Estimating the Impact of Trade Facilitation on Global Trade Flows

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Motivation

During the later half of twentieth century, massive trade liberalization measures around the globe have considerably reduced tariff barriers to trade; improvements in technology and declines in transportation costs also led to large expansions of trade. Successful efforts of reducing tariffs and transportation costs considerably altered the nature of trade barriers over the past few decades. It shifted the focus of research into exploring other forms of trade barriers that are taking increasingly larger shares of total trade cost. Among these barriers trade facilitation has recently sparked interest in the arena of policymaking.

In the recent literature trade facilitation is defined as ‘improving efficiency in administration and procedure, along with improving logistics at ports and customs’ (Wilson, Mann and Otsuki, 2003). These also include ‘streamlining regulatory environments, deepening harmonization of standards, conforming to international regulations’ (Woo and Wilson, 2000) and enhancing timeliness in trade (Hummels, 2001). Poor trade facilitation in developing countries deters efficient transportation of goods due to excessive costs and wasted time at customs caused by elaborate clearance procedures and often costs associated with informal trade, such as the practice of bribery; additional trade costs are imposed by the inefficiency of government officials, institutional structures and bureaucracy at the borders. In a world of severe competition in capturing global markets, these additional costs impose burden on trading countries and reduce their competitiveness with other exporters.

In this paper I study the importance of trade facilitation in determining global trade flows. Part of the motivation comes from particular interest on the role of trade facilitation in South Asia. The case of South Asia is particularly interesting because, according to the empirical literature countries in this region, namely India, Pakistan, Bangladesh, Sri Lanka, Bhutan, Nepal and Myanmar, are characterized by unusually low volumes of intraregional trade in goods. Political conflicts, similar endowments, export of similar products and poor trade facilitation are identified as some of the reasons for low trade. Thus identifying the significance of trade facilitation will provide more insight into the one of the causes of low trade volumes and how appropriate policies can be adopted to promote greater regional integration in South Asia.

The objective of this paper is to determine whether cross-country differences in trade facilitation affect the share of global demand captured by exporters. Suppose that two countries are identical in the production of a particular good in all respects, except that one provides more efficient movement of goods across borders. Then the country that has relatively more efficient trade facilitation in terms of lower time and monetary costs incurred at the borders will tend to gain the larger share of the exporting market. With this intuition, the goal is to identify whether differences in trade facilitation play an important role in determining trade flows around the globe. In this paper I use a cross-sectional global gravity model to identify the relative sizes of barriers posed by tariff versus trade facilitation on trade flows.

Literature Review

The literature on trade facilitation is fairly recent and somewhat limited. A few empirical papers attempt to quantify the sizes of trade barriers posed by lack of amenities and extensive procedures at the borders. A recent study on trade facilitation by Wilson, Mann and Otsuki (2005) (henceforth WMO) estimates the impact of trade facilitation on trade flows using a global econometric model. They use four indices to measure trade facilitation using data on manufactured goods between 2000-2001. Their findings suggest that enhancing facilitation amasses to a global increase of $377 billion in trade volumes.

Hummels (2001) examines the importance of time as a trade barrier. Using data of U.S. imports from the rest of the world, he evaluates the magnitude of trade costs incurred by time spent on shipments. Results suggest that each additional day spent on transportation reduces the probability that U.S. will import from a country by 1-1.5%; each day corresponds to an ad-valorem tariff equivalent of 0.8% on manufactured goods. He also highlights that increases in the use of relatively-more-expensive air-cargo provides support for a greater affinity for time savings.

Using data from 1988 to 2002, Francois and Manchin (2007) find that infrastructure and institutional quality are significant determinants of export levels and largely influence the propensity to participate in trade. They find that these factors are even more important in explaining trade growth than changes in tariffs. Thus they conclude that policy emphases on developing countries are misplaced. On a similar note, Freund and Weinhold (2000) find that a 10% increase in web hosts increases trade flows by 1%.

A few papers employ CGE modeling to estimate the effect of trade facilitation on welfare. Walkenhorst (2004) decomposes the costs of border barriers into direct and indirect costs, where direct costs measure the logistic barriers of moving goods across borders, such as efficiency of customs services, transparency and integrity of administrative processes, while indirect costs measures undue delays in freight movement, border waiting times, etc. Since indirect cost measures timeliness and increases with waiting time it is modeled using the iceberg-approach, whereas direct costs are modeled as taxes since they generate revenue for private and public firms that provide customs facilities, shipping services, etc. Incorporating these into the CGE model they simulate the effect of reducing border-related transaction costs. Their findings suggest that estimated world income grows significantly in the wake of trade facilitation. Similarly, Hertel, Walmsley and Itakura (2001) find that expansion of e-business and automation of customs procedures between Japan and Singapore expands bilateral trade between these countries and their trade with the rest of the world. Ivanic, Mann and Wilson (2006) find that investments of USD 400 million by developed countries on enhancing trade facilitation among the neediest developing countries leads to a global welfare gain of USD 750 with countries in South Asia, Middle East and Africa gaining the most in terms of welfare distribution.

Objectives

Given the strong empirical support in the literature, my research focuses on the relevance of trade facilitation as a trade barrier using a modified global cross-country gravity model. Statistically significant positive coefficient estimates for trade facilitation will imply that improving facilitation will be trade enhancing for countries, especially those with poor amenities in cross-border trade. I primarily build on the work of WMO and other existing empirical literature on trade facilitation by focusing on several new aspects. Firstly, I use better quality and more recent data for bilateral trade flows, tariffs and trade facilitation. Secondly, I investigate the extent to which the importance of trade facilitation may vary across sectors. Next I investigate which aspects of trade facilitation such as 'customs efficiency', 'infrastructure' or 'timeliness add larger costs to movement of goods across borders. Lastly, I highlight the issue of reverse causality between trade facilitation and trade volumes and attempt to address it. I also account for biased coefficient estimates that may result from spurious correlation between trade facilitation and other characteristics of country, such as GDP. I elaborate further on each of these points in the following sections.

