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LOGISTICS AND EXPORTS

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Drawing on a new and comprehensive measure of logistics quality, our gravity model suggests logistics in the exporting and partner-country can have an important impact on bilateral exports. A one standard deviation improvement in the exporter's logistics quality, which for example would improve Gabon to the level of Guinea, would raise exports by almost 60%. Landlocked countries' exports depend on their neighbours' logistics, but their own logistics quality is not as important as for other countries. We also find that logistics act to reduce the trade effects of distance, but without eliminating them.

KEY WORDS: Logistics, exports, gravity models. JEL CODES: F1, R11, H54

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1. INTRODUCTION

Although tariffs on industrial products have generally declined, non-tariff barriers to trade remain. One example of non-tariff barriers is the cost of transporting goods to foreign markets (Nordås & Piermartini, 2004). As argued in Brun, Carrere, Guillaumont & de Melo (2005), transport costs associated with distance are still material – distance is not dead. The length of time goods take to ship, and the uncertainty potentially associated with the time are also costly to potential exporters (Hummels, 2001). Anderson and van Wincoop (2004) provide a summary of the costs of trade. They estimate that international trade costs are equivalent to a 74 per cent *ad valorem* tariff for a typical product between developed countries.

Buys, Deichman & Wheeler (2006) calculate that their programme of road network expansion in Africa would increase trade by $250 billion over 15 years at a cost of $20 billion plus $1 billion per year. The case for roads may be compelling, but roads are not everything. Freight costs have *inter alia* been attributed to aspects affecting the broader infrastructure, including rail, ports and communications (Clark, Dollar & Micco, 2004; Limao & Venables, 2001). Uncertainty interacts with the transport infrastructure – tarred roads are less likely to be flooded than gravel ones after a storm – but could also be due to a lack of transparency and reliability in customs procedures. Through this transport cost channel, a number of studies have associated the quality of infrastructure with trade volumes (Clarke et al, 2004; Limao & Venables, 2001; Wilson & Otsuki, 2005; Nordås & Piermartini, 2004). More generally, Calderon & Serven (2008) analyse the role of infrastructure in broader economic development.

We contribute to the literature by making use of a new index of logistics developed by the World Bank to investigate the relationships between logistics and bilateral exports. This new index offers a number of advantages. It draws on a wide range of criteria. In addition to physical infrastructure, it incorporates *inter alia* measures of expertise and of customs clearance. It stems from a single source, and is based on detailed evaluations provided by logistics professionals (Arvis, Muster et al, 2007).

In a gravity framework, we find that the logistics of both the source and destination country are associated with bilateral exports. We also find that good logistics can reduce effective distance, but, paraphrasing Brun et al (2005), logistics cannot kill it.

We also investigate whether logistics in the countries' neighbours play a role in bilateral exports. Neighbours can be important when exports form part of a regional supply chain,[1] but can be particularly important for landlocked countries. Apart from airfreight, landlocked countries rely on the logistics of their neighbours to send goods overseas.

Our results indicate that bordering countries' logistics are not important, *except* for the landlocked exporters. Also, the landlocked's own logistics are less important. Furthermore, the quality of the destination country's neighbours' logistics is negatively related to exports to that country. This may be because there is more competition in the choice of export destination: countries choosing amongst various drop off points may decide to send their exports to the relatively well-equipped countries before allowing regional distributors to take over.

The rest of this paper proceeds as follows. Section 2 briefly reviews work on the role of infrastructure and other logistics measures. Section 3 introduces and discusses our modelling approach while section 4 describes the data. Section 5 presents the results while section 6 provides a concluding discussion.

[1] Redding & Venables (2003) develop the term "supplier access" to refer to the availability of inputs using distance measures and other features of transport costs.

2. LITERATURE REVIEW

Lower transport costs would increase trade volumes. Limao & Venables (2001) map information on road, rail and phone infrastructure to shipping cost information garnered from freight forwarders. They calculate that infrastructure accounts for 40% of transport costs. In a gravity framework, they find that improvements in infrastructure would increase trade materially: a country improving its infrastructure from the median to the 75th percentile would increase its trade 68%. A deterioration of infrastructure from the median to the bottom quartile would reduce trade volumes by 28%.

Similarly, Clarke et al (2004) find port facilities and general infrastructure contribute to ocean freight costs. These costs, which are based on containerization, the regulatory environment, seaport infrastructure and other variables also materially impact trade.[2] Nordås & Piermartini (2004) adopt a similar approach to Limao & Venables but use more infrastructure measures. They have separate specifications for a number of indicators – airports, roads, telephone lines, port efficiency and the median port clearance time – which are estimated separately. They find all components to be a significant determinant of trade, with port efficiency being the most influential.

Moving beyond infrastructure, Hummels (2001) finds that improvements in customs clearance sufficient to reduce waiting times by a day would be equivalent to a 0.8% point reduction in *ad valorem* tariffs.[3] Djankov et al (2006) calculate that a delay of one day is equivalent to an additional bilateral distance of about 70km. They suggest the delay cost is higher for developing countries because of the nature of their exports.

