explain about 71 – 81 percent of the variations in direction of trade flows. Tariff and transport costs have appeared as significant barriers. Model 2 in Table 11 shows that 10 percent savings in tariff and transport costs each will likely to increase trade in electronics sector by 4.1 and 1.2 percent respectively.

However, none of the dummies is statistically significant. Along with India, some of the major auto components exporting countries like Thailand, and Korea show negative and significant country effect, whereas Japan has positive and significant country effect in the auto component sector. Japan being leading automobile manufacturer positively influences the Asia's automobile and auto component sector, whereas countries like India, Korea and Thailand are still not able to get adequate benefits due to the presence of comparatively higher trade barriers such as higher tariffs and transport costs.

Table 12: OLS Results at 4-digit HS for the Year 2004: Steel and Metal

	Model 2	
	Coefficients	**t-values**
GDP of importing countries	0.100*	1.861
GDP of exporting countries	0.289***	6.707
Infrastructure of importing countries	0.151*	1.843
Infrastructure of exporting countries	-0.174***	-4.151
Tariff	-0.057**	-2.305
Trade-weighted transport costs#	-0.101***	-15.002
Remoteness of importing countries	-0.124*	-2.189
Remoteness of exporting countries	-0.382***	-8.377
Distance	-0.590***	-14.255
FTA Dummy	-0.128*	-2.211
Adjacency Dummy	0.087	1.055
Language Dummy	0.015	0.203
Country effect		
China	0.744***	5.508
Hong Kong	0.365**	2.566
India	-0.395**	-3.477
Indonesia	-0.145*	-1.514
Japan	0.100	0.549
Korea	-0.258*	-2.238
Malaysia	-0.455***	-4.370
Singapore	0.152	1.015
Thailand	-0.223*	-2.180
No of observations	5204	
Adjusted R^2	0.763	

Notes: Model 1 is omitted due to insignificant results. # Estimated following equation (2). *,**,and *** imply estimated coefficients are significant at 10, 5, and 1 percent level, respectively. OLS regressions exclude all missing / negative / zero transport costs.

Steel and Metal

Intra-regional trade in steel and metal sector is concentrated in China, Korea and Japan. Estimated results in Table 12 indicate trade in steel and metal is associated with reasonably high barriers to trade, where estimated coefficients for tariffs, country's infrastructure quality and transport costs are significant. The models explain about 76 percent of the variations in direction of trade flows. Model 2 in Table 12 shows that 10 percent savings in tariff and transport costs each will likely to increase trade in steel and metal sector by 0.6 and 1 percent respectively. At the same time, 10 percent improvement in exporting countries infrastructure quality will lead to rise about 1.7 percent of trade. Therefore, propensity to increase the trade in steel and metal is likely to be higher with reduction of transport costs, rather than tariff reduction at the present context. The estimated coefficient of FTA dummy indicates that the trade in steel and metal in Asia has been benefited from FTA. India, Indonesia, Korea and Malaysia show negative and significant country effect. One of the reasons could be that these countries indicate low exploitation of trade potentiality and high presence of trade barriers.

Table 13: OLS Results at 4-digit HS for the Year 2004: Transport Equipment

	Model 2	
	Coefficients	**t-values**
GDP of importing countries	0.130	0.529
GDP of exporting countries	0.269*	1.548
Infrastructure of importing countries	0.286	0.764
Infrastructure of exporting countries	0.388*	2.047
Tariff	-0.014	-0.116
Trade-weighted transport costs#	-0.143***	-8.132
Remoteness of importing countries	-0.116	-0.448
Remoteness of exporting countries	-0.193	-1.051
Distance	-0.681**	-3.826
FTA Dummy	0.273	1.072
Adjacency Dummy	-0.191	-0.538
Language Dummy	-0.078	-0.239
Country effect		
China	-0.162	-0.261
Hong Kong	1.529*	2.217
India	0.997*	1.948
Indonesia	0.110	0.261
Japan	0.262	0.306
Korea	0.077	0.149
Malaysia	0.003	0.006
Singapore	-0.411	-0.610
Thailand	-0.834*	-1.649
No of observations	138	
Adjusted R^2	0.641	

Notes: Model 1 is omitted due to insignificant results. # Estimated following equation (2). *,**,and *** imply estimated coefficients are significant at 10, 5, and 1 percent level, respectively. OLS regressions exclude all missing / negative / zero transport costs.