<u>Data Quality</u>

Developing indices to capture the degree of trade facilitation at an international level is not an easy task; previous researchers were restricted by limited data availability. Wilson et al. (2005) used data from three sources, namely the Global Competitiveness Index 2001-02 (GCR), World Competitiveness Yearbook 2002 (WCY) and Kaufmann, Kraay and Zoido-Lobaton (2002) (KKZ). The GCR (WCY) surveyed a randomly selected sample of 4022 (3532) firms around the globe and obtained information from CEOs and officials in the top management of firms. The KKZ research collected data on the general governance and institutional structure of countries, such as voice and accountability, political stability, control of corruption, etc. Using these data sources and surveys they constructed four indices to estimate trade facilitation.

I employ an alternative dataset, the Logistics Perceptions Index (LPI), which was launched by the World Bank International Trade and Transport Department in 2006. This dataset is directly associated with the logistics having to do with goods crossing international borders, as opposed to the KKZ dataset that provides an estimate of the overall governance of a country. In order to grasp the entire macro supply chain of exports and imports, this dataset comprises of seven components, namely, *customs,* *infrastructure, ease of shipment, logistic services, ease of tracking, internal log costs,* and *timeliness*. Instead of obtaining data from firm level officials as done in the GCR and WCY datasets, surveys are completed by freight forwarders and express carriers who are in charge of shipping products in and out of countries. Since these professional operators work in multinational companies that manage trade with multiple partners they are in an excellent position to make knowledgeable assessments about border logistics across countries. Each surveyor chooses a set of 8 countries, particularly those they have most frequently served, to able to provide accurate information. A web-based questionnaire is designed which covers questions on a wide variety of topics to develop each indicator. For instance, questions regarding direct costs ask about the percentage of damaged shipments, the relative cost of rail services, etc. Similarly, questions regarding *timeliness* may ask about the average number of days between customs declaration and customs clearance, frequency of shipments reaching consignees at the scheduled delivery time, etc. Taken a whole these components of the survey make it appealing for use in a cross-country analysis of trade facilitation. Up until the present time these estimates are really among the closest available data to obtain direct cost and time estimates of border transactions on a global basis.

In addition to the trade facilitation data, I also improve on the tariff and trade data. Bilateral tariff data used by WMO are particularly problematic because for most importing countries a single tariff rate is determined for exporting to all countries. For example, Germany faces the same bilateral tariff with all other countries within and outside of EU. I employ a more accurate representation of actual bilateral tariff rates by using true, applied tariffs that reflect trade preferences, as well as the ad valorem equivalents of specific tariffs. I use the GTAP data on tariffs based on MacMap data base from CEPII and the GTAP trade data which is compiled from COMTRADE.

<u>Analysis across sectors</u>

Another extension of this paper is to estimate the effect of trade facilitation across various sectors. The goal is to identify whether certain sectors are more susceptible to differences in trade facilitation than others. For instance, delays in transportation of perishable goods, such as flowers, newspapers and magazines, will greatly reduce their values. Similarly, untimely delivery of goods that hold up the supply chain (such as auto parts) push trade costs upwards. Hence border costs may vary across sectors depending upon the characteristics of the good. Using data on tariff rates that vary across sectors, it is possible to estimate the cross-sectoral effect of trade facilitation on trade. I use four aggregated sectors, namely, *Agriculture*, *Extraction and Mining*, P*rocessed Food* and M*anufactured goods*. This will provide a general idea on which of these broadly classified industries are affected most by trade facilitation.

<u>Analysis across components of Trade Facilitation</u>

A natural next step is to investigate what type of differences in trade facilitation affects these sectors, since trade facilitation broadly defines a wide variety of aspects such as, timeliness, port efficiency, e-business structure and customs services. For example, improvements in timeliness will largely affect goods that require faster delivery, such as those that halt the supply chain, while improvements in infrastructure, such as better highways will affect those goods that are transported by roads. It is possible to do this exercise using the LPI data on trade facilitation, since it is constructed from 7 separate indices. I will focus on three of these indices, namely, *customs*, *infrastructure* and *timeliness* and estimate their relative impacts on trade.

<u>Accounting for Potential Biases in Estimates</u>

The last improvement focuses on the specification of the model and associated econometric issues. It is possible that regressing trade facilitation on trade may lead to biased coefficient estimates due to spurious correlation of trade facilitation with other characteristics of a country that also affect trade. Developed countries tend to have high levels of trade facilitation and also high levels of GDP, growth, liberal trade policies, etc, all of which boosts trade. Hence it may be that the coefficient of trade facilitation is capturing the effect of these variables rather than the direct effect. The direct effect can be filtered by controlling for these variables by including them in the model. I include real GDP, real GDP per capita and tariffs, all of which are likely to be highly correlated with trade facilitation. A potential problem of including ‘too many’ of these variables is that it may result in multicollinearity, which may lead to statistically insignificant coefficients for the correlated explanatory variables.

Another particular issue that deserves attention is that trade facilitation may be endogenous. Although building efficient infrastructure at the borders may ensure faster movement of goods, one can argue that countries that trade more also have more efficient electronic and physical infrastructural networks. For example, Singapore is largely dependent on trade and has improved amenities for smoother transportation of goods across borders. Thus it is not clear whether improvements in border infrastructure enhance trade or whether more trade entails larger investment incentives for the government to enhance public facilities, such as ports, waterways and highways for efficient trading. The natural approach to deal with this issue of reverse causality is to employ the instrumental variable/two-stage least-squares procedure. The first stage estimates trade facilitation using instruments and the second stage estimates bilateral trade using predicted trade facilitation. If appropriate instruments can be identified then the error terms will no longer be correlated with trade facilitation and this will essentially fix endogeneity.