Wilson et al (2005) define and evaluate four measures of trade facilitation: port facilities, customs handling, the regulatory environment and the availability of service sector infrastructure. To do this, they combine information from three sources to study manufacturing exports from 75 countries. They find that improvements in all four measures would have material impacts on both exports and imports, with a bigger impact on exports. They simulate the effect of bringing all countries with below-average measures of trade facilitation half way up to the global average. The effect on world trade is an increase of 9.7%, with the biggest contribution coming from the service sector infrastructure.

Limao & Venables (2001) find the median landlocked country trades much less than a coastal country; controlling for size and distance, it trades less than half as much. This may be because the incidence of transport costs falls on landlocked countries (Amjadi & Yeats, 1995). Limao & Venables calculate that the transport cost for the median landlocked country is 55% higher than for the median coastal country. They calculate that, for landlocked countries, their own infrastructure accounts for 36% of transit costs but infrastructure in the transit countries they use to get to port accounts for an additional 24%.

Gallup, Sachs & Mellinger (1999) have suggested the landlocked are particularly vulnerable because cross-national infrastructure projects are difficult to implement, but it's not just about infrastructure: Gallup et al also suggest coastal neighbours may have military or economic incentives to impose costs on the landlocked deliberately. As a result, the "Almaty Programme" is aimed at relieving some of the difficulties faced by landlocked countries. Goals include recognizing freedom of transit, developing transport infrastructure and fostering transnational co-operation (Arvis, Raballiland & Marteau, 2007). These difficulties may be better captured by the broad logistics index than by pure infrastructure indices.

[2] Clarke et al find a move from the 25th to 75th percentiles would increase trade by 22%, which appears to be less of an impact than for Limao & Venables. Clarke et al have only 43 countries in their sample, many of which are developed. The interquartile range may be lower in Clarke's sample and/or there may be decreasing returns to infrastructure improvements.

[3] (Nordås & Piermartini, 2004) find tariffs have a negative impact on trade in their gravity specification.

3. MODEL and ESTIMATION ISSUES

We model the relationship between exports and logistics using a gravity equation. This equation has a long and successful history in explaining bilateral trade patterns, with much of the explanatory power coming from the two countries' GDPs and the distance between them. Theory has subsequently provided grounding for the empirical success of the gravity model (Anderson 1979, Bergstrand 1985). The theory behind the gravity model concludes that physical distance is a proxy for bilateral trade costs.

Other geographical contributors to transport costs include a country's land area and whether or not it is landlocked or has access to navigable rivers. Broader interpretations of "distance" motivate a wide variety of variables that may be thought to affect costs, such as common language and colonial relationships. As argued in section 2, gravity models have been used to show that the actual costs incurred can be reduced by aspects of physical infrastructure and, more generally, trade facilitation.

The canonical gravity equation links bilateral trade flows (X_{ij}) to the GDPs of the exporting and importing countries (y_i and y_j) and the distance between them (d_{ij}) Our contribution focuses on the logistics indices for the exporter and importer. (l_i and l_j) (equation 1). $\mathbf{W}$ is a vector of controls thought to proxy for aspects of distance and other country characteristics. All variables are specified in logs, except for the logistics index and if otherwise stated.

$$X_{ij} = \beta_0 + \beta_1 . y_i + \beta_2 . y_j + \beta_3 . d_{ij} + \beta_4 . l_i + \beta_5 . l_j + \Upsilon \boldsymbol{W} + e_{ij}$$

(equation 1)

Some additional specifications will include terms for infrastructure in neighbouring countries and interactions between logistics and whether or not the countries are landlocked.

Equation (1) assumes e_{ij} is an iid error term, which is uncorrelated with the other explanatory variables in the equation. This assumption must hold for consistent estimation of the coefficients. We are in effect assuming that any remaining unobserved country-specific effects are uncorrelated with the other explanatory variables, which may be invalid (Egger & Pfaffermayr, 2003). Unobserved bilateral fixed effects can be controlled for using panel data for some applications, eg Behar & Manners (2008), but the logistics index is only available for one period, so we use a single cross-section.

Simply including country (but not bilateral) dummies would prevent our identifying a number of coefficients, including the country-specific logistics indices. Egger (2005) proposes a cross-sectional implementation of the Hausman Taylor (1981) estimator to control for unobservables yet still identify the fixed variables of interest. Wilson et al (2005) estimate a gravity equation using OLS on their variables of interest and subsequently run two separate regressions including exporter (but not importer) and importer (but not exporter) fixed effects to see the impact on the other coefficients. This is the approach we follow, but cannot completely discount the possibility of invalid correlations due to omitted unobservables.

