The Role of Infrastructure in Determining Export Competitiveness: Framework Paper

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(Revised July 2007)

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1. INTRODUCTION

Trade is beneficial for poverty reduction. "The central effect on poverty is assumed to come from the effects on real wages of the unskilled workers, endowed with labor but no human or financial capital" (Bhagwati and Srinivasani (2002)). There is little persuasive evidence concerning the effect of trade on income and therefore growth. Such results are fragile, do not indicate causality (does trade lead to growth or vice versa?) and cannot be used to say much about the trade policies that underlie increased trade performance. Also, although many countries have benefited greatly from policies aimed at fuller integration into the world economy, lagging countries are found in all regions, though regional aggregates suggest that Sub Saharan Africa has been the least successful. Reasons for this are numerous, and include civil conflict and macroeconomic policies that led to real exchange rate overvaluation. In addition to such important factors, unfavorable demand characteristics for the primary commodities and raw materials that constitute Sub-Saharan Africa's traditional exports may jeopardize the region's growth and industrialization prospects.[1]

It is widely believed that in a proper policy environment trade can promote growth and thereby reducing poverty. However, despite major efforts at reform, African countries have not yet been able to integrate successfully into the global markets, and hence to participate in the growth-inducing and poverty-reducing benefits of trade. The full integration of local farm-households into the national economy has not been possible because of the underdevelopment of the domestic network of marketing, transport and communications. As a result, large regions of Africa's domestic economy have remained insulated from international trade.

The reversal of this trend towards marginalisation and helping African countries reap full benefits from the global trading system has become important national and regional policy objectives. African countries would like to join in the globalisation process, they would like to enhance the conditions for faster investment and economic growth, expanding and diversifying their exports – and ultimately reducing poverty. However, integration in the global economy will require major efforts at further reforms to enhance productivity, competitiveness and trade facilitation and therefore exploit market access opportunities.

A significant part of the reform agenda of most African governments since the late 1980s has been directed at removing cross-border regulatory

[1] Work seeking to enhance the understanding of links between trade (policy) and growth is mainly microeconomic. It involves industry- or firm-level analysis of individual economies or groups of developed and developing countries and focuses not only on trade policies but on complementary 'behind the border' policies as well. These types of studies can shed light on linkages between trade and growth in a way that cross-country regressions do.

impediments to the efficient operation of their economies. Much of this agenda has been fashioned in response to pressure to improve the international competitiveness of their exports. While considerable progress has been made in lessening impediments to the development of national markets in several areas, it is also apparent that the reform task is far from complete. For example, considerable scope remains to integrate better and improve the quality of much of Africa's services sector, notably in the areas of telecommunications, energy and freight transport.

With China and India emerging as major new players in international commerce, globalisation of trade and investment and with it the integration of the world economies is increasing. While this provides important new opportunities for African countries, it also heightens competitive pressures. The future of Africa's participation in international trade will be shaped by how well the continent responds to the challenges. Countries that are unable to respond efficiently and innovatively to changing patterns of demand, technological change, increasing mobility of capital and labour and shifts in underlying comparative advantage, risk seeing their exports losing competitiveness.

With increased competition in major markets forcing business to adapt to just in time production and management systems, flexibility, speed and reliability in delivery of goods have assumed significant importance. However, for most African countries, inadequate infrastructure and poor transport network make it difficult for their manufacturers to participation in new global outsourcing and just in time production because they cannot guarantee timely delivery of goods or ensure reliability or flexibility in the supply of the goods. Some of the delays are due to poor infrastructure in both transit countries and in national economies. The fact that delays can occur outside the territorial boundaries of one country underlines the point that these countries acting alone would not be in a position to overcome the real obstacles.

The high transport costs of imports of African countries inflate the prices of capital goods and intermediate inputs, thereby increasing the cost of domestic agricultural and industrial production. Outside Oceania, Africa has the highest freight costs as a percentage of import value (see Table 1). The ratio increased from 9.4 in 1990 to 9.9 in 2004 (slightly lower than in 2003). Developing European countries have, however, managed to reduce the cost of freight as a percentage of import value from 6.9 in 1990 to 2.8 in 2004. Thus a significant reduction in the transport cost of imports would boost domestic production, support diversification efforts and increase the competitiveness of African exports.

Table 1: Freight Costs as percentage of Import Value

	1990	2000	2003	2004
World total	3.7	3.6	3.6	3.6
Developed countries	2.9	2.9	2.9	3.0
Developing countries	6.7	5.9	6.1	5.9
Africa	9.4	9.8	10.0	9.9
America	5.1	4.2	4.1	4.3
Asia	6.9	6.5	6.7	6.5
Europe	6.9	2.8	2.6	2.8

Oceania	12.3	15.8	15.6	15.4

Source: UNCTAD (2006a)

The median landlocked country tends to incur transport costs 50 per cent higher than those of the median coastal country, and to have trade volumes that are 60 per cent lower (Limão and Venables (2001)). Of the 30 landlocked developing countries worldwide, 15 are in Africa (12 of them are least developed countries (LDCs)). There are 16 principal coastal transit countries serving the landlocked African countries by providing land transit corridors to ports, giving them access to the sea and to world markets.

Notably, the high transit costs faced by African exports have become a far more restrictive barrier to trade than tariffs in major markets. Tariffs in Canada, the European Union, Japan and the United States vary from averages of 3 to 7 per cent on goods originating in Africa. In contrast, transit costs paid by landlocked African countries are on average almost three times higher than the average tariffs. Transit costs vary from a low of under 5 percent for Swaziland to a high of 50 percent for Chad and Malawi. Border delays form a significant part of the transit costs. For example, border post delays in Southern Africa range from 4 to 36 hours on average (see Table 2). It is estimated that delays at major border posts in Southern Africa cost the region in the range of $48 million annually.

Table 2: Border Clearing Times in Southern Africa

Border post	Countries	Estimated delays (hours)
Machipanda	Mozambique/Zimbabwe	24
Zobue	Mozambique/Malawi	24
Mutare	Mozambique/Zimbabwe	26
Ressano Garcia	South Africa/ Mozambique	6
Namaacha	Swaziland/Mozambique	4
Beit-Bridge	South Africa/Zimbabwe	36
Chirundu	Zimbabwe/Zambia	24
Victoria Falls	Zimbabwe/Zambia	36
Martins Drift	South Africa/Botswana	6
Kazungula	Botswana/Zambia	24
Buitepos	Namibia/Botswana	6
Pioneer Gate	Botswana/South Africa	4
Nakonde	Zambia/Tanzania	17

Source: InfraAfrica (Pty) Ltd (2003)

Why is Africa's Trade Performance Poor?

If trade matters, why do African countries trade less relative to other developing countries? The poor export performance is despite lower tariffs in foreign markets. Recent liberalization has reduced tariff and, in some cases, non-tariff barriers in the export markets of African countries. Direct evidence on border costs shows that tariff barriers are now low in most countries, on average (trade-weighted or arithmetic) they are less than 5 percent for rich countries, and with a few exceptions are on average

between 10 percent and 20 percent for developing countries.[2] Overall representative estimate of policy barriers for industrialized countries (including non-tariff barriers) is about 8 percent.

There is now a large domestic agenda to address competitiveness and capacity problems that underlie Africa's poor trade performance. To understand the relationship between infrastructure and international trade, one needs to consider commercial operations in their entirety. International trade transaction relies on a complex chain of interdependent operators and players that include exporters, Customs administrations, suppliers and carriers of information, bankers, insurers, transporters, and eventually importers. For international trade transaction to be efficient all the components have to be efficient.

The poor performance of Africa's exports is linked to the political economy of policy reform, institutional development and supply constraints related to infrastructure. Reduction in tariff and non tariff barriers (NTBs) have implied that the relative importance of trade costs (especially infrastructure) as a determinant of trade has increased. In most African countries, poor service delivery has handicapped firms through unreliable transport, power and water, and inadequate telecommunications networks (Collier and Gunning (1999)).