The difficulty with this approach is to identify appropriate instruments for estimating the expected cross-country trade facilitation levels, such that these instruments are uncorrelated with trade flows. The problem is that countries that have improved trade facilitation at the borders tend to have high trade volumes, and hence factors that affect trade facilitation also affects trade flows. In order to overcome this issue, I consider the fact that countries that have good infrastructural amenities at the borders generally have good infrastructural network in the interior of the country. For example, the U.S. has high levels of trade facilitation and also good airports, highways and railways across all States, whereas Bangladesh has poorly constructed, congested roads in the major cities of Dhaka and Chittagong and poor trade facilitation at the borders. Given this expected correlation between ‘interior’ and ‘border’ infrastructure, I can use instruments that affect ‘interior’ rather than ‘border’ infrastructure since they are less likely to be correlated with trade flows.

A range of factors may affect the ‘interior’ infrastructure of a country. Countries that have a relatively large public sector as a share of GDP tend to have substantial investments in public projects such as education, social security and infrastructure. Thus the ‘relative size of public sector’ could be a potential instrument. Note, that although GDP is likely to be correlated with trade, it is not obvious how the relative size of government expenditure may directly influence trade. Another possible variable may be a governance indicator that estimates institutional structure, rule of law, corruption, etc. Countries that have high levels of corruption tend to have inadequate public amenities, such as infrastructure. For example, in many countries in Africa funds allocated towards public projects, such as the building of roads and highways, are often misdirected by corrupt public officials. Hence countries with bureaucratic institutions tend to have poorer provision of public services. These two instruments are particularly appealing due to the availability of data.

There may be other possible instruments that are appropriate, but data are not easily available at a global level. For instance, congestion levels in roads and highways can be an instrument. Often high levels of congestion are characterized with inadequate development of roads and highways. Congestion could be measured using share of taxes on automobile purchases, since highly congested cities usually have high levels of taxes on automobiles. It may also be measured using travel time to work place. Road density in terms of land or population can also be used to estimate trade facilitation. Altogether considering variables that explain differences in the ‘interior’ infrastructure of countries but are uncorrelated with trade flows will help to address the issue of endogeneity. Since data is easily available for the former two instruments, the share of government expenditure and corruption as a governance indicator, I only consider these in the model.

Model Specification

I use the standard gravity model as established in the recent literature to estimate the effect of trade facilitation on trade flows. I estimate a simple gravity model closely following the econometric model of Rose (2003), WMO (2005) and Helmers and

Pasteels (2005). I begin with an OLS model to serve as a benchmark for comparison with findings in the existing literature. Following the OLS model, I estimate a second model using the instrumental variable approach to account for possible endogeneity between trade facilitation and trade flows. The latter model is discussed in more detail in the last section.

The specification of the OLS model is:

$$\ln X_{ijk} = \beta + \beta_T \ln Tariff_{ijk} + \beta_L \ln \sqrt{LPI_i LPI_j} + \beta_{GDP} \ln(GDP_i GDP_j) + \beta_{GPC} \ln(GDP_i GDP_j / Pop_i Pop_j)$$
$$+ \beta_D \ln Dist_{ij} + \beta_A \ln(A_i A_j) + \beta_{LL} LanLock_{ij} + \beta_B Border_{ij} + \beta_{LA} Lang_{ij} + \beta_C Currency_{ij} + \varepsilon_{ijk}$$

where,

i = exporting country

j = importing country

k = commodity

Since the gravity model estimates bilateral trade flows, all the explanatory variables included in the model are bilateral. The above model includes the following explanatory variables: tariffs, product of the square root of LPI's, product of the GDPs, product of the per capita GDPs, geographical distance, product of land areas, landlocked, common border, common language and currency union. The landlocked dummy variable takes a value of 0, 1, 2 for none, either and both countries being landlocked, respectively. Each of the rest of the dummy variables, namely common border, common language and currency union take a value of 0 or 1.

As motivated by Anderson and van Wincoop (2001) it is appealing to include country fixed effects to eliminate country- specific omitted variable bias. However, inclusion of these will lead to multicollinearity since several of the explanatory variables are constructed using exporter and importer specific variables.

I use ordinary least squares with heteroskedasticity-robust standard errors. The coefficients of interest are the relative sizes of β_T and β_L i.e. the importance of tariffs versus trade facilitation in determining trade flows. In the results section I discuss how the coefficient estimates for trade facilitation vary across sectors. I also investigate how the effect on trade varies over different components of the LPI index.

Data

I obtain the bilateral tariff data for year 2001 from GTAP Database V6. The tariff data is built using the Market Access Maps (MAcMap) contributed by the Centre d'Etudes Prospectives et d'Information Internationales (CEPII). The MAcMap Data Base is compiled from UNCTAD TRAINS data, country notifications to the WTO, AMAD, and from national customs information. The import data for V6 is more sophisticated in terms of their sourcing and coverage, nature and quality, and data processing. The data used is trade-weighted preferential rates data on ad valorem tariffs (including tariff rate quotas) plus the ad valorem equivalents (AVEs) of specific tariffs for 163 importers and 226 partner exporters. It incorporates tariff preferences from recent trade agreements. The tariff data is obtained at the sectoral level and aggregated to the regional level using the GTAP trade data.

GTAP V6 incorporates reconciled bilateral merchandise trade data for 2001. A major source of the trade dataset is COMTRADE. Data is available for 226 importers and 226 partner exporters. The trade data used in this study are data on value (or price*quantity) of imports at *cif* prices.