The iid assumption rules out reverse causation. In gravity models, output causes trade, not the other way around, as found for example in canonical growth regressions. Similarly, there is ambiguity regarding the relationship between logistics and trade. Equation (1) implies improved logistics allow for higher exports, possibly by reducing transport costs. However, it may be that higher trade volumes stimulate the construction of new infrastructure and the introduction of more efficient clearance technologies: the marginal value of investments in trade facilitating measures may be higher if exports are high, while some aspects of the logistics technology are subject to scale economies and thus only worthwhile at very high volume. This could lead to an upward bias in the estimated coefficient. On the other hand, high trade volumes may increase the strain on the system, leading to queues at the border and longer customs processing times (Djankov et al, 2006).[4]

Coe & Hoffmaister (1999) estimate gravity models in multiplicative form rather than adopting a log-linear specification. Their justification is that countries reporting zero trade would drop out of the data set, that the countries omitted would not be random, and that this would result in inconsistent estimates. Helpman, Melitz & Rubinstein (2007) develop a model incorporating selection of bilateral pairs as trading partners and construct a two-step estimation procedure embodying this selection process. Their application finds this source of bias to be small.[5]

[4] One might argue some aspects are more endogenous than others; customs delays may be endogenous while corruption is less likely to be. Using a similar argument, Djankov et al use the number of signatures required for customs clearance as an instrument for their measure of trade facilitation.

[5] Other potential selection issues remain. Helpman et al also discover potential biases on the distance coefficient induced by not accounting for the causes of asymmetries between countries in trade flows, which they attribute to heterogeneity among firms and their consequent decision to export to a particular destination. Interpreting missing data in bilateral trade datasets presents further potential selection issues. While such observations could be randomly absent, they could be missing due to country characteristics which determine the probability of reporting or simply omitted because trade is zero or low.

4. DATA and DESCRIPTIVE STATISTICS

We average merchandise exports data and GDP data for the period 2001-5, using the IMF *Direction of Trade Statistics*. For missing values in a particular year, we assume the missing value is equal to the average of the values that are available, as long as there is data for at least one year. If bilateral data reported as missing were actually zero or very low, then we would be overstating exports.

The measure of bilateral distance that we use captures the internal distance in a country and accounts for the distance from a number of major cities, constructed by CEPII.[6] Border data are also sourced from CEPII. This information is used to construct unweighted averages of logistics in a country's neighbours. Islands are excluded from our analysis.

Our control variables, including landlocked, common language, colonial relationships and land area are sourced from CEPII. We also include the proportion of the population within 100 kilometres of a navigable river or the coast using data from the Harvard Centre for International Development.

The logistics performance index is sourced from the World Bank[7] and is constructed on a scale from 1-5. The logistics performance index is an aggregate of sub-indices, namely:

i. Efficiency of the clearance process by customs and other border agencies (customs)
ii. Transport and information technology infrastructure (infrastructure)
iii. Ease and affordability of international shipments (international)
iv. Local logistics industry competence (logistics)
v. The facility to track and trace shipments (tracing and tracking)
vi. The timeliness with which shipments reach their destination (timeliness)

The aggregate index is calculated by the World Bank using a principal components analysis of the six[8] different sub-indicators. Table 1 reports the sub-indicators and their weights,[9] suggesting that the components have roughly equal importance.

Component	Weight
Customs	0.18
Infrastructure	0.15
International shipments	0.20
Logistics competence	0.16
Tracking and tracing	0.16
Timeliness	0.15

Table 1: The components of the logistics performance index and their weightings. Source: http://go.worldbank.org/88X6PU5GV0. Authors' calculations.

[6] The distance measure used is distw from http://www.cepii.fr/anglaisgraph/bdd/distances.htm.
[7] http://go.worldbank.org/88X6PU5GV0
[8] Originally, data was also collected on a seventh component, Domestic logistics costs. This component was found to be uncorrelated with the others and was consequently dropped.
[9] The weights that are used are not reported but can be backed out. For each country we have $LPI_i = C_i^T.w_i$ where LPI_i is the total LPI score, C_i is a 6x1 vector of the six component scores and w_i is a 6x1 vector of the weights. We can then use six different country LPI scores and components to form a matrix equation $w_i = (C^T)^{-1}.LPI$, which solves for the weights. We do this for a number of different sets of countries to ensure that the weights we calculate are unaffected by rounding errors.

Further details of the construction of each index are available in Arvis, Mustra et al (2007). In summary, the index is based on more than 5 000 country evaluations by logistics professionals. Of the 150 countries they report, Singapore ranks first and Afghanistan ranks last, with scores of 4.19 and 1.21.

The perceptions-based measure is corroborated with a variety of qualitative and quantitative indicators. For example, Arvis, Mustra et al (2007) calculate that, on average, a one-point rise in the overall logistics index corresponds to exports taking three more days to travel from the warehouse to port. Djankov et al (2006) contrast Denmark, where goods take 5 days to be cleared for export, with Burundi, where they take 67 days. In terms of the logistics index, the scores are 3.86 and 2.29 respectively. Denmark is amongst the highest but Burundi is not doing too badly. In fact, it is doing better than a quarter of our sample, as shown in Table 2.

Region	Mean
North America	3.88
Europe & Central Asia	3.13
East Asia & Pacific	3.09
Latin America & Caribbean	2.59
Middle East & North Africa	2.54
South Asia	2.49
Sub-Saharan Africa	2.34
Overall	
Mean	2.75
p25	2.29
Median	2.53
p75	3.13
Standard Deviation	0.62

Table 2: Sample summary statistics for logistics index.
Source: Authors' calculations.