> *'Telecommunications are both a vital intermediate input and crucial; to the dissemination and diffusion of knowledge. Transport costs are a major determinant of competitiveness – the cost of international transport is often above the applicable tariff in export markets, and intra-national transport costs can be a multiple of international costs' (Stern (2001)).*

The role of infrastructure in determining trade costs and therefore export competitiveness is explored in this paper. The rest paper is organised as follows: Section 2 provides a background to the link between infrastructure and export competitiveness; Section 3 reviews the literature on infrastructure and export competitiveness; and, section 4 proposes a methodology for analyzing the impact of infrastructure on export competitiveness.

2. INFRASTRUCTURE AND EXPORT COMPETITIVENESS

Infrastructure development is a key element of a countries' ability to produce and move goods. O'Rourke and Williamson (1999) argue "all of the commodity market integration in the Atlantic economy after the 1860s was due to the fall in transport costs between markets....". Weak infrastructure is a major impediment to trade, competitiveness and sustainable development in most African countries, particularly land-locked and small island countries. Recent literature has emphasized the dependence of trade costs on infrastructure. The literature has examined the importance of

[2] Preferential trading arrangements at regional level have also reduced tariffs on intra-African trade. African countries have reduced their tariffs to an average of 15 percent and aim at creating free trade areas within the next 2 to 5 years. Others have already done so.

transport costs and infrastructure in explaining trade and access to markets. Much of the historical literature has emphasized reductions in trade costs specifically those arising from endogenous changes in commercial policy and exogenous changes in transport technology (see O'Rourke and Williamson, 1999).

Trade costs can be defined as the cost of transaction and transport associated with the exchange of goods over and above the marginal cost of production. Broadly defined, 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 costs include transportation costs (both freight costs and time costs), policy barriers (tariffs and non-tariff barriers), communication costs, utility costs, and local distribution costs (wholesale and retail).

Trade costs vary widely across countries; on average African countries have significantly larger trade costs. Trade costs also vary widely across product lines. The patterns of variation make some economic sense, but more sense can still be extracted. Better measurement of trade costs is highly desirable. The quality of the existing measures is low and can be improved. For example, transport cost data could easily be improved. Estimates based on the structural gravity models can also be improved. Extensions of existing gravity models, better treatment of aggregation and endogeneity problems and better estimates of substitution elasticities are all likely to improve our understanding of trade costs and the resulting impact on competitiveness.

Trade costs impede Africa's participation in international trade. Surprisingly, economists and policy makers know little about the nature and magnitude of these obstacles to Africa's exports. While research has tracked certain costs like freight rates and tariffs reasonably well, and proxies for information costs have been examined, the magnitude and impact of a host of other important impediments to trade remain unexplored. Direct evidence on trade costs comes in two major categories; costs imposed by policy (tariffs, quotas and the like) and costs imposed by the environment (transportation, communication, insurance against various hazards and time costs among others). Our main interest is on the latter.

There is, however, very little understanding of the exact nature and impact of trade costs. Poor institutions and poor infrastructure penalize trade, differentially across countries. 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. It is obvious that determining total trade costs is more complex than adding together an ad valorem tariff value and unit shipping costs. Shipping costs alone vary by good, season and with local economic conditions. There is little consensus on the functional form that best describes trade costs.

Hummels (2001) measures trade costs indirectly by first presenting information on international freight and tariff rates and, then, estimating the technological relationship between freight rates and distance. He concludes that the tariff equivalent trade cost estimates derived from this method coming up in the range of 100 to 200 percent are implausibly large. However, Anderson and van Wincoop (2004) present a comprehensive survey

of the literature on trade costs and argue that the representative tariff equivalent of international trade costs might be as much as 74 percent for a typical developed country. They also conclude that the trade costs faced by developing countries are significantly larger, suggesting that trade costs could have important implications for international trade for developing countries.

Baier and Bergstrand (2001) demonstrate the importance of trade costs in explaining post-World War II international integration. Furthermore, Obstfeld and Rogoff (2000) place trade costs at the heart of the "major puzzles" of international macroeconomics. There is evidence that improvements in transportation contributed to lower trade costs so that distance mattered less and less for the degree of integration.

The analysis of the late nineteenth century is that changes in overall trade costs were ostensibly small. However, as Obstfeld and Rogoff (2000) have emphasized, large increases in trade can occur even when trade costs only change a little. Poor institutions and poor infrastructure penalize trade, differentially across countries. The most highly developed countries seem to have the lowest average trade costs. On the other hand, small, remote, and less developed countries seem to have the highest levels.[3]

Wilson et al (2004) have quantified the effects of ports, customs, regulations, and e-business (which is a proxy for the service sectors of telecommunications and financial intermediation). The authors find that that the scope and benefit of unilateral trade facilitation reforms are very large and that the gains fall disproportionately on exports.

The rest of the section looks at a number infrastructure services and their contribution to export competitiveness.

(a) Transport Services

Globalization requires the existence of a functioning international transport system. Marginalization of African countries is not only a reflection of their feeble industrial base, but is also aggravated by problems associated with access to adequate international transport and support services. For manufactured goods, reliability and speed of transport has become more important than transport cost. As the scope for compensating transport cost disadvantages by preferential tariff treatment is gradually eroding, excessive transport costs directly and adversely affect the competitive position of African countries' in foreign markets.

Transport plays a crucial role in determining the competitiveness of exports. Transport costs are an important barrier to trade and have an important effect on export. Problems of access to quality transport services manifest themselves in the form of reduced profit margins and reduced competitiveness. At the macroeconomic level they result in failure to develop a country's international trade potential and disadvantageous terms of trade. Direct transport costs include freight charges and insurance which

[3] For example, developed countries have a low ratio of fright cost to import value compared to developing countries especially small island countries like the Oceanic countries (see Table 1)

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.

Improvements in transportation services and infrastructure can lead to improvements in export performance. Limão and Venables (2001) show that infrastructure is quantitatively important in determining transport costs. They estimate that poor infrastructure accounts for 40 percent of predicted transport costs for coastal countries and up to 60 percent for landlocked countries.

Bougheas et al (1999) have analyzed the effects of infrastructure on trade through its influence on transport costs. By endogenising transport costs and infrastructure formation their findings predict that for pairs of countries for which it is optimal to invest in infrastructure, a positive relationship between the level of infrastructure and the volume of trade takes place. Using a gravity model they provide evidence from European countries.

Historical accounts from 1870 to 1913 have highlighted the important role played by developments in transportation and communication technologies in conquering time and space. According to O'Rourke and Williamson (1999) the "impressive increase in commodity market integration in the Atlantic economy [of] the late nineteenth century" was a consequence of "sharply declining transport costs". Mohammed and Williamson (2003) concluded that the historically unprecedented integration in 1913 must have been due to declining transportation costs on land and at sea.

For most African countries, transport costs are a greater barrier to regional and international markets than import tariffs. The transport sector is a key sector in creating a dynamic investment-export nexus in Africa, but transport systems in sub-Saharan Africa are being weakened by lack of investment, and the poor performance of the transport sector is adversely affecting export performance and market development.

Trade performance and competitiveness are affected by both international transport costs (costs of moving goods between countries) and internal transport costs (costs of moving goods within a country), and by the way in which these costs affect imports as well as exports. High transport costs for moving goods from points of production to final destinations can price a country out of export markets. This is particularly so in land locked countries where transport costs represent a large component of the final cost of the export product. High transport costs on imports inflate the prices of imported goods, including capital goods, intermediate inputs and fuel, thereby increasing the cost of domestic production. It has particularly negative consequences for the competitiveness of manufactured exports with a large import content both in terms of raw material and capital equipment. Available evidence suggests that producers in sub-Saharan Africa often face a transport disadvantage vis-à-vis their competitors.

Modern transport technology coupled with information networks has been one of the factors which have permitted the development of globalization of

manufacturing through efficient transport networks linking suppliers, manufacturers and consumers. However, transport suppliers in most African countries have been unable to improve their efficiency and bear the consequent adverse impact on trading opportunities open to them.

Transport and logistics are the most important cost elements in Africa's foreign trade. Particular transport problems exist for landlocked countries and for small island countries. For a number of landlocked African countries transport costs account for some 30 per cent of c.i.f import value (UNCTAD, 2006). For exports, this share will most likely be even higher. Thus the decisive impact of transport efficiency on countries' competitiveness is obvious since the annual cost of international maritime transport was estimated at US$ 270.8 billion in 2004 (half of which being incurred in ports), a 5 per cent reduction in port and transport costs could save traders some US$15.5 billion per annum.