Transport Equipment

There is a slight change in direction in case of transport equipments. The model in Table 13 explains about 76 percent of the variations in direction of trade flows. What is interesting is that coefficient of bilateral tariff is found to be insignificant with negative sign, and the same of transport costs carries negative sign and significant. It also suggests that transport equipments being project goods used in infrastructure sector has lower tariff incidence, and therefore the estimated coefficient has appeared as insignificant. However, estimated coefficients show that country's infrastructure quality and transport costs are significant barriers to trade in transport equipment. None of the dummies is significant. Estimated country dummy is consistent. For example, India has about 19 percent share in total intra-regional import in transport equipment (Table 5), and therefore, its country effect shows positive and significant sign (at 10 percent level).

Table 14. Pooled OLS Estimates: All Sectors

	Model 2			
	With censored t_{ij}		With replaced t_{ij}	
	Coefficients	t-values	Coefficients	t-values
GDP of importing countries	0.032	1.210	0.318***	7.460
GDP of exporting countries	0.242**	3.100	0.367***	8.740
Infrastructure of importing countries	-0.019	-0.320	-0.068	-0.500
Infrastructure of exporting countries	-0.110***	-5.200	-0.057**	-2.740
Tariff	-0.010	-0.590	-0.037	-1.080
Trade-weighted transport costs#	-0.120***	-9.120	-0.588***	-10.270
Remoteness of importing countries	-0.190*	-1.900	-0.106	-1.108
Remoteness of exporting countries	-0.610***	-6.840	-1.292***	-7.340
Distance	-0.520***	-8.650	-0.578***	-9.420
FTA Dummy	0.080**	2.900	0.180***	7.640
Adjacency Dummy	0.146***	3.750	0.151***	4.690
Language Dummy	0.035*	1.560	0.022	0.103
Country effect				
China	0.399***	6.670	0.538***	7.360
Hong Kong	*Insignificant*		*Insignificant*	
India	*Insignificant*		*Insignificant*	
Indonesia	-0.076*	-1.800	-0.748***	-14.190
Japan	*Insignificant*		*Insignificant*	
Korea	0.058*	1.830	0.133**	3.880
Malaysia	0.363***	4.950	0.249***	7.080
Singapore	*Insignificant*		*Insignificant*	
Thailand	0.101*	2.240	0.207***	4.930
No of observations	28591		60919	
Adjusted R^2	0.647		0.515	

Notes: # Estimated following equation (2). * Significant at the 10 percent level. ** Significant at the 5 percent level. ***Significant at the 1 percent level.

All Sectors: Pooled OLS Results

To understand whether the direction of relationship captured in individual sectors through gravity estimates has any resemblance when we consider the model with total trade in pooled framework at HS 4, we have found that the pooled OLS results (in Table 14) show no much difference. Rather, country effects dummies have appeared with expected signs for those countries which carry more trade under FTA environment (significant FTA dummy), and sharing borders (significant adjacency dummy). Since tariff has been reduced heavily exception being agriculture and food, in pooled framework, coefficients of tariffs have came out insignificant, but have negative relationship with trade flows. This is not consistent with the results obtained in cases of individual sectors. However, quite consistent with the behaviour of transport costs, exporting country's infrastructure quality produces negative signs (and significant) with bilateral trade. Both the models explain about 52 to 65 percent of variations in trade flows. The models indicate that a 10 percent savings in transport costs would increase trade by about 1 to 6 percent in Asia. At the same time, 10 percent improvement in exporting countries infrastructure quality will lead to rise 0.6 to 1 percent of trade.