The trade and tariff data from GTAP V6 are at the 57 GTAP sectoral level of aggregation. In this paper I focus on 4 aggregated commodities: *Agriculture*, *Extraction and Mining*, P*rocessed Food* and M*anufactured goods*. I aggregate 42 GTAP sectors to these four commodities. The mapping is shown in Table 1. For each bilateral pair of traders, I aggregate the trade data by summing VIWS across sectors. For example, suppose that I have bilateral trade date between the US and Saudi Arabia for each commodity in the *Extraction and Mining* sector. I will aggregate them by simply summing the total value of trade between these two countries for the relevant GTAP sectors that fall under this category to obtain the level of bilateral trade of *Extraction and*

Mining $\left(\sum_i Trade_i, i \in \text{Forestry, Fishing, Coal, Oil, Gas and Minerals nec}\right)$. Then I obtain tariff data for each aggregated sector by taking the sum of trade-weighted shares of tariffs $\left(\frac{\sum_i Trade_i * Tariff_i}{\sum_j Tariff_j}, i, j \in \text{Forestry, Fishing, Coal, Oil, Gas and Minerals nec}\right)$.

As mentioned earlier, trade facilitation is measured using the 'Logistics Perception Index' obtained from survey data in year 2006. This index ranges from a scale of 1 to 5, where higher values indicate better trade facilitation. South Asia and African countries have low levels of trade facilitation, while North America and European countries rank much higher. Since I use all bilateral variables in the model, I compute bilateral LPI by taking the square root of the product of the LPI indices of the trading countries. The intuition for taking the square root is that if a country trades with itself, then the bilateral LPI will be the same as the unilateral. Another plausible alternative is to take a simple average. It turns out that there are no differences in the regression results with these two alternative specifications.

Data for the remaining bilateral variables are available for a wide range of countries. I use the dataset made available by Rose (2003), where data on real GDP and population are obtained from the Penn World Tables, World Bank's Development Indicators and IMF's International Financial Statistics. Other bilateral variables in Rose's dataset, such as distance, products of land areas, landlocked, common border, common language and currency union are obtained from CIA's World Factbook. I merge all the above datasets using bilateral pairs as identifying variables. There are 30,690 observations or bilateral pairs in this combined dataset. Finally, for the IV model I obtain data on the relative size of public sector from the Penn World Tables and data on corruption from the 'Corruption Perceptions Index' constructed by Transparency International.

Table 2 shows the correlation matrix for explanatory variables. The correlations between the explanatory variables are generally low. As expected, GDP and per capita GDP are highly correlated (0.65). Interestingly, LPI is also highly correlated with GDP (0.71) and per capita GDP (0.80). This is not surprising since richer countries (high GDP per capita) have larger government funds to invest more on public projects such as facilitating trade by building adequate infrastructure at the borders. Larger countries (high GDP) trade more and have more incentives to invest on trade facilitation. Since these variables are highly correlated, it is important to include GDP and GDP per capita in the model in order to capture the causal effect of LPI on trade flows and avoid obtaining biased estimates resulting from spurious correlation.

Regression results for OLS

<u>Benchmark Model</u>

Estimated coefficients, standard errors and confidence intervals for the benchmark model are displayed in Table 3. The elasticity of trade with respect to tariffs is -1.99 i.e. increasing ln(tariffs) by one unit will reduce bilateral ln(trade) by 1.99 units. An increase in the great-circle distance by 1 mile reduces trade volume by 1.08 measured at *cif* prices. These estimates are similar to that established in the empirical literature of gravity models. WMO find a coefficient estimate of -1.16 for ad valorem tariffs and an estimate of -1.26 for distance, while Rose (2003) find an estimate of 1.20 for regional FTA and -1.12 for distance. The coefficient estimates for all variables, except currency union, are statistically significant at the 1% level of significance. All explanatory variables, except currency union and the log of per capita real GDP, display expected signs on the coefficient estimate. Countries that have same the language are expected to trade 0.75% more than countries with different languages. If two countries share a common border their expected trade increases by 1.82%. Countries that have larger land areas and those that are landlocked trade less. Since these coefficient estimates are consistent with previous findings, they form useful benchmark for comparison with the LPI coefficient estimates.

The signs of the coefficient estimates for the dummy currency union and the log of per capita real GDP are the only ones that deviate from expectations. The coefficient estimate of currency union is negative, but the t-statistic is too small and the results are not statistically significant. The 95% confidence interval is (-0.70, 0.23) also includes the value 0. We cannot reject the null hypothesis that currency unions have a causal effect on trade. The sign for the per capita real GDP is negative, which probably arises due to the high correlation of per capita real GDP with LPI and real GDP, which extract the variations in log of per capita real GDP with trade. Notice that excluding either LPI or real GDP from the regression equation resolves this issue of multicollinearity and changes the sign of per capita real GDP back to positive.

In this regression I am most interested in the effect of LPI on trade flows. A coefficient estimate of 5.72 indicates that increasing bilateral LPI by 1% (equivalent to 0.2 units on a scale of 1-5) will expand trade volume by 5.72%. This indicates that improving trade logistics has a sizeable effect on trade. Figure 1 shows how LPI varies across continents and groups of countries with varying income levels. The world average level of bilateral LPI is about 2.8; in general, low and middle income countries and also countries from South and East Asia, Sub-Saharan Africa, Middle East, Latin America and the Caribbean rank lower in their border logistics. I simulate the effect of increasing bilateral TF between Bangladesh and Pakistan (2.5) to the global average TF (2.8). This shows that the volume of bilateral trade on manufacturing goods will then increase from 1.10 to 1.92 by 74%. Note that improving individual country TF also increases trade with other partners. Similar simulations with positive shocks on TF for other countries shows that the effect is largely trade enhancing.