Our effective regression sample consists of about 100-110 countries rather than the 150 countries for which the logistics index is available. The difference is in large part due to our omission of islands, because of our interest in neighbours' logistics. Our overall sample statistics are very much in line with those for all 150 countries.[10]

Table 2 suggests a variation in logistics quality across regions, with Sub-Saharan Africa having the lowest average in our sample. However, the 150-country sample gives South Asia approximately the same average as Sub-Saharan Africa. The East Asia & Pacific region, which is more affected by the omission of islands, has a relatively high mean of only 3.09, while the 150-country sample would generate a mean of 2.58, placing it below the overall average.

Our data indicates some dispersion between regions, but there are some large differences within regions too (Figure 1). For example, Arvis, Mustra et al (2007) document variation within landlocked countries in Sub-Saharan Africa. Many landlocked countries have efficient logistics relative to the rest of the region, but many experience overregulated and poor logistics. They also suggest the Eastern side of the continent has better logistics than the Western side.

[10] Summary statistics for the complete sample are reported at http://info.worldbank.org/etools/tradesurvey/mode1b.asp#ranking

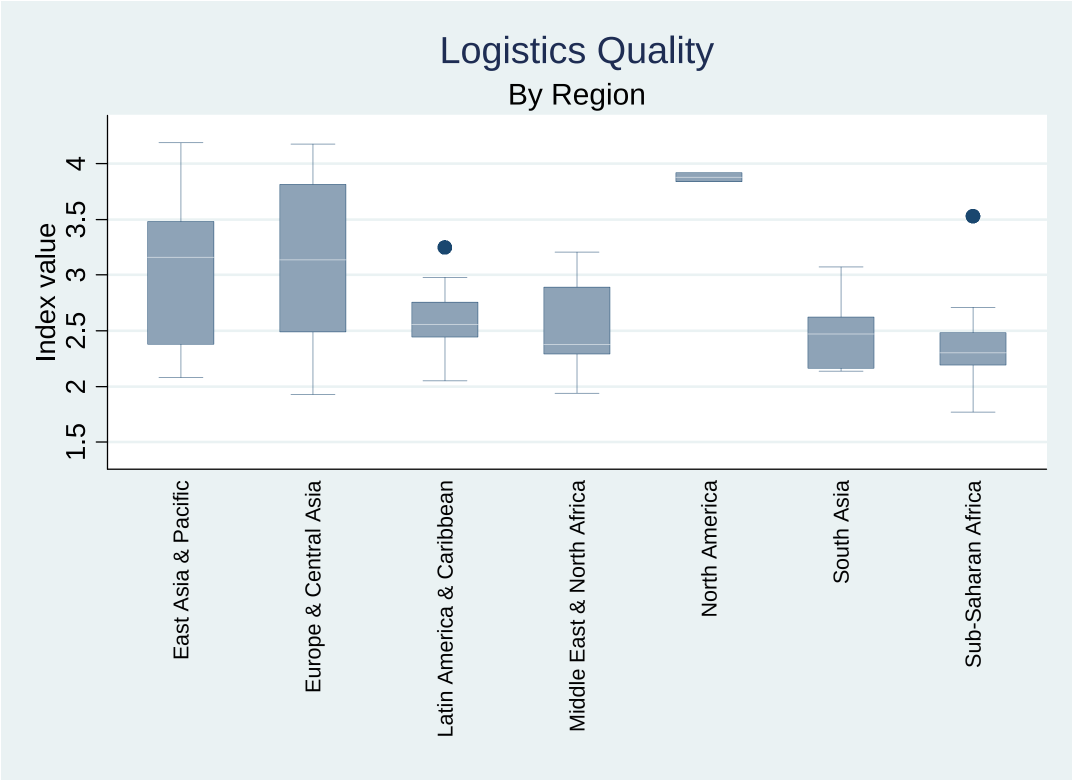

Figure 1: Box and whisker diagrams for logistics index, by region, based on our sample of countries which have neighbours. In each box, the white line represents the median while the top and bottom of the shaded boxes denote the 75th and 25th percentiles. The horizontal lines at the end of the whiskers show the highest and lowest observations that are not statistical outliers. Statistical outliers are represented by diamonds. The diagrams suggest there is a large variation within some regions, but most sub-Saharan African and South Asian countries perform poorly.