Transport is a key sector for international trade. It provides physical access to market places, without which trade could not take place. Rural agricultural production faces failure if goods cannot be conveyed to markets because of lack of transport infrastructure and services. There is a cause and effect relationship between the availability of adequate transport services, access thereto and the scope for exporting. Excessive transport costs create the major effective barrier to foreign markets. Trade success or failure of Africa trading low-value goods, with little potential for differentiation but considerable risk of substitution, is largely determined by transport availability and cost. The share of freight cost in import values can serve as an indication of the impact of transport cost on the ability of countries to effectively participate in global trade. Africa face freight costs of up to 10 per cent of import value compared to the world average of 3.6 per cent and the developing country average of 5.9 percent (see Table 1). In 2004, total freight payments for Africa's imports were estimated at US$9.9 billion for a total c.i.f. import value of US$151.5 billion (UNCTAD, 2006).

With technological developments enabling the manufacture of larger and faster road vehicles, road transport in the 1980s easily outpaced railways as the leading means of overland transport in Africa. However, the development of road infrastructure was uneven, favouring centres of population at the expense of rural areas where food and agricultural exports are produced. As a result, both domestic and international transport costs are very high.

High international and internal transport costs reduce returns to producers in Africa since they have to sell at world prices set beyond their control. For manufactured exports, the scope for squeezing wages or profits to offset high transport costs is highly limited. It is almost impossible to shift the burden of high transport costs onto wages since the latter are close to subsistence level. An increase in shipping costs of 6 percentage points on both exports and imports would wipe out one-third of domestic value-added for typical manufactured exports with high import content.

For both primary commodities and manufactured goods, the quality of domestic and international transport services has critical effects on

competitiveness. Uncertainties in delivery times result in a discount on the market price for exports. They also disable just-in-time deliveries which are important for international outsourcing. Uncertainties in import delivery mean that firms dependent on imported goods have to maintain large stocks, thereby tying up working capital.

As liberalization continues to reduce artificial barriers, the effective rate of protection provided by transport costs is now in many cases higher than the one provided by tariffs. It is striking to realize that for most African countries, transport costs exceed average tariffs by more than twenty times. Consequently, any additional effort to integrate African countries into the global trading system by improving the competitiveness of their exports should consider and analyze the effect of transport costs and its determinants.

The precise magnitude and nature of the impact of transport costs varies between countries, but in general, two patterns seem to prevail. Firstly, for international transport costs, the margin seems to be higher for imports than for exports. Secondly, internal transport costs incurred in getting exports from production areas through ports and out of the country, and imports from their point of entry into the country to producers and consumers, are in most cases a more serious source of competitive disadvantage than inter-country transport costs.

Case studies undertaken to examine the supply chains for specific commodities on specific routes indicate that internal transport costs are particularly high. Factors which inflate costs include the distance of production areas from the coast, relatively high port charges and high road transport costs. High inland transport costs are a particular problem for landlocked countries. There are 15 such countries in sub-Saharan Africa. Most are more than 1,000 km from seaports (see Table 3). Their transport costs are also inflated and service quality reduced because of poor road network and port facilities and unnecessary bureaucratic procedures involving documentation, customs and administrative costs, which cause unnecessary delays in the movement of goods.

Table 3: Landlocked African Countries

	Closest distance from sea (km)	Paved roads (% of total)	Port and route	Transit country	Comment
Burkina Faso	1,154	16	Abidjan - Ouagadougou Lome - Ouagadougou Tema/Takoradi – Ouagadougou	Cote d'Ivoire Togo Ghana	Mix of rail and road from Abidjan By road from Togo By road (via Accra)
Burundi	1,254	..	Mombasa – Kigali Dar es Salaam - Kigali	Kenya, Tanzania Tanzania	Two transit corridors link Burundi, Rwanda and Uganda to the port of Mombasa an Dar es Salaam. The Northern Corridor from Mombasa is a network of rail, lake (via Lake Victoria) and road routes up to Kampala in Uganda. Road links extend the Corridor southward to Rwanda and Burundi. The Central Corridor from Dar es Salaam comprises road, rail/lake routes to Burundi via Lake Tanganyika, road and rail/road routes to Rwanda, and a rail/lake route to Uganda via Lake Victoria.
Rwanda	1,867	8.3	Mombasa Dar es Salaam	Kenya Tanzania	
Uganda	1,187	6.7	Mombasa – Kampala	Kenya	
Central African Republic (CAR)	1,518	2.7	Douala – Bangui Douala – Ngaoundere-Bangui Douala – Belabo – Bangui	Cameroon Cameroon Cameroon	The Trans-Cameroon corridor starts from N'Djamena in Chad and Bangui in Centra Africa Republic to reach Doula in Cameroon. The transport is either entirely a road or a combination of road and rail.
Chad	1,669	0.8	Douala – N'Djamena Doula – N'Goundere – N'Djamena	Cameroon Cameroon	
Ethiopia	781	12	Assab – Addis Ababa Djibouti – Addis Ababa Berbera – Addis Ababa	Eritrea Djibouti Somalia	Ethiopia's three main access corridors to the sea are the Assab (Eritrea), Djibouti (Djibouti) and Berbera (Somalia) corridors. The outbreak of hostilities between Ethiopia and Eritrea in May 1998 brought the closure of the Assab-Addis Ababa corridor.
Niger	1,057	7.9	Cotonou - Niamey Lome - Niamey Lagos - Niamey Tema/Takoradi -	Benin Togo/Burkina Faso Nigeria Burkina	

	Closest distance from sea (km)	Paved roads (% of total)	Port and route	Transit country	Comment
			Niamey	Faso/Togo	
Mali	1,225	12.1	Dakar - Bamako Abidjan - Bamako Lome - Bamako	Senegal Cote d'Ivoire Burkina Faso/Togo	
Botswana	905	55	Durban - Gaborone Welvis Bay - Gaborone	South Africa Namibia	Transit is mostly through Mozambique (Beira, Maputo, Nacala), Tanzania (Dar es Salaam), South Africa (Durban and Cape Town) and Namibia (Walvis Bay). The Dar es Salaam Corridor to Zambia and Malawi comprises road and rail. TAZARA rail corridor links the port of Dar-es-salaam to Zambia. The Malawi northern route comprises of a road route. The Nacala corridor is the main transit route to Malawi. The Beira Corridor links Malawi, Zambia and Zimbabwe. The route to Malawi has two parallel links, one rail and one road. The Beira route to Zimbabwe and Zambia is a network of road and rail. The Maputo corridor comprises three transit routes. The transit route to Zimbabwe is the Limpopo rail line. The transit route to Swaziland connects through Goba border post by rail and road links. Maputo also provides transit route to South Africa. The Durban corridor comprises access routes to Zimbabwe, Lesotho, Botswana, Zambia and Malawi. The Walvis Bay corridor is composed of transit routes to Namibia, Zambia and Zimbabwe through the Trans-Caprivi link and to Botswana through the Trans-Kalahari link.
Lesotho	575	18.3	Durban – Maseru	South Africa	
Malawi	803	18.5	Beira – Blantyre Nacala - Blantyre Dar es Salaam - Blantyre Durban – Blantyre	Mozambique Mozambique Tanzania South Africa	
Swaziland	193	..	Durban – Mbabane Maputo – Mbabane	South Africa Mozambique	
Zambia	1,975	22	Dar es Salaam - Lusaka Walvis Bay – Lusaka	Tanzania Namibia	
Zimbabwe	464	47.4	Beira – Harara Durban - Harare Walvis Bay – Harare	Mozambique South Africa Namibia	

Source: UNCTAD (2006b)

The indirect effects of transport costs

The quality of onshore infrastructure is an important determinant of transport costs. Limão and Venables (2000) find that infrastructure accounts for 40 percent of predicted transport costs for coastal countries, and up to 60 percent for landlocked countries. They show that if a country with a relatively poor infrastructure, for example at the 75th percentile in an international ranking, is able to upgrade to the 25th percentile, it will be able to reduce transport costs by 30 percent based on shipping data (from $6,604 to $4,638) and by more than 50% based on the c.i.f./f.o.b ratio (from 1.40 to 1.11). In addition, an improvement in own and transit countries' infrastructure from the 75th to the 25th percentiles reduces the disadvantage associated with being landlocked by more than half.