In order to compare the relative sizes of effects of TF versus tariffs, I bring them to the same units by multiplying the coefficient estimates with the respective standard errors. This shows that the relative impact of TF (1.37) is larger in magnitude than that of tariffs (-0.28) and other explanatory variables including tariffs. This confirms the hypothesis that trade facilitation poses a larger barrier to trade than tariffs. Massive trade liberalization around the globe for the past decade have reduced the relevance of tariffs as trade barriers and increased the importance of other barriers to trade. Since the trade data reflects global trade for the year 2001 it incorporates the latest Doha round of negotiations, phasing out of MFA quotas, China's accession to the WTO and numerous other bilateral and multilateral trade agreements. Since the 1990's more than 250 regional trade agreements have been notified to the WTO and about 70 other are known to be operational. These include the commonly known EU-ACP (2000) which combines EU with 77 other states in Africa, Carribean and the Pacific, NAFTA (1994), CAFTA (2004) - the Central American FTA, Mersosur (1991) - a CU in Latin America, SAFTA (2006) - South Asian PTA and many more. These significant liberalization efforts have reshuffled trading routes as countries with initially larger trade barriers gained competitiveness. However, following the declining importance of tariffs as trade barriers, other types of costs such as trade facilitation are now taking a larger share in total trade costs.

Effects on Trade across sectors

I run additional regressions to study how the relative effects of tariffs versus trade facilitation changes across the four aggregated sectors. Results for these regressions are shown in Table 4. The first column shows regression on *Agriculture* followed by *Extraction and Mining*, P*rocessed Food* and *Light and Heavy* M*anufactured goods*. It is important to note that the only variables that vary across sectors are trade and tariff. The rest of the variables are bilateral pair specific and hence remain same across sectors.

The coefficient estimates of tariffs remain similar for all sectors except for *Extraction and Mining* where the estimated effect is much larger. This implies that variations in trade of *Extraction and Mining* are largely explained by cross-country differences in tariffs. The sign of coefficients changes across sectors for only two variables, the product of areas and currency unions. These results are however not statistically significant. Results are statistically significant at the 1% level for all other variables for each of the four regressions. The coefficient estimates for all other variables, except LPI, are quite similar across each of the regressions with small scale variations. Landlockedness affects the trade of *Extraction and Mining* (-1.20) more than any other sector. This is plausible because countries that do not have access to the oceans are likely to have smaller fishing and extraction sectors.

The focus of this exercise is particularly on the coefficient estimates of LPI which changes dramatically across sectors. The elasticity of LPI with respect to trade is the smallest for agriculture and largest for manufactures. In other words, differences in cross-country trade facilitation can better explain differences in trade for manufacturing goods than agricultural goods. This result is not surprising and there may be many reasons why trade facilitation forms a larger barrier to trade for manufacturing goods. For instance, slow delivery of manufacturing goods, such as auto parts to countries where it is assembled, may obstruct the production chain and cause costly delays. Thus countries will prefer to import from competitive exporters who have a smoother and faster delivery system and hence the level of trade facilitation will have a large impact in determining trade. Probably many other aspects of trade facilitation affect aggregated manufacturing sectors more than others. These general results motivate further research on cross-sectoral effects of trade facilitation on trade. It will be worthwhile to conduct this analysis at a more disaggregated level of goods (HS6) to uncover which industries are most affected by trade facilitation.

Effects on Trade across components of LPI

Another interesting extension is to investigate which aspect of logistics affects trade the most. This type of analysis is relevant because it will guide policymakers to target specific features of trade facilitation to make appropriate discrete choices, such as building a bridge versus improving e-business facilities. Since the LPI index is constructed from 7 other indices, it is possible to decompose to individual indices. I focus on the differential effects of 3 of these components, namely *Customs*, *Infrastructure* and *Timeliness* on trade by replacing LPI with each of these effects. The results look quite similar to the benchmark model as shown in Table 5. The effect of tariff is slightly larger (approx. 2.1%), while the effect of trade facilitation is smaller than the benchmark model in all cases. An increase in the cost of inefficient customs procedures by 1% reduces trade by 3.87%; increases in costs by 1% imposed by poor infrastructure and lack of timeliness reduces trade by 4.72% and 4.43%, respectively. This shows that the relative costs associated with inadequate infrastructure and lack of timeliness reduces trade slightly more than additional costs imposed by inefficient customs procedures.

Regression using IV approach

In this regression I try to address the problem of reverse causality between trade facilitation and trade flows. I begin by considering the validity of using 'the share of government expenditure in GDP' and 'corruption' as instruments for LPI. As mentioned earlier, the intuition is that countries that have a large public sector must have a good 'interior' infrastructure and countries that are more corrupt are likely to have poor provision of public goods such as proper roads, highways, etc. Although these instruments may sound reasonable, I need to find evidence in the data to ensure their validity. The basic criteria for these to be valid instruments are that they must be correlated with LPI and uncorrelated with the error terms, and there is no known way of determining the latter. The correlation of LPI with the size of government sector is -0.33, where the negative sign indicates that it is inversely related with LPI which contradicts our hypothesis. Thus the data does not provide sufficient evidence for this to be a valid instrument. On the other hand, corruption is highly positively correlated with LPI (0.82) which implies that the cleaner a country is in terms of corruption the better its trade facilitation indicators are. Figure 1 shows the scatter plot of corruption with LPI. The relationship with LPI appears to be linear and upward sloping. Since corruption as an instrument appears to be reasonably appropriate, I use it as the only instrument in the IV model.

Table 6 shows regression results for the IV model. The first stage estimates LPI using corruption and all other exogenous variables of the model. The F-test is statistically significant which implies that the model rejects the null hypothesis that the independent variables have no causal effect on LPI. The first stage regression also has a large R-squared (0.81) i.e. that the data fits the model very well or that the predicted LPI values are highly correlated with the actual LPI values. This indicates that we can reasonably assume away the possibility of corruption to be a 'weak instrument'.

The second stage regression estimates trade using predicted LPI and the remaining variables assumed to be exogenous in the model. Results look almost identical to the OLS model. The R-squared takes a value of 0.52, which is similar to the value (0.54) in the OLS model; the F-statistic for 10 degrees of freedom is 3172, as opposed to 3629 in the OLS model. The coefficient estimates are very close to the OLS model, and for some are the same up to the second decimal place. The only significant difference is in that the coefficient estimate of the LPI variable is almost twice as much larger and that of the 'Land Area' variable is not statistically significant.