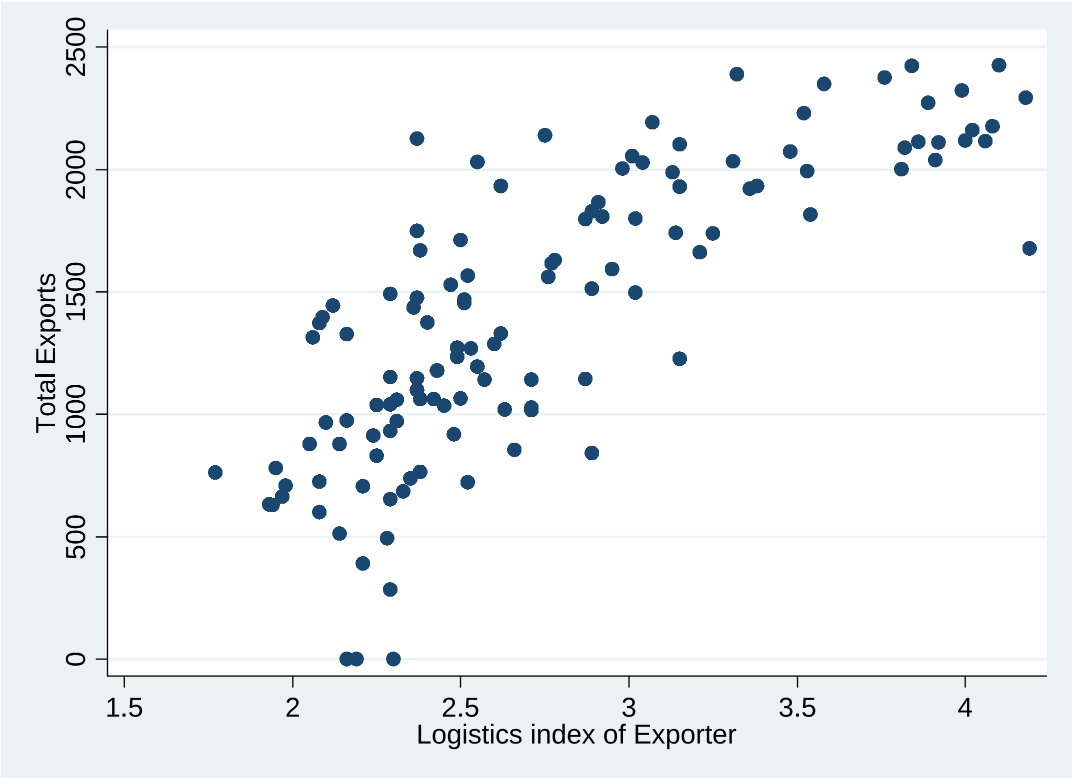

Figure 2: Plotting each country's total exports (in logs) against its logistic index provides preliminary evidence of a positive relationship between the variables. (This is based on our sample of countries with neighbours.)

Much of the variation within Europe & Central Asia in Figure 1 is accounted for by income levels: excluding high income countries yields a median of 2.49, which is close to that for the whole sample. Despite the large variations, it appears that logistics in Sub-Saharan Africa and in South Asia are generally lower than other regions in our sample.[11]

In Figure 2, we see evidence of a positive and only slightly concave relationship between the exports of a country and its logistics index, without accounting for country income levels. In the next section, we provide a more formal analysis of the relationship, taking into account the effects of country size and other controls.

[11] The outlier is South Africa, which is incidentally the top-ranked middle income country in the world (Arvis, Mustra et al, 2007).

5. RESULTS

Table 3 reports our core results based on OLS estimates. Our results were robust to specifications using either exporter or importer fixed effects, where the coefficients were remarkably similar. The appendix contains these alternative specifications.

	-1	-2	-3	-4
Dependent Variable	Exports	Exports	Exports	Exports
GDP1	1.308***	1.133***	1.081***	1.097***
GDP2	0.985***	0.911***	0.845***	0.861***
Distance	-1.516***	-1.483***	-1.369***	-1.510***
Logistics1		0.772***	0.947***	1.040***
Logistics2		0.356***	0.425***	0.523***
Logistics*distance				0.436***
Area1			0.103***	0.0856***
Area2			0.0561*	0.0372
Common neighbour			1.067***	0.991***
Common official language			0.137	0.146
Common ethnic language			0.527***	0.405***
Exporter ever a colony of importer			0.071	0.165
Common colonizer			1.304***	1.196***
Exporter a colony of importer since 1945			1.402***	1.205***
Countries were once the same country			0.533**	0.338
Proportion of population within river/coast 1			0.00951	0.0338
Proportion of population within river/coast 2			0.162	0.188
Landlocked1			-0.0821	-0.0563
Landlocked2			-0.733***	-0.706***
Constant	-28.02***	-25.46***	-26.43***	-26.08***
N	11479	11479	10881	10881
Adjusted R^2	0.677	0.684	0.711	0.717

Table 3: Results based on OLS regressions. *** p<0.001, ** p<0.01, * p<0.05; country 1 is exporter and country 2 is importer.

Column 1 reports the results for the most basic specification, which has three variables. We note that the coefficients stay constant across specifications and that these three variables contribute the most in terms of explanatory power.[12] Column 2 adds the logistics indices for the exporter (Logistics1) and importer (Logistics2), suggesting they are positively related to bilateral exports. For example, controlling for distance and GDP, a one-unit rise in the exporter's logistics index would raise its exports by 77.2%.

Adding a rich set of controls in column 3 increases the estimated coefficients to 0.947 and 0.425 for own and partner logistics respectively. Column 3 implies that a one standard deviation rise in logistics quality in the exporter would increase exports by 59% (the 95% confidence intervals are at 51% and 66%). Note that these simulated improvements are not heroic. They do not require a Guyana to become a Germany or Djibouti to become Japan: a one standard deviation change (0.62 units) would move a middle income country like Mauritius up to the mean or put Gabon on a par with Guinea.

In column 4, we interact logistics in both countries with their bilateral distance in deviation form.[13] As would be expected, the positive sign on the interaction term (Logistics*distance) serves to lessen then negative effect of distance on trade. A one standard deviation rise in logistic in both importer and exporter logistics quality would reduce the distance coefficient by 0.54, or one third. However, we note that a pair of countries with logistics indices of 4, which would put both of them in the top ten, would

[12] Even allowing for exporter or importer fixed effects does not materially increase the adjusted R^2.