In the predominantly agricultural economies of sub-Saharan Africa where production is dominated by smallholder farmers, the degree of market development depends critically on the extent to which farm households are integrated into the national economy. As a rational response to high transaction costs in getting produce from farms to markets, as well as to the costs and risks of purchasing foodstuffs, households cling to some degree of subsistence production even when they could expect higher returns through specialization in high-value export of food crops. The costs are related mainly to poor local-level transport systems in rural areas. Rural road densities are very low and of low quality. Some rural roads become inaccessible during the rainy season, and even in the dry season driving is difficult. The percentage of paved roads in most of the land locked countries is less than 20 percent (Table 3). Among the landlocked countries, only Botswana and Zimbabwe (the two developing land locked countries) have more than 20 percent of their roads paved (actually the percentage is more than 40 percent, showing the huge differential in the levels of infrastructure between developing and LDCs in Africa. One effect of the weakness of local rural transport systems is reduction in agricultural production for export as the degree to which farmers can specialize and take advantage of local resource advantages is reduced.

Another problem related to the underdevelopment of internal transport systems is the tendency for many basic staple foodstuffs in sub-Saharan Africa to be internationally non-tradable outside the continent. In some cases, this reflects product characteristics such as perishability. In most, it is due to the high transport costs for these bulky and low-value goods. This undermines export performance by raising price of exports.

The highest freight-to-import rates in the world are in West Africa, reflecting first of all the extreme distances involved (see Table 3), and no doubt inefficiencies and quality shortfalls in transit transport facilities and arrangements. The rates for many of the main coastal outlets are also particularly high.

The obvious and most studied determinant of transport cost is geography, particularly distance. The greater the distance between two markets, the higher the expected transport cost is. Using shipping company quotes for the cost of transporting a standard container from Baltimore (USA) to

selected worldwide destinations, Limão and Venables (2001) find that an extra 1,000 km raises transport costs by $380 (or 8% for a median shipment).

Breaking the journey into an overland and a sea component, an extra 1,000 km by sea raises costs by only $190 (4 percent) while the same distance by land raises costs by $1,380 (30 percent of a median shipment), respectively. In addition, if a country is landlocked, transport costs rise by $2,170 (almost a 50 percent increase in the average cost). In other words, being landlocked is equivalent to being located 10,000 km farther away from markets. Most of the landlocked countries are over 1,000km from the sea and have to transit through countries with poor infrastructure (mostly LDCs).

(b) Port Facilities

The efficiency of the ports will determine whether a country or a region will be part of, or detached from, global transport and international trade. If customs clearance can be speeded up or carried out at final destination, goods could quickly pass through the port rather than waiting for controls. The benefit for the shipper is reduced transit times and transport costs. For transport operators, this would mean more productive use of their equipment and thus increased profitability and the ability to lower tariffs, and therefore reduction in transport costs.

The greater the efficiency at port level, the lower the transport costs. The overall level of infrastructure, is assumed to be positively correlated with a country's level of seaport infrastructure. Better infrastructure is expected to have a higher probability of an efficient port; that is, a positive coefficient for this variable.

Port efficiency varies widely from country to country and, specially, from region to region. It is well known that some Asian countries (Singapore and Hong Kong) have the most efficient ports in the world, while some of the most inefficient ports are located in Africa. Port efficiency is highly correlated with handling cost. Countries with inefficient seaports have higher handling costs. Countries with good infrastructure also have lower seaport costs. The clear negative relationship shows that countries where ports are considered the most efficient (e.g. Singapore and Belgium) are at the same time the ones whose ports charge the least for their services (in comparable units). In turn, some African countries are among the worst ranked in terms of their efficiency and also present the highest charges per services (after controlling by the level of infrastructure).

An immediate that that questions arises is. How much do these transport costs affect exports? The broad literature that applies the gravity approach to the study of international bilateral trade shows that geographical distance, which is used as proxy for transport costs, is negatively related to trade. Limão and Venables (2001) show that raising transport costs by 10 percent reduces trade volumes by more than 20 percent. They also show that poor infrastructure accounts for more than 40 percent of predicted transport costs. In a different analysis, Radelet and Sachs (1998) show that shipping costs reduce the rate of growth of manufactured exports.

In spite of the relevance of transport costs to trade, there are not many other studies on transport costs. Moreover, these few studies rely on macro

level data, which is certainly useful but misses the advantages that micro data can have. An exception is a study of Fink, Mattoo and Neagu (2000), which analyzes the determinants of maritime transport costs in 1998. Focusing on the effect of non-competitive public and private policies, they find the latter have a significant effect on transport costs. But, what about other factors influencing transport costs, such as port efficiency? There is a wide consensus on the crucial importance of port activities for the transport services. However, there are no measures of the importance of inefficiencies in transport costs within port level.

(c) Communications

Poor communications as well as slow delivery increase transaction costs by raising the financial costs as well as the exchange rate risks. The growth of e-commerce in the majority of African countries is held back due to the lack of basic infrastructures in telecommunications and electricity. According to the International Telecommunications Union (ITU), the United States has 60 telephone lines per 100 people, China has 7, while Sub-Saharan Africa has less than 1 line per 100 people (Table 4). The mobile tele-density is much better even though the cost is high especially when compared with calls from Europe, Asia and USA. Internet use is still underdeveloped and costly, thereby making it difficult for most businesses to conduct their business transitions electronically.

Table 4: ICT Indicators 2003

	Population (000s)	Fixed lines per 100	Mobile subscribers per 100	Internet users per 100
Angola	14,358	0.6	1.7	0.3
Benin	7,025	0.9	3.4	0.9
Botswana	1760	9.1	28	3.4
Burkina Faso	12258	0.5	1.9	0.4
Burundi	7118	0.3	0.9	0.1
Cameroon	16258	0.7	6.6	0.4
Cape Verde	441	16.3	12.1	4.6
CAR	4140	0.2	0.3	0.1
Chad	8084	0.2	0.8	0.2
Comoros	799	1.7	0.3	0.6
Congo	3500	0.2	9.4	0.4
Côte d'Ivoire	16632	2.0	7.4	0.6
D.R. Congo	52771	0.0	1.9	0.1
Djibouti	668	1.4	3.4	0.9
Equatorial Guinea	543	1.8	7.6	0.4
Eritrea	4151	0.9	..	0.2
Ethiopia	69363	0.6	0.1	0.1
Gabon	1337	2.9	22.4	4.1
Gambia	1365	3.1	9.5	2.2
Ghana	22444	1.3	3.6	0.9
Guinea	7751	0.3	1.4	0.5
Guinea-Bissau	1280	0.8	0.1	1.5
Kenya	31708	1.0	5.0	1.6
Lesotho	2174	1.4	7.6	1.1
Liberia	3372	0.2	0.1	0.1
Madagascar	16340	0.4	1.7	0.4
Malawi	10488	0.8	1.3	0.3
Mali	10863	0.6	2.3	0.3

	Population (000s)	Fixed lines per 100	Mobile subscribers per 100	Internet users per 100
Mauritania	2752	1.3	10.9	0.5
Mauritius	1221	28.5	37.9	12.3
Mozambique	18831	0.4	2.3	0.3
Namibia	1924	6.6	9.9	3.4
Niger	12291	0.2	0.2	0.1
Nigeria	123314	0.7	2.6	1.3
Rèunion	756	39.7	74.7	23.1
Rwanda	8399	0.3	1.6	0.4
Sao Tomè & Principe	152	4.6	3.2	9.9
Senegal	13359	2.2	7.6	2.2
Sierra Leone	4971	0.5	2.0	0.2
Somalia	10275	1.0	0.4	0.9
Sudan	33286	2.7	2.0	0.9
Swaziland	1044	3.4	8.4	2.1
Tanzania	35,313	0.4	2.5	0.7
Togo	5,000	1.0	4.0	4.0
Uganda	25,599	0.2	3.0	0.5
Zambia	11,195	0.8	1.3	0.6
Zimbabwe	11,765	2.5	3.1	5.1

Source: ITU

As services become an increasing part of world production and trade, telecommunications often offer new routes to export and import such services either directly (e.g. education services through distance learning), or indirectly (e.g. tourism services through promotion of sites or hotels on the Internet). This represents an impressive export potential in many African countries. Moreover, efficient trade transaction now require to be accompanied by international trade flows, which are much less expensive and much more reliable when achieved through electronic telecommunications.