There are two possibilities for the difference in the coefficient estimate value of the LPI. One possibility is that since corruption is highly correlated with LPI, the problem of endogeneity still remains in the model. This biases the coefficient estimates in the same direction and the estimates are inconsistent. In this case more research is required to identify alternative instruments that are valid and obtain consistent estimates.

Alternatively, if the instrument is in fact valid and the model has successfully accounted for endogeneity, then the coefficient estimates of LPI are consistent and unbiased. This suggests that LPI have relatively large effect (9.33) on trade flows. The effect of trade, distance, common language barriers take relatively smaller portions of total trade costs. This may be because of large declines in transportation, increases in communication facilities, trade liberalizations, etc. With declines in these costs, other costs such as trade facilitation are now important trade barriers that differentiate countries.

Conclusion

With large reductions in tariff and transportation costs, the relative importance of these barriers has declined, and that of other types of costs, such as trade facilitation has increased. Countries that have good infrastructure at the borders, ensures faster delivery of goods and has efficient customs procedures gains competitiveness over other exporters and takes larger shares of the global market. This paper illustrates that trade facilitation plays a central role in determining competitiveness of exporters. Using a gravity model representing the global economy in 2001, I find statistically significant coefficient estimates for trade facilitation (5.72). I also find that the relative effects of TF on trade are larger than other explanatory variables included in the model, such as tariffs and distance. In addition to the simple OLS model, I also estimate a second model using the instrumental variable approach to account for possible reverse causality between trade facilitation and trade flows. The IV model finds coefficient estimates for trade facilitation that are larger (9.33) and statistically significant. I also extend the simple OLS model by investigating variation in effects across sectors. These results indicate that trade in manufacturing sectors are affected most (7.20), and that in agriculture is affected the least (3.40) due to changes in trade facilitation.

There are several ways this paper can be improved. In this paper I began with several instruments in mind to correct for endogeneity. However, it is difficult to obtain data for many of these instruments. Hence it will be useful to identify valid instruments for which data is available at a global level. Also since the literature on trade facilitation have consistently found large and significant coefficient estimates, it calls for the development of theoretical models that incorporate the notion of trade facilitation in trade models. Developing theory will aid to identify valid instruments and account for endogeniety.

This paper also illustrates that the role of trade facilitation is likely to vary across sectors. One interesting extension could be to use a finer level of sectoral disaggregation to investigate what type of industries can benefit from improved trade facilitation. This will be useful for development agencies that enhance trade facilitation for countries. This paper also shows that different types of trade facilitation measures such as improving customs procedures, infrastructure or timeliness have varying effects on trade flows. This motivates further research in this area to identify what type of improvements in trade facilitation measures will reap highest returns.

References

Das, Samantak and Pohit Sanjib Pohit (2006). Quantifying Transport, Regulatory and other costs of Indian Overland exports to Bangladesh. The World Economy, Vol. 29, Issue 9.

Francois, Joseph and Manchin, Miriam (2007). Institutions, Infrastructure, and Trade. World Bank Policy Research Working Paper 4152.

Freund, C. and Weinhold, D. (2000). On the effect of the Internet on International Trade. Technical report, International Finance Discussion Papers 693, Board of Governors of the Federal Reserve System USA.

Helmers, Chrsitian and Jean-Michel Pasteels. June 2005. “TradeSim (3rd version), a Gravity Model for the calculation of Trade Potentials for Developing Countries and Economies of Transition”. International Trade Center, Market Analysis Section.

Hertel, T. W., editor (1997). Global Trade Analysis, Modeling and Applications. Cambridge University Press.

Hertel, T. W., Walmsley, T., and Itakura, K. (2001). Dynamic effects of the ”new age” free trade agreement between japan and singapore. Technical report, GTAP Center.

Hummels, David (2001). Time as trade barrier. GTAP working paper 1152. Purdue University.

Ivanic, Maros, Mann, C. L., and Wilson, John. S. (2006). Aid for Trade Facilitation. Global Welfare Gains and Developing Countries. Draft.

Kaufmann, D., Kraay, A., and Zoido-Lobaton, P. (1999). Governance matters. Technical report, Working Papers, Governance, corruption, legal reform, 2196, World Bank.

Khan, S. R., Yusuf, Moyeed, Bokhari, Shahbaz and Aziz, Shoaib (2005). Quantifying Informal Trade Between Pakistan and India. Sustainable Development Policy Institute (SDPI) for World Bank.

Measuring Global Connections - A New Set of Logistics Indicators. World Bank Publications.

Regional Trade Agreements in South Asia: Trade and Conflict Linkages (2006). Sustainable Development Policy Institute (SDPI) for International Development Resource Centre (IDRC).

Rose, Andrew K. 2004. “Do we Really Know that the WTO Increases Trade?” American Economic Review (forthcoming).

South Asian Free Trade Area – Opportunities and Challenges. USAID. Nathan Associates INC.

Taneja, Nisha (2006). India – Pakistan Trade. ICRIER, Working Paper No. 182.

Walkenhorst, Peter (2004). Border process characteristics and the impact of trade facilitation. OECD Publications, 2 rue André Pascal, 75775 Paris Cedex 16, France.

Wilson, J. S., Mann, C. L., and Otsuki, T. (2003). Trade facilitation and economic development: Measuring the impact. Technical report, World Bank Policy Research Working Paper 2988.

Wilson, J. S., Mann, C. L., and Otsuki, T. (2005). Assessing the Potential Benefit of Trade Facilitation: A Global Perspective. The World Economy, 28(6).

Woo, Yuen Pau and John S. Wilson (2000). Cutting Through Red Tape: New Directions for APEC's Trade Facilitation Agenda. Asia Pacific Foundation of Canada: Vancouver.