[13] This is constructed by the formula

$$\big(\text{Logistics1} - \text{mean}(\text{Logistics1}) + \text{Logistics2} - \text{mean}(\text{Logistics2})\big) * (\ln(\text{Distance}) - \text{mean}(\ln(\text{Distance})))$$

still have a distance coefficient of –0.42.[14] This simple exercise suggests that, while this value is less than a third of the typical distance coefficient, not even the most advanced countries can kill physical distance.

We proceed to include the effects of neighbours' logistics in Table 4.

	-1	-2
Dependent Variable	Exports	Exports
GDP1	1.074***	1.068***
GDP2	0.862***	0.866***
Distance	-1.362***	-1.364***
Logistics1	0.896***	0.949***
Logistics2	0.545***	0.538***
Logistics_neighbour1	0.111	0.0111
Logistics_neighbour2	-0.256***	-0.200**
Logistics*landlock1		-0.332*
Logistics*landlock2		0.0501
Logistics_neighbour1*landlock1		0.675***
Logistics_neighbour2*landlock2		-0.365*
Area1	0.110***	0.122***
Area2	0.045	0.0347
Common neighbour	1.095***	1.087***
Common official language	0.141	0.133
Common ethnic language	0.516***	0.527***
Exporter ever a colony of importer	0.0711	0.0703
Common colonizer	1.313***	1.318***
Exporter a colony of importer since 1945	1.407***	1.415***
Countries were once the same country	0.485*	0.487*
Proportion of population within river/coast 1	-0.0033	-0.000634
Proportion of population within river/coast 2	0.224*	0.230*
Landlocked1	-0.108	-1.128***
Landlocked2	-0.683***	0.216
Constant	-26.54***	-26.49***
N	10792	10792
Adjusted R^2	0.711	0.712

Table 4: Results including neighbours' logistics based on OLS regressions. *** p<0.001, ** p<0.01, * p<0.05; country 1 is exporter and country 2 is importer.

In column 1, the exporter's neighbours' logistics (Logistics_neighbour1) are not significant while the importer's neighbours' logistics (Logistics_neighbour2) are significant. The control variables in all the specifications indicate that landlocked countries tend to trade less overall and, in column 2, we see if our neighbourhood findings differ for landlocked countries.

Focussing on the exporter first, we find that a landlocked country's own logistics matter less than for those who are not landlocked (with a net coefficient of 0.949–0.332=0.617) but that its neighbours' logistics are now significant (with a coefficient of 0.675). A one standard deviation improvement in a landlocked country's logistics together with a one standard deviation improvement in its neighbours' logistics would raise a landlocked country's exports by 74%.[15]

This evidence supports the motivation behind the Almaty accord. Landlocked countries would benefit materially from improvements in their neighbours' logistics quality. Furthermore, there is little incentive for a landlocked country to improve its logistics if goods will be held up in transit countries because of

[14] Because the variable is constructed in deviation form, the calculation is –1.510+0.436*(4-2.75+4-2.75)

[15] A standard deviation corresponds to 0.35 units for landlocked countries and to 0.76 units for other countries. The 95% confidence intervals are at 57% and 91%.

poor roads or cumbersome bureaucracy. Our simulations illustrate that, if Uganda's neighbours were to increase their average quality by 0.48 units and reach the quality of Zimbabwe's neighbours while Uganda's logistics remain constant, Uganda's exports would rise by a third.[16]

Turning to the importer, column 2 confirms the negative logistics coefficient seen in column 1, which indicates a negative effect of an importer's neighbours' logistics quality on exports to that importer. Furthermore, the negative effect seems bigger if the importer is landlocked (Logistics_border2*landlock2). This may suggest that alternative countries in a region compete as export destinations. It may be that the exporter sends all goods to one place to satisfy the region's demand, with local distributors being responsible for the rest. This may reflect in intraregional trade data (and the positive significant common border terms, for example), but would be classified as exports to a single country. Given this argument, it is no surprise that Singapore and many other countries with good logistics are well established transport hubs (Arvis, Mustra et al, 2007).

[16] Like many simulations, these treat all neighbours equally on average and ignore the fact that, for example, Uganda's Eastern neighbours, particularly Kenya and Tanzania, are more important than the others for Uganda's exports.

6. CONCLUSIONS

Our results suggest that logistics quality in the importer and exporter are important for bilateral exports and, by implication, trade. Simulation results indicate a one standard deviation improvement in logistics quality, which would place Mauritius at the mean or put Gabon on a par with Guinea, would increase a country's exports by 59%. Good logistics can reduce the effects of distance on trade but cannot remove it. For a landlocked country's exports, its own logistics matter less while the neighbours' logistics quality is important. If Uganda's neighbours were like Zimbabwe's, Uganda's exports would rise by a third. Our findings also suggest that countries may to some extent compete to be the recipients of goods in a region.