(d) Energy

Shortage of electricity is identified as the single most important constraint upon firm growth in Africa. Own generators account for the bulk of the capital equipment of small manufacturers in Africa. Unreliable supply of electricity is due mainly to lack of investment in the energy sector and drought. High electricity costs contribute significantly to the cost of production in most African countries.

(e) Financial Services

Inadequate access to competitive trade finance and insurance products is a key obstacle to increasing international trade in a number of African countries. This problem is particularly acute for the small and medium sized enterprises. A number of factors contribute to the insufficient availability of financial services to traders within Africa. Some of these affect directly the supply of such services, such as the general unavailability of financial capital or insurance capacity or regulatory constraints or State monopolies of certain financial products. Others result in ineffective or high cost delivery of financial services, unreliable and expensive telecommunication systems and lack of information on local firms in Africa. The lack of access to necessary financial market expertise and information system technology

has also been a major obstacle to the use by African traders of modern trade finance and insurance products.

(f) Business Services

Outdated procedures, as well as multiple, non-standardized documents result in additional transaction costs and unnecessary delays to the movement of goods. The lack of coordination among the many parties to a trade transaction and lack of appropriate forums for transparent discussions between public and private sectors to simplify procedures, documentation and (excessive) regulations inhibit exports and increase the costs of imports.

Problems of availability, selection, access and international standardization hamper enterprises in making the best use of information for trade. Lack of information regarding developments in these fields act as barriers to modernization of trade in Africa. This can be particularly damaging for newcomers to international business and small and medium-sized enterprises. Not having access to the relevant business information can be as serious an obstacle as tariff and non-tariff barriers.

The market for business information is complex and tends to suffer from lack of transparency. This is due to rapid technological change, highly differentiated array of products and services, and the large variety of forms under which information is made available. For smaller players, like most enterprises in Africa, this often creates confusion and an impression that gathering and using information is an activity reserved to advanced, sophisticated (and generally larger) players. Such a situation contributes to broadening the gap between the bigger players that have access to business information and the smaller players that have little or no access. This gap is compounded by problems of physical access and cost. For most producers and collectors of business information, African countries are, at best, a marginal market. The endemic lack of access to information is aggravated by a quasi-total absence of locally-collected and produced information. Because the capabilities and products of local enterprises in Africa are not known abroad, significant trading and investment opportunities are lost.

3. INTERVENTIONS TO ADDRESS INFRASTRUCTURE PROBLEMS

3.1 Interventions by National Governments

Some of the intervention to address infrastructure problems can and are being down at national level. A feasible but ambitious scenario of road upgrading is likely to bring greater intraregional trade benefits than comparable actions affecting either tariffs or customs procedures. A number of countries have embarked on ambitious projects aimed at upgrading transport infrastructure. In any case, the combined impact of upgrading road network quality and improving trade facilitation appears likely to produce gains well in excess of those that could be expected from comparable tariff reductions.

Electricity supply is another serious infrastructure problem driving up exporter's costs. Unreliable and costly power supply is one of the biggest

problems affecting their operations. Frequent power outages stop production and drive up operating costs. Dealing with high electricity costs and reliability of supply will require new investments. Poor management of Power Authorities has led to the poor delivery of electricity which is vital to production. Improvement in systems management is a first step towards addressing the power shortage in most African countries. In some countries huge investments to reach the demand of the consumers; in such instances, institutions such as the African development Bank and the World Bank can provide the necessary financial assistance.

Improvement in telecommunications infrastructure may lead to reduction is costs. High costs of telecommunications in most African countries are due to poor regulatory environment and government reluctance to open up the sector to more competition. This is one sector that has expanded without the government expenditure. Actually, African governments the main beneficiaries because of the licensing revenue they receive from the mobile operators. Greater competition will reduce the cost of communicating. Such an intervention can be done national governments.

3.2 Interventions by Regional Institutions

Infrastructure projects can have important intraregional spillovers. Landlocked countries face added problems in that they have only limited control over many of the costs of transporting goods, as they arise in neighboring countries as exports transit to and from ports in those locations. They have to find ways to address transport problems outside their borders through there memberships in regional organizations. Regional economic bodies such as SADC, COMESA, ECOWAS and UEMOA can play an important role in facilitating improvement in cross border transport networks.

Port charges add another dimension to the freight cost problem. Long delays and high port clearing charges are experienced in importing and exporting containers in many African ports. The landlocked countries have no control over the management of the ports of entry or exit of their goods. Regional organisations can facilitate a regional approach to dealing with such bottlenecks including improvement in infrastructure.

In terms of electricity, countries in southern Africa took a regional approach to dealing with electricity distribution. They created a power pool that will provide power to countries with low capacities.

3.3 Interventions by International Players

The main intervention by international players is the provision of financial and technical resources to address infrastructure problems in Africa. One instrument is the aid of trade initiative. The international community can provide best practices in improving road network (such as in Europe and Asia), energy management and port infrastructure.

4. INFRASTRUCTURE AND EXPORT COMPETITIVENESS: REVIEW OF THEORY AND EMPIRICAL LITERATURE

Trade costs (particularly infrastructure costs) have economically sensible magnitudes and patterns across countries and regions and across goods,

suggesting useful hypotheses for deeper understanding. Despite many difficulties in measuring and inferring the height of trade costs and their decomposition into economically useful components, the outlines of a coherent picture emerge from recent developments in data collection and especially in structural modeling of costs. Obstfeld and Rogoff (2000) argue that all the major puzzles of international macroeconomics hang on trade costs.

A theoretical approach is inevitable to infer the large portion of trade costs that cannot be directly measured in the data. The literature on inference about trade barriers (impact of infrastructure) from final goods prices remains largely devoid of theory. The gravity model provides the main link between trade barriers and trade flows. Gravity is often taken to be rather atheoretic or justified only under highly restrictive assumptions. Gravity links the cross-country general equilibrium trade allocation to the cross-country trade barriers, all conditional on the observed consumption and production allocations. Appropriate aggregation of trade costs, especially the impact of infrastructure on international trade is a key concern. Aggregation of some sort is inevitable due both to the coarseness of observations of complex underlying phenomena and the desirability of simple measures of very high dimensional information.

The rest of the section reviews literature on impact of infrastructure on international trade. The literature is divided into five groups. An important theme is the many difficulties faced in obtaining accurate measures of trade costs.

Bernard et al (2000 and 2003), Melitz (2002), and Yeaple (2002)

An increase in aggregate industry productivity as a result of falling trade costs (improved infrastructure) is a key feature of three heterogeneous-firm, general equilibrium trade models introduced by Bernard et al. (2000), Melitz (2002), and Yeaple (2002). The models emphasize productivity differences across firms operating in an imperfectly competitive industry consisting of horizontally differentiated varieties. In all three models, the existence of trade costs induces only the most productive firms to self-select into exporting. As trade costs fall, as a result of improved physical infrastructure, industry productivity rises due a reallocation of activity across firms: lower trade costs cause low productivity non-exporting firms to exit and high productivity non-exporters to increase their sales through exports, thereby increasing their weight in aggregate industry productivity.

Bernard et al. (2000), Melitz (2002), and Yeaple (2002) develop firm-level models of intra-industry trade that are designed to match a set of stylized facts about exporting firms. In all the three papers, exporter superiority is shown to be the equilibrium outcome of more productive firms self-selecting into the export market. This selection is driven by the existence of trade costs, which only the most productive firms can absorb while still remaining profitable. All three papers relate reductions in trade costs to increases in aggregate industry productivity: as trade costs fall, lower productivity, non-exporting firms die, more productive non-exporters enter the export

market, and the level of exports sold by the most productive firms increases.

Declining trade costs force low productivity plants to exit the market in both Bernard et al. (2000) and Melitz (2002), but the mechanism by which this occurs differs faintly. In Bernard et al. (2000), low productivity plants exit because of increased import competition while in Melitz (2002), countries' varieties do not overlap. As a result, an increase in imports raises the probability of death at all levels of productivity while the death of low productivity plants is actually driven by the entry into exporting of other domestic firms.

