CORRIDOR DIAGNOSTIC STUDY OF THE NORTHERN AND CENTRAL CORRIDORS OF EAST AFRICA

ACTION PLAN

Volume 2: Technical Papers

B. Trade and Traffic Forecast

SUBMITTED TO
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Acronyms

BOL	bill of lading
CCTFA	Central Corridor Transit Transport Facilitation Agency
CD	chart datum
CDS	Corridor Diagnostic Study
CFS	container freight stations
COFC	container on flat car
COMESA	Common Market for Eastern and Southern Africa
CY	container yard
DRC	Democratic Republic of Congo
EAC	East African Community
EIR	equipment interchange report
EIRR	Economic internal rate of return
FONA	First Order Network Assessment
GRT	gross register tonnage
HCM	Highway Capacity Manual
HDM	Highway Design Manual
ICD	inland container depots
IRI	International Road Indices
KMA	Kenya Maritime Authority
KPA	Kenya Port Authority
km	kilometers
LoLo	lift on-lift off
LOS	Level of service
m	Meters
MCT	Mombasa Container Terminal
MHC	mobile harbor crane
MLL	Marine Logistics Ltd.
NCTTCA	Northern Corridor Transit Transport Coordination Authority
OCR	Optical Characteristic Reader
PPP	Public Private Partnership
RA	Revenue Authorities
RAHCO	Reli Assets Holding Company
RFID	Radio Frequency Identification Device
RMG	rail mounted gantry
RoRo	roll on-roll off
RTG	rubber tire gantry
RS	reachstackers
RVR	Rift Valley Railways
SADC	Southern African Development Community
SPM	single point mooring
STS	ship to shore

SUMATRA	Surface and Marine Transport Regulatory Authority, Tanzania
TICTS	Tanzania International Container Terminal Services
TAZARA	Tanzania-Zambia Railway Authority
TEU	twenty-foot equivalent unit
TOFC	trailer on flat car
TOS	terminal operating system
TPA	Tanzania Port Authority
TRC	Tanzania Railways Corporation
TRH	Tanzania Road Haulage
TRL	Tanzania Railways Limited

1. Introduction and Methodology

Background

The Northern Corridor anchored by the port of Mombasa in Kenya, and the Central Corridor, anchored by the port of Dar es Salaam in Tanzania, are principal and crucial transport routes for national, regional and international trade of the five East African Community (EAC) countries, namely; Burundi, Kenya, Rwanda, Tanzania and Uganda. Due to inadequate physical infrastructure and inefficiency, these corridors are characterized by long transit times and high cost. Freight costs per km are more than 50 percent higher than the USA and Europe and for the landlocked countries; transport costs can be as high as 75 percent of the value of exports. Modernization of transport infrastructure and removal of non-tariff barriers along these corridors is critical for trade expansion and economic growth, which are key to the success of regional integration as well as creation of wealth and poverty alleviation in the individual countries.

The Heads of State in the COMESA, EAC and SADC, the Tripartite, have determined that the transport inefficiencies are among the biggest impediments to realizing their vision to lead their countries out of poverty. Transport costs are prohibitively high and are a barrier to trade and investment, which are the cornerstone for the aspired economic growth to regional prosperity.

Having had the experience of successful development of an action plan to effectively tackle transport bottlenecks on the North-South Corridor, the Tripartite have ordered the preparation of a similar action plan for the key trade routes of Eastern Africa. As a technical foundation for the action plan, regional stakeholders in March 2009 agreed to carry out a Corridor Diagnostic Study (CDS) with funding from the U.S. Agency for International Development (USAID) and the U.K. Department for International Development (DFID).