The results do not change if we include exporter or importer country effects, but we cannot discount the possibility that remaining unobservables are affecting our estimates. Our simulations rely on a linear causal interpretation of the results, ignoring the possibility of materially decreasing returns to logistics quality and feedback effects from exports to logistics quality. The implied linearity in exports effects is less likely to hold were all countries to improve their logistics simultaneously. Countries in a region competing to be hubs may not find a commensurate increase in trade if they all improve their logistics quality.

We have thus far focussed on logistics as a whole without breaking down the index into its components and have measured the effects on aggregate merchandise exports. There is evidence of variations in the effects of infrastructure and other indicators by sector (eg Nordås & Piermartini, 2004) and region (Wilson et al, 2005; Djankov et al, 2006) and the investigations of such heterogeneity with respect to logistics would provide opportunities for further research.

With these cautions in mind, we conclude that our findings support the view that broad measures of logistics can increase trade through reduced transport costs. Realistic steps can be taken to improve logistics in many countries. As argued by Wilson et al (2005), administration and legal procedures needn't be expensive. Furthermore, tracking technology and software can be copied by developing countries at relatively low cost. Other aspects of infrastructure development would take money, but Buys et al (2006) report that both the World Bank and African Development Bank are willing to pay for it.

REFERENCES

Amjadi, A and A Yeats (1995) "Have transport costs contributed to the relative decline of sub-saharan African exports? Some preliminary empirical evidence" *World Bank Policy Research Working Paper, 1559*

Anderson, J (1979) "A Theoretical Foundation for the Gravity Equation", *The American Economic Review*, Vol. 69, No. 1., pp. 106-116.

Anderson, J amd E van Wincoop (2004), "Trade costs", *NBER Working Papers*, No. 10480, May.

Arvis, J-F, M Mustra, J Panzer, L Ojala and T. Naula (2007), *Connecting to Compete: Trade logistics in the global economy,* World Bank: Washington.

Arvis, J-F, G Raballiland & J-F Marteau (2007), "The Cost of Being Landlocked: Logistics Costs and Supply Chain Reliability", *World Bank Policy Research Working Paper 4258*

Behar, A and P Manners (2008), "Distance to growing markets and Sub-Saharan African exports", unpublished CSAE manuscript

Bergstrand. J (1985). "The Gravity Equation in International Trade: Some Microeconomic Foundations and Empirical Evidence", *The Review of Economics and Statistics*, Vol. 67, No. 3., pp. 474-481.

Brun, J, C Carrere, P Guillaumont and J de Melo (2005), "Has Distance Died? Evidence from a Panel Gravity Model", *World Bank Economic Review,* Vol. 19, No. 1, pp 99-120.

Buys, P, U Deichmann and D Wheeler (2006), "Road Network Upgrading and Overland Trade Expansion in Sub-Saharan Africa", World Bank Development Policy Research Group

Calderon, C and L Serven (2008), "Infrastructure and economic development in Sub-Saharan Africa", Paper presented at CSAE Conference 2008 on Economic Development in Africa

Clark, X, D Dollar and A Micco (2004), "Port Efficiency, Maritime Transport Costs and Bilateral Trade", *NBER Working Paper , 10353, March.*

Coe, D and A Hoffmaister (1999), "North-South Trade: Is Africa Unusual?", *Journal of African Economies,* Vol. 8, No. 2, pp228-256.

Djankov, S, C Freund and C Pham (2006), "Trading on time", World Bank Policy Research Working Paper 3909

Egger, P (2005), "Alternative Techniques for Estimation of Cross-Section Gravity Models", *Review of International Economics*

Egger, P and M Pfaffermayr (2003), "The proper panel econometric specification of the gravity equation: A three-way model with bilateral interaction effects" *Empirical Economics*

Gallup J.L., Sachs J.D. and Mellinger A.D. (1999), "Geography and Economic Development", *International Regional Science Review,* Volume 22, Number 2, pp.179-232.

Hausman, Jerry A. and William E. Taylor, "Panel Data and Unobservable Individual Effects," *Econometrica* 49 (1981):1377–98.

Helpman, E, M Melitz and Y Rubinstein (2007), "Estimating trade flows: Trading partners and trading volumes", *NBER Working Papers,* No. 12927, February

Hummels, D (2001), "Time as a trade barrier", *GTAP Working Paper 18*

Limão, N and AJ Venables (2001), "Infrastructure, Geographical Disadvantage, Transport Costs and Trade", *World Bank Economic Review,* 15, 451-479

Nordås, H & R Piermartini (2004), "Infrastructure and Trade", *WTO Staff Staff Working Paper ERSD-2004-04*

Redding, S and AJ Venables (2003), "Geography and Export Performance: External market access and internal supply capacity"*, CEPR Discussion Paper Series,* No. 3807, February

Wilson, J and T Otsuki (2005), "Assessing the benefits of trade facilitation: a global perspective", *The Global Economy*