Table 1: Mapping from GTAP 57 commodities to 4 aggregated sectors

Number	Code	Description	4 Aggregated Sectors
1	PDR	Paddy rice	Agriculture
2	WHT	Wheat	Agriculture
3	GRO	Cereal grains nec	Agriculture
4	V_F	Vegetables, fruit, nuts	Agriculture
5	OSD	Oil seeds	Agriculture
6	C_B	Sugar cane, sugar beet	Agriculture
7	PFB	Plant-based fibers	Agriculture
8	OCR	Crops nec	Agriculture
9	CTL	Bovine cattle, sheep and goats, horses	Agriculture
10	OAP	Animal products nec	Agriculture
11	RMK	Raw milk	Agriculture
12	WOL	Wool, silk-worm cocoons	Agriculture
13	FOR	Forestry	Extraction and Mining
14	FSH	Fishing	Extraction and Mining
15	COL	Coal	Extraction and Mining
16	OIL	Oil	Extraction and Mining
17	GAS	Gas	Extraction and Mining
18	OMN	Minerals nec	Extraction and Mining
19	CMT	Bovine meat products	Processed Food
20	OMT	Meat products nec	Processed Food
21	VOL	Vegetable oils and fats	Processed Food
22	MIL	Dairy products	Processed Food
23	PCR	Processed rice	Processed Food
24	SGR	Sugar	Processed Food
25	OFD	Food products nec	Processed Food
26	B_T	Beverages and tobacco products	Processed Food
27	TEX	Textiles	Manufacturing
28	WAP	Wearing apparel	Manufacturing
29	LEA	Leather products	Manufacturing
30	LUM	Wood products	Manufacturing
31	PPP	Paper products, publishing	Manufacturing
32	P_C	Petroleum, coal products	Manufacturing
33	CRP	Chemical, rubber, plastic products	Manufacturing
34	NMM	Mineral products nec	Manufacturing
35	I_S	Ferrous metals	Manufacturing
36	NFM	Metals nec	Manufacturing
37	FMP	Metal products	Manufacturing
38	MVH	Motor vehicles and parts	Manufacturing
39	OTN	Transport equipment nec	Manufacturing
40	ELE	Electronic equipment	Manufacturing
41	OME	Machinery and equipment nec	Manufacturing
42	OMF	Manufactures nec	Manufacturing

Table 2: Correlation Matrix for Explanatory Variables

	Log Trade	Log Tariff	Log LPI	Log prod Real GDPs	Log prod Per Capita Real GDPs	Log Distance	Log prod Areas	Landlocked	Border	Common Language	Currency Union
Log Trade	1										
Log Tariff	-0.13	1									
Log LPI	0.56	-0.16	1								
Log prod Real GDPs	0.68	-0.07	**0.71**	1							
Log prod Per Capita Real GDPs	0.46	-0.16	**0.80**	**0.65**	1						
Log Distance	-0.17	0.11	0.00	0.09	0.00	1					
Log prod Areas	0.18	0.08	-0.10	0.36	-0.23	0.16	1				
Landlocked	-0.26	-0.09	-0.22	-0.28	-0.21	-0.15	-0.07	1			
Border	0.15	-0.05	-0.03	0.01	-0.05	-0.40	0.07	0.05	1		
Common Language	0.06	0.00	-0.06	-0.05	-0.05	-0.13	-0.02	-0.05	0.11	1	
Currency Union	-0.05	-0.04	-0.10	-0.13	-0.11	-0.13	0.01	0.05	0.12	0.16	1

Table 3: Benchmark Regression Results

	Coefficient	**Std. Error.**	**P-value**	**95% Confidence Intervals**	
Log Tariff	-1.99	0.14	0.00	-2.27	-1.71
Log LPI	5.72	0.24	0.00	5.26	6.18
Log product Real GDPs	1.02	0.01	0.00	0.99	1.04
Log product Per Capita Real GDPs	-0.24	0.02	0.00	-0.27	-0.20
Log Distance	-1.08	0.02	0.00	-1.13	-1.03
Log product Areas	-0.04	0.01	0.00	-0.06	-0.02
Landlocked	-0.82	0.03	0.00	-0.88	-0.75
Border	1.82	0.13	0.00	1.56	2.09
Common Language	0.75	0.05	0.00	0.64	0.85
Currency Union	-0.24	0.26	0.36	-0.75	0.27
Constant	-43.67	0.41	0.00	-44.47	-42.87
R-squared	0.5419				
F(10, 30679); Prob>F	4420; 0.000				
Number of observations	30690				

Note: Results are statistically significant at the 1% level for all variables, except Currency Union.

Table 4: Comparison of Regression Results across Aggregated Sectors

	Agriculture		Extraction and Mining		Processed Food		Manufacturing	
	Coeff	**St. Dev**	**Coeff**	**St. Dev**	**Coeff**	**St. Dev**	**Coeff**	**St. Dev**
Log Tariff	-2.98	0.34	-5.91	0.47	-2.76	0.22	-2.78	0.33
Log LPI	3.40	0.43	5.05	0.41	6.39	0.37	7.20	0.33
Log product Real GDPs	1.12	0.02	0.95	0.02	0.88	0.02	1.11	0.02
Log product Per Capita Real GDPs	-0.39	0.03	-0.31	0.03	-0.09	0.02	-0.18	0.02
Log Distance	-1.02	0.04	-1.21	0.04	-0.86	0.04	-1.14	0.03
Log product Areas	-0.08	0.02	0.03	0.02	0.01	0.01	-0.11	0.01
Landlocked	-0.73	0.06	-1.20	0.06	-0.92	0.05	-0.57	0.05
Border	1.95	0.24	2.24	0.27	1.77	0.23	1.26	0.21
Common Language	0.56	0.09	0.51	0.09	0.82	0.08	1.08	0.07
Currency Union	-0.87	0.41	-0.27	0.49	-0.50	0.44	0.34	0.48
Constant	-44.08	0.71	-41.47	0.69	-42.52	0.67	-45.77	0.58
R-squared	0.586		0.620		0.679		0.787	

Note: Results are statistically significant at the 1% level for all variables, except Currency Union in all cases, and also Log products of Areas for Extraction and Mining and Processed Food.