Melitz (2002) builds a dynamic industry model with heterogeneous firms producing a horizontally differentiated good with a single factor, and allows for variation in firm productivity. The coexistence of firms with different productivity levels in equilibrium is the result of uncertainty about productivity before an irreversible entry decision is made. Entry into the export market is costly, but the decision to export occurs after firms observe their productivity. Firms produce a unique horizontal variety for the domestic market if their productivity is above some threshold, and export to a foreign market if their productivity is above a higher threshold. The analysis is restricted to countries with symmetric attributes to focus solely on the relationship between trade costs and firm performance.

In equilibrium, declining variable trade costs mean greater profits for exporters, which are also the most productive firms, because of their increased access to external markets and lower per unit costs net of trade. Higher export profits pull higher productivity firms from the competitive fringe into the market, raising the productivity threshold for market entry and forcing the least productive non-exporters to shut down. Higher export profits (due to lower trade costs) also reduce the productivity threshold for exporting, increasing the number of firms which export. In addition, declining trade costs invite more foreign varieties into the market and reduce the domestic sales of all domestic firms. The increased exports of the most productive exporters more than compensate for this decline in domestic market share. A decrease in the fixed cost of exporting has effects similar to a reduction in variable trade costs. One difference is that export sales do not increase at existing exporters. Rather, the increase in exports comes entirely from new entrants.

Bernard et al. (2000) construct a static Ricardian model of heterogeneous firms, imperfect (Bertrand) competition with incomplete markups, and international trade. Firms use identical bundles of inputs to produce differentiated products under monopolistic competition. Within a country without external trade, only the most efficient producer actually supplies the domestic market for a given product.

With international trade and variable trade costs, a firm produces for the home market if it is the most efficient domestic producer of a particular variety and if no foreign producer is a lower cost supplier net of trade costs. A domestic firm will export if it produces for the domestic market and if, net of trade costs, it is the low cost producer for a foreign market.

With positive trade costs, exporters are firms with higher than average productivity. Bernard et al. (2000) use a simulation to demonstrate that as trade costs fall, aggregate productivity rises because high productivity plants expand at the expense of low productivity firms.

Yeaple (2002) develops a static one factor model of trade in differentiated products that differs from Melitz (2002) and Bernard et al. (2000) in three respects: firms choose between producing a homogeneous non-tradeable or a differentiated variety; workers vary in terms of skill; and, firm labor productivity is determined endogenously as two production techniques are available to produce differentiated goods, either low fixed/high unit cost or high fixed/low unit cost. With trade costs, firms with the highest productivity produce the differentiated good via the high fixed cost technique and export, while firms with the lowest productivity produce the homogenous good. Firms using the low fixed cost technology have intermediate productivity levels. A reduction in trade costs increases the incentive for firms to adopt the high fixed cost production technique and export. As a result, a larger number of firms adopt this technology while the absolute number of "domestic" firms in the industry falls.

Bernard et al (2003) examine the response of industries and firms to changes in trade costs. They develop testable predictions on the reallocation of activity across plants and within industries as a result of changes in trade costs models using international trade with heterogeneous firms. To test the hypotheses, they create a new dataset of trade costs by industry over a twenty year period and link the measures to plant-level data on the entire U.S. manufacturing sector.

A key contribution of the analysis is the connection of plant-level manufacturing data to industry-level measures of trade cost changes. The paper provides the first empirical examination of the relationship among industry trade costs, firm reallocation, and industry productivity in the U.S. Trade costs are defined as the sum of ad valorem tariff and transport costs, and are constructed using U.S. product-level trade data. The paper uses firm-level models of international trade to explore a third channel, the evolution of industry productivity resulting from a reallocation of activity across firms in response to changes in trade costs. A new measure of trade costs is created over time and industries using disaggregated U.S. import data.

An important contribution of the analysis is the creation of a new set of industry-level trade costs that can be related to plant behavior over time. To most closely match the notion of trade costs in the theoretical models, the authors construct an ad valorem trade costs model that vary over time and across industries.

Clark, Dollar and Micco (2004)

Clark, Dollar and Micco (2004) investigated the determinants of shipping costs to the United States. Using a reduced form price equation they quantify the factors affecting transport costs on maritime transport charges paid by U.S. imports carried by liner companies from countries all over the world during the period 1995-2000. They stress the effect of port efficiency

on maritime transport costs and address the problems of endogeneity and omitted variable bias associated with price equation.

They find that port efficiency is an important determinant of shipping costs. Improving port efficiency from 25th to the 75th percentile reduces shipping costs by 12 percent. Reductions in country inefficiencies associated to transport costs from the 25th to 75th percentiles imply an increase in bilateral trade of around 25 percent. Bad ports are equivalent to being 60% farther away from markets for the average country. Inefficient ports also increase handling costs, which are one of the components of shipping costs. In turn, when looking at the determinants of port efficiency, they find that the level of infrastructure exert a significant influence.

Jacks, Meissner and Novy (2006)

Jacks, Meissner and Novy (2006) use a new measure of total trade costs at the bilateral country level to examine the change in international trade integration during the first wave of globalization from 1870 to 1913. The measure is derived from a micro-founded multiple-country general equilibrium model of trade in differentiated products that incorporates trade costs. These costs are broad and encompass not only shipping costs and tariffs but also many other barriers to trade such as informational, institutional and non-pecuniary barriers. The model yields a gravity equation of international trade which is used with trade and output data to compute implied bilateral trade costs. The outcome is a theoretically consistent measure of bilateral trade integration which can then be averaged over trading partners to provide a measure of overall integration with the global economy.

They paper finds that trade costs are lowest amongst the most developed countries and highest in the peripheral and poor countries. On average, the measure declined by roughly ten percent during the period 1870-1913, declining most slowly in the richest countries. They sort the determinants of trade costs into four main categories: geographic; political; transportation and communications; and, institutional and cultural. They find that all the factors play a role in explaining the variation in the data. Transportation costs and other factors related to proximity explain the largest fraction of the variance. In the regressions they find evidence that transportation infrastructure matters. And there is a fairly significant role for the accumulation of railroad infrastructure and the length of waterways. Tariffs, and increased exchange rate regime coordination also play a strong role. The results also show that reductions in trade costs explain roughly 40 percent of the global trade boom.

Limão and Venables (2001)

Limão and Venables (2001) emphasize the dependence of trade costs on infrastructure. They gather price quotes for shipment of a standardized container from Baltimore to various points in the world. 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%. The median

landlocked country has transport costs which are 55% higher than the median coastal economy. The infrastructure variables also have explanatory power in predicting trade volume.

Francois and Manchin (2006)

Francois and Manchin (2006) examine the influence of institutions, geographic context, and infrastructure on trade. The authors focus on threshold effects, emphasizing cases where bilateral pairs do not trade. They work with a panel of bilateral trade from 1988 to 2002. Matching bilateral trade and tariff data and controlling for tariff preferences, level of development, and distance, they find that infrastructure, and less so institutional quality, is a significant determinant not only of export levels, but also of the likelihood exports will take place at all. Landlocked countries also do consistently worse. They control for correlation between the general level of income and infrastructure and institutional development, focusing on country deviations from expected institutional and infrastructure development given its income cohort. The results support the notion that export performance, and the propensity to take part in the trading system at all, depends on institutional quality and access to transport and communications infrastructure. In addition, on the basis of split sample regressions, they conclude that for least developed countries, there is evidence of a broad three-part complimentarity between greater involvement of the government in the economy and both the domestic communications and domestic transport infrastructures on the one hand, and export performance on the other.

5. FRAMEWORK FOR ANALYSING IMPACT OF INFRASTRUCTURE AND EXPORT COMPETITIVENESS

5.1 Methodologies

Due lack of reliable data research on infrastructure and export competitiveness will require the use of different methodologies to inform policy.

(a) Route Analysis

This method is particularly useful for country studies because of asymmetry of information on the quality of road networks. The method tracks infrastructure pertaining to transportation networks within and outside a country.