To summarize, there is strong empirical evidence that trade costs components, namely, infrastructure quality, tariffs, and transport costs are important for international trade patterns of eight prominent sectors. Country's infrastructure quality, tariff, and transport costs are the main three important determinants of cross-country variations of trade flows in present context. More specifically, cross-border cooperation in building and maintaining hard and soft infrastructure will lead to a reduction in trade costs.

5. Concluding Remarks

The analysis carried out in this paper provides sufficient evidences to ascertain that variations in tariffs, transport costs along with infrastructure facilities have significant influence on regional trade flows in Asia. Further, we find that tariffs have a relatively large and negative impact on trade when we consider individual sectors. Among the sectors, except transport equipment, trade in all other sectors is influenced by tariffs, transport costs and infrastructure quality. For transport equipment, bilateral tariff has less significant role as trade is more demand-driven.

This paper has provided additional measures of bilateral trade restrictions in empirical estimates using the gravity model. First, the study is carried out on eight important sectors on which Asian countries are increasingly having trade interdependence. Second, we introduce infrastructure quality that we believe have an impact on trade. Third, we introduce bilateral tariffs, which are largely ignored in the empirical gravity literature in context of Asia. Fourth, in order to ensure unbiased estimates, we used resistance parameters. Fifth, in order to find out the relative robustness of the transport costs, we used trade-weighted transport costs using cross-country shipping rates, which is also a new entry in the gravity literature.

Table 15. Selected Trade Facilitation Indicators in Northeast Asia in 2005

Exporter/ Origin	Importer / Destination	Documents for export (number)	Time for export (days)	Shipping cost (US$ per container)[1]	Documents for import (number)	Time for import (days)
Japan	China	5	11	498.11	7	11
China	Japan	6	20	1165.90	11	24
Japan	Korea	5	11	563.68	7	11
Korea	Japan	5	12	662.25	8	12
Korea	China	5	12	570.33	8	12
China	Korea	6	20	739.86	11	24
World Average[2]		7	30		11	37
Asian Average[3]		7	23		10	26

Notes: 1. Cost including both the partners (taken from Table 7). 2. Includes 154 countries. 3. Includes ASEAN+6 countries except Brunei and Myanmar.
Sources: 1. World Bank (2006b). 2. Maersk Sealand (2006)

Progress in lowering trade costs is uneven (Word Bank, 2006c). Trading across Europe is becoming seamless whereas same in Asia is not yet improved, if not deteriorated. Lengthy procedure and transaction at border multiply trade costs. For example, requirement of export documentations in terms of numbers is now less at most of the ports in Asia, but it still involves 20 to 11 days in Asia. It takes average 20 days when consignment is exported from China, whereas Japan and Korea take average 24 days to clear imports coming from China (Table 15). Generally, a consignment needs several documentations, signatures, and copies for the final approval, taking into account both sides, and encounter multiple transhipments, resulting which costs are rising high day-by-day which often changes the composition and direction of trade. Sending a containerised cargo from China to Japan costs about US$ 1166 (in 2005), whereas the same from Japan to China costs only US$ 498. Due to favourable policy (tariff) and environment (improved infrastructure), Japan's welfare gain from her trade with Korea and China seems to be much higher.

Needless to mention, procedural complexities coupled with high auxiliary shipping charges work as deterrent to trade in Asia. As noted in Table 15, even though performances of Asian countries in export facilitation (in terms of days and numbers) are comparatively better than the world and Asian averages, the variability in case of imports facilitation between three Northeast Asian countries and World and/or Asia is not much wide thereby indicating the need for further improvement of trade facilitation performances in Asia.

Our results have important policy implications for countries seeking to expand trade at a time when tariffs tend to be lower not only in Asia but also across most of the economies in the world. Attention is being paid towards trade and transport facilitation. Generally speaking, tariffs are not regarded as major barriers to trade although high-tariff items and tariff escalation still exist for certain sensitive products. Therefore, when the tariffs have been reduced, the economies of this region could potentially benefit substantially from higher trade if improvement in quality infrastructure leads to mitigate rising trade costs. Strengthening the chain of necessary trading infrastructure facilities, starting from the production point to the shipment point, and associated trade facilitation measures at border, is also an important segment, which need special attention. The challenge for Asian countries is thus to identify improvements in logistics services and related infrastructure that can be achieved in the short-to-medium term and that would have a significant impact on competitiveness of these countries.