Table 5: Comparison of Regression Results across components of LPI

	Customs		Infrastructure		Timeliness	
	Coeff	**St. Dev**	**Coeff**	**St. Dev**	**Coeff**	**St. Dev**
Log Tariff	-2.07	0.14	-2.13	0.14	-2.04	0.14
Log LPI	3.87	0.20	4.72	0.21	4.43	0.23
Log product Real GDPs	1.07	0.01	1.02	0.01	1.08	0.01
Log product Per Capita Real GDPs	-0.19	0.02	-0.25	0.02	-0.19	0.02
Log Distance	-1.09	0.02	-1.07	0.02	-1.08	0.02
Log product Areas	-0.05	0.01	-0.03	0.01	-0.07	0.01
Landlocked	-0.82	0.03	-0.78	0.03	-0.88	0.03
Border	1.84	0.14	1.81	0.13	1.82	0.13
Common Language	0.71	0.05	0.76	0.05	0.74	0.05
Currency Union	-0.25	0.26	-0.19	0.27	-0.08	0.26
Constant	-44.43	0.41	-42.70	0.43	-45.74	0.39
R-squared	0.586		0.620		0.679	

Note: Results are statistically significant at the 1% level for all variables, except Currency Union for all cases and Log product of areas for Infrastructure

Table 6: IV Model Results

First Stage

	Coefficient	Std. Error.
Log Tariff	0.024	0.003
Log CPI	0.230	0.002
Log product Real GDPs	0.025	0.000
Log product Per Capita Real GDPs	0.002	0.000
Log Distance	0.005	0.000
Log product Areas	0.002	0.001
Landlocked	0.019	0.001
Border	0.004	0.001
Common Language	0.005	0.003
Currency Union	0.008	0.005
Constant	0.401	0.008
R-squared	0.8112	
F(10, 28577); Prob>F	12280; 0.000	
Number of observations	28588	

Note: Results are statistically significant at the 1% level for all variables, except Log of Distance, Border Dummy and Currency Union.

Second Stage

	Coefficient	Std. Error.
Log Tariff	-1.98	0.17
Log CPI	9.33	0.49
Log product Real GDPs	0.90	0.02
Log product Per Capita Real GDPs	-0.35	0.02
Log Distance	0.00	0.01
Log product Areas	-1.07	0.03
Landlocked	0.75	0.05
Border	-0.92	0.03
Common Language	1.82	0.13
Currency Union	0.12	0.26
Constant	-41.03	0.48
R-squared	0.5227	
F(10, 28577); Prob>F	3172; 0.000	
Number of observations	28588	

Note: Results are statistically significant at the 1% level for all variables, except Log of Areas and Currency Union.

Figure 1: TF across countries from different continents and income levels

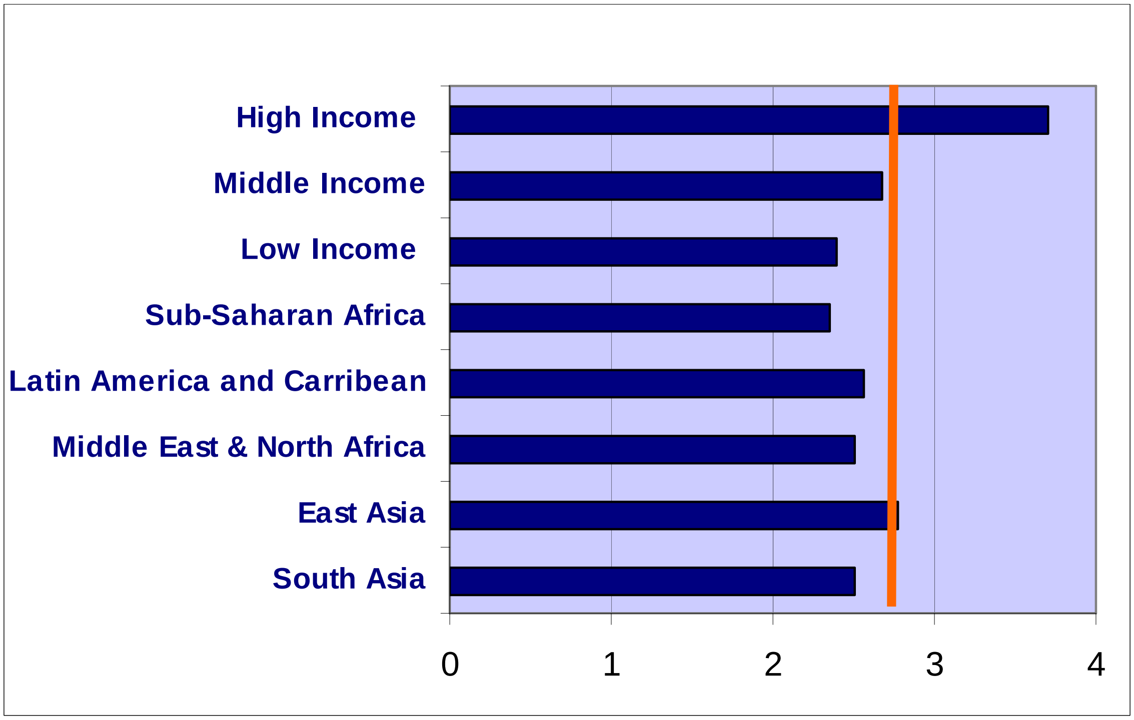

Figure 2: Relationship between Corruption and Trade Facilitation