We focus on road transport because of its particular importance in sub-Saharan Africa. Part of this importance comes from the fact that 15 sub-Saharan African countries are landlocked. The available empirical evidence suggests that being landlocked adds significantly to the cost of trading internationally. In a number of landlocked countries transport can be the single most important component of cost for some products.

High transport costs are mainly due to poor and fragmented infrastructure and inadequate maintenance. Road quality and infrastructure clearly matter for trade. Exporting firms rely not only on the quality of infrastructure provided by their home governments, but also on that of neighboring

countries through which goods must transit. However, available data has not allowed researchers to pay detailed attention to the state of upkeep of particular road links.

To examine the impact of road network quality across the whole of sub-Saharan Africa (SSA) researchers should use detailed road transport data to construct measures of international distance on an overland basis. They should then build up a multi-dimensional measure of road quality, which can be aggregated taking proper account of transit effects.

- Construct minimum distance routes connecting major cities in the exporting and transit countries to calculate international distances;
- Calculate quality of roads (percentage of paved roads; highways; single lanes; double lanes etc) and maintenance capacity. This is important because the variables can significantly alter the apparent percent of paved roads;
- Quality of bridges;

The advantage of route analysis is that it enables the researcher produce detailed measures of bilateral road quality rather take full account of transit effects. The analysis uses actual transit distance to weight road quality in each country along the route, rather than using paved road approximation and number of border crossings with different base years.

(b) Enterprise Survey of Cost of Production

Assessing the impact of infrastructure cost and quality on firms requires enterprise level surveys. Policy focused data is required. Survey of exporting firms aimed at gathering data on costs in a way that can isolate contribution costs related to infrastructure will be an important contribution to policy formulation. An industry survey of cost of production will provide information of the cost structure of different exporting industries. For example, an exporting firm that is randomly selected in a particular country the contribution of costs from infrastructure (such as electricity, communication, transport etc) to the total cost of production and exporting will be delivered and analysed. The value chain will show how total costs are distributed along all process of manufacturing and exporting a product. The survey will provide a tool for understanding the source of competitive cost disadvantage to the exporting industries in a particular country.

The enterprise survey will involve collecting primary data from a selected sample of exporting firms, primarily through a questionnaire. Follow up interviews would, where necessary be used to supplement the information obtained through the main instrument of the survey. Because of the need and our interest in exports and infrastructure, the survey will deliberately target exporters and have a detailed breakdown of the infrastructure costs in the production and exporting processes. The exporters will be a mix of international and regional exporters to identify differences between exporting to the regional market and the international market.

(c) Econometric Analysis

Trade costs can be inferred from an economic model linking trade flows to observable variables and unobservable trade costs. Inference has mainly used the gravity model. We follow the model Francois and Manchin (2006). In the paper they explored the evolution of trade across a panel spanning bilateral trade flows from 1988 to 2002. In addition, they examined trade volumes where trade is observed, they also examine the determinants of zero trade flows. They work with a gravity model where the standard right hand side variables are expanded to include indexes of both physical infrastructure and institutional development. The results indicate that while the evidence on institutions is somewhat mixed, variation in infrastructure relative to the expected values for a given income cohort is strongly linked to exports. Domestic infrastructure (communications and transportation) matters for exports.

The estimation strategy involves specifying a sample selection model to take account of the censoring process that leads to zero or missing bilateral trade flows. The amount of the trade can only be observed if trade occurs. A two-step Heckit estimation is therefore employed: First a probit model on trade occuring or not is estimated, and then estimate the trade volumes using OLS analysis. This is based on the following two latent variable sub-models:

$$M1 = \beta'X + \varepsilon_1 \qquad (1)$$

$$M2 = \gamma'Z + \varepsilon_2 \qquad (2)$$

Where;

X and Z are respectively k and m vectors of regressors;

ε_1 and ε_2 are the error terms which are jointly normally distributed, independently of X and Z, with zero expectations; and,

M1 is only observed if M2 > 0. M2 = 1 if M1 is observed and M2 = 0 if the variable M1 is missing.

In the regressions M1 is the value of imports, while M2 is a dummy variable taking the value one if trade occurs while zero otherwise. Equation 1 shows how the value of imports is affected by different factors, while Equation 2 gives some insight into why trade occurs at all between two partner countries.

In specifying the underlying structure of equation (1) we follow the gravity-model literature. However, we do not include time varying fixed importer and exporter effects, instead we include time specific and reporter (importer) country specific dummies because we want to work with time-varying country-specific variables related to infrastructure, which precludes the use of time-varying country dummies. In addition to the well known variables in the gravity literature we also include measures of infrastructure aspects of importers and exporters that we expect to impact on trading costs. We specify the following Heckit model:

$$\ln M_{i,j,t} = \beta_0 + \beta_1 p\_pcGDP_{j,t} + \beta_2 r\_pcGDP_{i,t} + \beta_3 rPOP_{j,t} + \beta_4 rPOP_{i,t} + \beta_5 T_{i,j,t} + \beta_6 6dist_{i,j} + \beta_7 landlocked_i + \beta_8 contig_{i,j} + \beta_9 comlang\_ethno_{i,j} + \beta_{10} colony_{i,j} + \beta_{11} INF1_{j,t} + + \beta_{12} INF2_{j,t} + \mu_1 \quad (3)$$

and for the probit estimation for non-zero flows we assume that $M_{i,j,t}$ is observed when we have

$$\beta_0 + \beta_1 p\_pcGDP_{j,t} + \beta_2 r\_pcGDP_{i,t} + \beta_3 rPOP_{j,t} + \beta_4 rPOP_{i,t} + \beta_5 T_{i,j,t} + \beta_6 6dist_{i,j} + \beta_7 landlocked_i + \beta_8 contig_{i,j} + \beta_9 comlang\_ethno_{i,j} + \beta_{10} colony_{i,j} + \beta_{11} INF1_{j,t} + + \beta_{12} INF2_{j,t} + \mu_1 > 0 \quad (4)$$

Right hand variables in equations 3 and 4	
p_pcGDP:	log of per-capita GDP of partner
r_pcGDP:	log of per-capita GDP of reporter
pPOP:	log of population of partner
rPOP:	log of population of reporter
T:	tariff
Dist:	the log of distance (km, great circle method)
Landlocked:	landlocked partner
Contig:	reporter and partner share a border
comlang ethno:	shared linguistic/cultural heritage
colony:	reporter and partner had colonial relations
INF1:	partner infrastructure index 1
INF2:	partner infrastructure index 2

In equations (3) and (4), β_1 and β_2 have correlation _. Equation (3) assesses the determinants of the bilateral trade and shows the main factors influencing the amount of trade, given trade occurred between the two trading partners. Equation (4) sets out the selection criteria and provides information on the factors that determine whether or not we observe trade between country pairs.

The choice of variables is from standard gravity models.

- $M_{i,j,t}$ is country *i* imports from country *j* at time t;
- As a proxy for market potential, *POP* is included for partner (exporter) and reporter countries, as well as per-capita income *pcGDP;*
- Distance *dist* and tariffs *T*. For bilateral import protection, we use applied tariffs, $lnT_{i,j,t} = ln\ (1 + \_{i,j,t})$. $\_{i,j,t}$ indicates the applied tariff rate offered by importer *i* to exporter *j* in period *t*.

Because the reporter specific fixed effects in the regressions are highly correlated with the tariff data we regress the log of the tariffs on the reporter dummies and retain the residuals. The residuals are used for the regressions and provide a measure of the effects of bilateral tariffs given other reporter specific characteristics.

The *landlocked* dummy takes the value of one if the importing country is landlocked and zero otherwise. Landlocked countries are expected to have higher transportation costs than countries with similar characteristics but are not landlocked.

To capture historical and cultural linkages between trading partners several zero-one type dummy variables are included in the estimating equation. The variable *Excolony* takes the value of 1 if the exporting country *j* was a colony of the partner country *i*. A separate dummy, *comlang_ethno* captures if the traders of the two partner countries can speak the same language, or generally share the same linguistic heritage. Finally, a dummy to capture common borders *contig* is also included in the regressions.