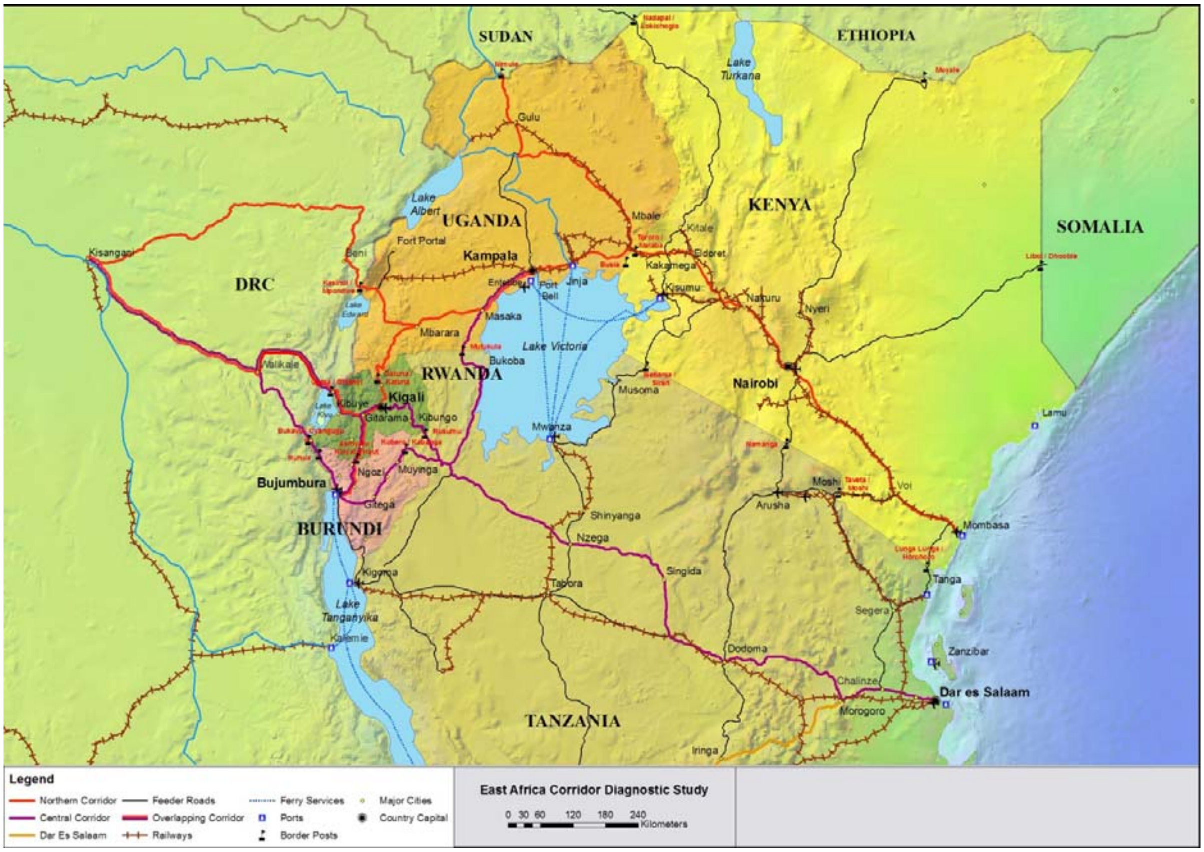
This Technical Paper presents the CDS forecast of trade and traffic for the Northern and Central Corridors. An overview of historical trade and traffic patterns in the Northern and Central Corridors, including discussions of types of traffic, modes utilized and commodities transported is provided. The traffic forecast methodology is described; involving models for trade demand forecasts, corridor and mode allocation and the impact of improved corridor performance parameters on future trade. The emphasis of this paper is on the estimation of the impact of improved performance resulting from proposed projects on the allocation of traffic to corridors and modes; while estimating impact on trade takes a secondary role. The technical paper summarizes selected results of traffic analysis and surveys carried out by Nathan Associates for the Northern and Central Corridors of East Africa. This paper also utilizes the results reported in two separate ongoing studies: The Northern Corridor Infrastructure Master Plan (NCIMP) being implemented by Louis Berger for the Northern Corridor Transit Coordination Authority[1] and the Definition and Investment Strategy for a Core Strategic Transport Network for Eastern and Southern Africa (Core Network Study) being implemented by Nathan Associates, Inc. for the World Bank.[2] The results of these two studies were used as part of the input to the analysis and forecasts in this working paper. Other sources were also included as described in the methodology below.