In order to better inform policy-making process, future research may be undertaken to complement the findings of this paper. As correctly noted by Hummels (1999a), without knowing the constant elasticity of substitution (CES) parameter, we can not infer the size of the trade barriers, and without knowing the size of the barrier, we can not infer CES. So, future study should be attempted in this direction. We should also attempt to establish the technological relationship between transportation costs and distance as we now have bigger vessels plying across Asian ports. This study has considered some direct trade costs but omitted infrastructure costs. Variability in infrastructure costs thus needs to be captured more accurately in the model. Finally, studies should be attempted to understand how the components of ocean freight costs (such as base ocean freight and auxiliary shipping charges) along with other trade barriers are affecting trade in Asia.

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Appendix 1

Estimated Weights

Infrastructure Indicator	**Factor Loadings 1**	**Factor Loadings 2**
Air transport freight (million tons per km)	0.81	0.57
Air transport, passengers carried (percentage of population)	0.88	-0.38
Aircraft departures (percentage of population)	0.91	-0.36
Country's percentage share in world fleet (percent)	0.36	0.69
Container port traffic (TEUs per terminal)	0.53	0.69
Electric power consumption (kwh per capita)	0.90	0.10
Fixed line and mobile phone subscribers (per 1,000 people)	0.93	0.02
Railway length density (km per 1000 sq. km of surface area)	0.92	-0.31
Road length density (km per 1000 sq. km of surface area)	0.90	-0.26
Expl.Var (% of total)	0.67	0.19

Note: Factor Loadings (Unrotated)
Source: Taken from De (2007)

Infrastructure Index and Ranks in 2004

Country	**Score**	**Rank**
Singapore	6.01	1
Hong Kong	5.60	2
Japan	4.23	3
Korea	3.22	4
China	1.92	5
Malaysia	1.74	6
Thailand	0.99	7
India	0.59	8
Philippines	0.59	9
Indonesia	0.46	10
Vietnam	0.40	11

Source: Taken from De (2007)

Appendix 2

Trade Category

Sector	Corresponding HS 2	Remarks
Food	16 - 23	Taken all at HS 4
Chemical	28 - 40	
Textile and clothing	41 - 67	
Machinery	84	Excluding HS 8415, 8418, 8471, 8473
Electronics	85, 90, 91, 92, 95,	Including HS 8415, 8418, 8471, 8473
Auto components	87	Taken all at HS 4
Steel and metal	72 - 83	
Transport equipment	86, 88, 89	

Appendix 3

Discrepancy in Transport Costs Estimation at 4-digit HS

Importer	Total number of observations at HS 4	Total number of observations with positive transport costs at HS 4	Total number of observations with zero/negative/missing transport costs at HS4
China	6380	2847	3533
Hong Kong	5734	2626	3108
India	5652	2566	3086
Indonesia	6213	2916	3297
Japan	5582	2548	3034
Korea	5705	2599	3106
Malaysia	6736	2924	3812
Singapore	6937	2755	4182
Taiwan	5517	2266	3251
Thailand	6463	2584	3879
Grand Total	60919	26631	34288

Appendix 5

Sources of Data

Particular	**Source**
Bilateral trade	UN COMTRADE IMF DOTS
Bilateral tariff	WB WITS
GDP, GDP per capita, surface area, population	WB WDI 2006
Distance	Great circle distance, http://www.wcrl.ars.usda.gov/cec/java/lat-long.htm
Infrastructure variables: (i) railway length, (ii) road length, (iii) air transport freight, (iv) air transport passengers carried, (v) aircraft departures, (vi) container traffic, (vii) fixed line and mobile phone subscribers, (viii) internet users, and (ix) electric power consumption	WB WDI 2006
Shipping freight	Maersk Sealand, Denmark, http://www.maerskline.com