Since the factor measuring the availability of infrastructure is highly correlated with income per capita and population, we regress our indexes against per-capita income and population and take the residuals as representative of deviations from income-conditional expected values for each of the two indexes.

$$INDEX_{k,j,t} = \alpha_{k,0} + \beta_{k,1}\, pcGDP_{j,t} + \beta_{k,2}\, (POP_{j,t})^2 + e_{j,t},\ k = 1, 2 \quad (5)$$

These deviations $e_{j,t}$ then correspond to the index values in equations (3) and (4).

5.2 Data

The seemingly simple question 'how high are trade costs in Africa?' cannot usually be answered with accuracy for most goods in most countries. The inaccuracy arises from three sources: absence of data; data which are useful only in combination with other missing or fragmentary data; and, aggregation bias. The absence of reliable data makes it difficult to measure the burden of infrastructure costs on the foreign trade of African exports. Any attempt to compare the infrastructure cost situation of each of the African countries with the other runs up against problem of data comparability because there are no readily available international data series which can relate the value of merchandise exports and merchandise imports on a free on board (f.o.b.) basis (i.e. excluding all freight and insurance charges) to the value when delivered abroad or received from abroad (i.e. on a cost, insurance and freight basis) including freight and insurance.

There are three main sources of data for transport costs:

(i) The most direct is industry or shipping firm information. Limão and Venables (2001) obtain quotes from shipping firms for a standard container shipped from Baltimore to various destinations. Hummels (2001) obtains indices of ocean shipping and air freight rates from trade journals which presumably are averages of such quotes. Direct methods are best but not always feasible due to data limitations and the very large size of the resulting datasets.

(ii) National customs data in some cases allow fine detail. Customs reports for some countries attempt to provide such information with respect to imports, identifying the difference between f.o.b. and c.i.f. valuations for individual import transactions, but most countries are unable to do this. Customs data on exports are typically on an f.o.b. basis. For example, the U.S. Census provides data on U.S. imports at the 10 digit Harmonized System level by

exporter country, mode of transport and entry port and valued at f.o.b. and c.i.f. bases. Dividing the former value into the latter yields an ad valorem estimate of bilateral transport cost. Hummels (2001) makes use of this source for the U.S. and several other countries.

(iii) The most widely available (many countries and years are covered) but least satisfactory average ad valorem transport costs are the aggregate bilateral c.i.f./f.o.b ratios produced by the IMF from matching export data (reported f.o.b.) to import data (reported c.i.f.). The IMF uses the UN's COMTRADE database, supplemented with national data sources. The estimates for the IMF's balance-of-payments database are generally prepared by specialists in the various countries' central banks, on the basis of customs data and special surveys of banks and other firms engaged in foreign trade and transport. In some cases formulas may be used to adjust the raw customs data, which are usually simply imports (c.i.f.). Estimates typically attempt to cover items excluded from customs, such as so-called shuttle trade, or informal trade with neighbouring countries. Hummels (2001), however, points out that since a high proportion of observations are imputed and also because the compositional shifts in aggregate trade flows which occur over time "quality problems should disqualify these data from use as a measure of transportation costs in even semi careful studies."

If we are to compare transport cost burdens among countries, there is really only one readily available data source - the International Monetary Fund's Balance of Payments Yearbook estimates of the value of a country's merchandise (i.e. goods) imports on an f.o.b. basis, together with estimates of foreign exchange payments (debits) for freight. Debit payments for insurance can also be noted, but this includes all types of insurance in addition to that on cargo (which is not available separately); thus a conservative measure of transport cost burden for a country is simply the ratio of debit payments for freight to total value of goods imports (f.o.b.), expressed as a percentage. These data are available for virtually all countries in the world, although the estimates for a number of African countries may be delayed by as much as five years.

Before comparing particular landlocked and transit countries, it is worth restating the main factors that affect the level of the freight-to-import ratio:

(i) The actual freight costs, which are specified for particular routes, are a function of factors such as the distance travelled, the mode of transport and number and type of changes entailed, the efficiency of ports, the quality of infrastructure and of the vehicles or freight cars, the frequency of scheduled service, the volume of traffic, the degree of competition, the cost of energy, and simplicity of border-crossing and transit procedures;

(ii) While freight charges may vary to some extent according to the value of merchandise, weight or volume is likely to be the main determinant of freight cost for a particular mode of transport. If the value of a country's imports is higher because its commodity structure is biased towards high-value low-weight items, then its freight-to-import ratio will be lower. On the other hand, low-value per ton items such as sugar can have very high freight-to-value ratios. African countries may be likely to have a preponderance of lower-valued bulky imports with higher freight ratios, but there is no readily available yardstick to measure the extent of this phenomenon. Indeed, landlocked countries with little industry may import relatively few raw materials for further processing and may import many finished goods which might act to lower the freight-to-import ratio;

(iii) The composition of imports according to their region of origin will play an important role in determining the freight-to-import ratio. If dependence on distant industrial countries for imports is higher the ratio will be higher; if imports from the country's own region are higher the ratio is likely to be lower. In addition, if imports from industrial countries are resold off the shelf by large coastal countries to neighbouring landlocked countries, the freight ratio of the latter will be lowered as compared with direct import from the industrial country; and,

(iv) The freight-to-import ratios are estimates based on surveys and analyses, which appear to show varying degrees of conservatism and which may be out of date. It will be important to try to improve these data.

To measure infrastructure, perhaps the most readily available data is from the World Development Indicators database. The World Bank produces indexes on infrastructure. This includes data on the percentage of paved roads out of total roads, on the number of fixed and mobile telephone subscribers (per 1000 people), on the number of internet subscribers (per 1,000 people) and freight of air transport (million tons per km). Each index ranges from 0 to 10 reflecting the distribution of the underlying data. Notionally, a low value is bad, and a higher value is good. The indexes are provided for 1985, 1990, 1995, 2000, 2001 and 2002. Interpolation can be used for years where no data are available.

Data on maritime transport costs, value and volume of imports, and shipping characteristics, like the percentage of the goods transported through containers, can be obtained from the U.S. Import Waterborne Databank (U.S. Department of Transportation). This, however, restricts the analysis to exports to the U.S. It will therefore make more sense to obtain information from many ports around the world.

Transport costs can be constructed using imports charges and import weight per product, aggregated at the six level HS system. The U.S. Census Bureau defines Imports charges as: "...the aggregate cost of all freight, insurance, and other charges (excluding U.S. import duties) incurred in bringing the

merchandise from alongside the carrier at the port of exportation -in the country of exportation- and placing it alongside the carrier at the first port of entry in the United States."

Seaport infrastructure can be used as proxy for port efficiency. A port can classified as large if it has lifts with a leverage capacity of 50 tons and above. A countries' GDP per capita can also be used as an alternative proxy of port efficiency. Countries' GDP per capita are correlated with their level of infrastructure. Unfortunately, there is not much comparable information about port efficiency at port level to be used in a cross-country analysis. The nearest source (yet far from perfect) is the Global Competitiveness Report (GCR). This annual data is available from 1995. Greater caution should be taken since the index varies over time.

Another measure of infrastructure can be based on information at country level on paved road, paved airports, railways and telephone lines. This is based on the assumption that the level of infrastructure of a country is highly correlated with the level of infrastructure of their ports. Use of transport cost information at product level is more realistic that the c.i.f/f.o.b ratio, which has the disadvantage of being an aggregate measure for all products.

Since the indexes are highly correlated, a principal component analysis should be used to produce a set of summary indexes. Ideally, principal component analysis identifies patterns in data and based on these patterns it reduces the number of dimensions of the data without a lot of loss of information.

5.3 Proposed Country Studies

Country studies will only make sense if there is a mix of landlocked and transit countries. It is possible for the region to reap a large proportion of the overall gains by focusing attention on a few countries which are important transit corridors but also exhibit significant limitations in terms of infrastructure quality.

There are 15 landlocked countries in Africa of which 12 are LDCs. There are 16 principal coastal transit countries serving the landlocked African countries (9 of which are LDCs).

West Africa:	Landlocked – Burkina Faso and Niger
	Transit – Togo and Nigeria
Central Africa:	Landlocked – Central African Republic and Chad
	Transit – Cameroon
East Africa:	Landlocked – Uganda and Rwanda
	Transit – Kenya and Tanzania
Southern Africa:	Landlocked – Botswana, Malawi, Zambia and Zimbabwe (important transit country)
	Transit – Mozambique and South Africa

Ethiopia and Djibouti

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