APPENDIX

		-2			-3			-4	
Dependent Variable	Exports	Exports	Exports	Exports	Exports	Exports	Exports	Exports	Exports
Y1	1.133***	1.141***		1.081***	1.074***		1.097***	1.090***	
Y2	0.911***		0.935***	0.845***		0.848***	0.861***		0.868***
Distance	-1.483***	-1.615***	-1.707***	-1.369***	-1.416***	-1.523***	-1.510***	-1.552***	-1.702***
Logistics1	0.772***	0.761***		0.947***	0.957***		1.040***	1.043***	
Logistics2	0.356***		0.337***	0.425***		0.455***	0.523***		0.568***
Logistics*distance							0.436***	0.412***	0.518***
Logistics_border1									
Logistics_border2									
Logistics*landlock1									
Logistics*landlock2									
Logistics_border1*landlock1									
Logistics_border2*landlock2									
Area1				0.103***	0.112***		0.0856***	0.0965***	
Area2				0.0561*		0.0786***	0.0372		0.0582**
Common border				1.067***	1.029***	0.746***	0.991***	0.952***	0.637***
Common official language				0.137	0.181	0.433***	0.146	0.173	0.430***
Common ethnic language				0.527***	0.479***	0.504***	0.405***	0.393***	0.392***
Exporter ever a colony of importer				0.071	-0.0269	0.209	0.165	0.0552	0.314**
Common colonizer+A64				1.304***	1.149***	1.143***	1.196***	1.072***	1.036***
Exporter a colony of importer since 1945				1.402***	1.368***	1.319***	1.205***	1.147***	1.034***
Countries were once the same country				0.533**	0.545**	0.512**	0.338	0.336	0.275
Proportion of population within river/coast 1				0.00951	0.0208		0.0338	0.0456	
Proportion of population within river/coast 2				0.162		0.201*	0.188		0.231**
Landlocked1				-0.0821	-0.098		-0.0563	-0.0714	
Landlocked2				-0.733***		-0.772***	-0.706***		-0.738***
Constant	-25.46***	-5.926***	3.998***	-26.43***	-9.047***	2.573***	-26.08***	-8.412***	3.166***
N	11479	11479	11479	10881	11179	11175	10881	11179	11175
Adjusted R^2	0.684	0.714	0.733	0.711	0.73	0.758	0.717	0.736	0.767
Country 1 dummies?	N	N	Y	N	N	Y	N	N	Y
Country 2 dummies?	N	Y	N	N	Y	N	N	Y	N

Table A1: Robustness checks for regressions 2-4 in Table 3. *** $p<0.001$, ** $p<0.01$, * $p<0.05$; country 1 is exporter and country 2 is importer. Some bilateral coefficients become significant at 5% (many were significant at 10%), but these coefficients are not strictly interpretable in the same way in the presence of additional fixed effects. The interaction term involving distance and logistics now strictly only measures the effect with respect to one country, not both. Other regressions suggested the effect of the partners' logistics was slightly higher than the exporters, which explains part of the slight change in coefficient.

	-1			-2		
Dependent Variable	Exports	Exports	Exports	Exports	Exports	Exports
GDP1	1.074***	1.068***		1.068***	1.062***	
GDP2	0.862***		0.867***	0.866***		0.870***
Distance	-1.362***	-1.410***	-1.520***	-1.364***	-1.418***	-1.515***
Logistics1	0.896***	0.903***		0.949***	0.951***	
Logistics2	0.545***		0.574***	0.538***		0.566***
Logistics*distance						
Logistics_border1	0.111	0.112		0.0111	0.0164	
Logistics_border2	-0.256***		-0.260***	-0.200**		-0.218***
Logistics*landlock1				-0.332*	-0.294*	
Logistics*landlock2				0.0501		0.044
Logistics_border1*landlock1				0.675***	0.642***	
Logistics_border2*landlock2				-0.365*		-0.272
Area1	0.110***	0.118***		0.122***	0.130***	
Area2	0.045		0.0657**	0.0347		0.0571**
Common border	1.095***	1.042***	0.760***	1.087***	1.025***	0.768***
Common official language	0.141	0.183	0.436***	0.133	0.167	0.440***
Common ethnic language	0.516***	0.485***	0.489***	0.527***	0.498***	0.489***
Exporter ever a colony of importer	0.0711	-0.0446	0.218	0.0703	-0.0329	0.21
Common colonizer	1.313***	1.153***	1.153***	1.318***	1.171***	1.144***
Exporter a colony of importer since 1945	1.407***	1.370***	1.347***	1.415***	1.400***	1.331***
Countries were once the same country	0.485*	0.545**	0.473*	0.487*	0.538**	0.479*
Proportion of population within river/coast 1	-0.0033	0.000348		-0.000634	0.00116	
Proportion of population within river/coast 2	0.224*		0.259**	0.230*		0.260**
Landlocked1	-0.108	-0.123*		-1.128***	-1.150***	
Landlocked2	-0.683***		-0.719***	0.216		-0.0686
Constant	-26.54***	-8.676***	2.622***	-26.49***	-8.477***	2.508***
N	10792	11155	11108	10792	11155	11108
Adjusted R^2	0.711	0.731	0.759	0.712	0.731	0.759
Country 1 dummies?	N	N	Y	N	N	Y
Country 2 dummies?	N	Y	N	N	Y	N

Table A2: Robustness checks for regressions in Table 4. *** p<0.001, ** p<0.01, * p<0.05; country 1 is exporter and country 2 is importer. Some bilateral coefficients become significant at 5% (many were significant at 10%), but these coefficients are not strictly interpretable in the same way in the presence of additional fixed effects.