Geographic Scope of Study

The Corridor Diagnostic Study reviewed the infrastructure condition and regulatory policy of the Northern Corridor anchored by the port of Mombasa in Kenya, and the Central Corridor, anchored by the port of Dar es Salaam in Tanzania, which are principal and crucial transport routes for national, regional and international trade of the five East African Community (EAC) countries, namely; Burundi, Kenya, Rwanda, Tanzania and Uganda (see Figure 1-1). The CDS analysis also includes the extension of the Northern and Central Corridors to the Democratic Republic of the Congo and links to Southern Sudan, Ethiopia and Zambia.

[1] Northern Corridor Infrastructure Master Plan: Interim Report: Interim Report, June 2010.
[2] Definition and Investment Strategy for a Core Strategic Transport Network for Eastern and Southern Africa, Regional Model Report, June 2010.

Figure 1-1. CDS Study Area



Traffic Forecasting Approach

An overview of the traffic forecasting approach is given this section. This approach is specifically tailored for the project and it improves on work documented in recent reports: More detailed description of the methodology employed is provided in subsequent chapters as noted below.

There were seven major steps involved in the methodology. Below the major steps of the methodology are summarized and Figure 1-2 presents them in a diagram:

1. Review historic trade and traffic data in the corridors

The forecast activities start with a review of historic trade data in the study area and traffic flows in the corridors in order to provide a reference point for future forecasts. Trade data was collected for country pairs within the study area and between country and overseas regional partners, in terms of values for the years 1998-2008. Traffic data was obtained from port data in the form of transit flows to landlocked countries for both Mombasa and Dar es Salaam; as well as from customs data for several of the study area countries. Historical data on economic country indicators (GDP and population) were collected. A review of historic trade and traffic flows can be found in Chapter 2.

2. Produce GDP and population forecasts

Data on GDP and population values for CDS study area countries were collected, reviewed and cleaned. Once reorganized, the historical economic data was used to forecast future values from 2009 to 2030. The results were compared and contrasted with the country economic forecasts in the reference studies; adjustments were made where necessary to render the data more accurate.

3. Create forecast of trade flows

First, using the data collected on historical trade flows, GDP and population in the first step and the forecasts calculated in the second step, total trade values for all countries in the study area were estimated. Then, trade values (import and export flows) for trading partners were forecasted from 2009 to 2030, through a regression model. Trade shares obtained from the results of the regression model were applied to total regional trade obtained from country level trade values, and produced the trade forecasts. The adjusted results in values were finally converted into tonnages; through conversion factors using commodities the study area countries trade. A detailed explanation of this methodology and summary tables of the results of trade forecasts can be found in Chapter 3.

4. Assign trade flows to corridors and modes to obtain status quo traffic forecasts

Once demand was estimated between trading partners, trade flows were assigned to corridors, by mode: road, rail and ports. The allocation was based on corridor performance data (price, time and reliability as perceived by shippers) estimated by FastPath, socioeconomic indicators (language groupings and economic association groupings), and policy indicators (mode preference for certain types of traffic and preference for or bias against specific ports or countries)[3]. This activity produces a set of status quo traffic forecasts, meaning that the forecasts assume that only regular upgrade, maintenance and expansion works of the corridor are incorporated; excluding any proposed projects that would lead to improvements in corridor performance. This analysis was done for years 2015 and 2030.

5. Identify potential impact of proposed projects on corridor performance

In order to estimate the impact of the proposed projects, their localized impact on performance variables (time, cost, reliability) was coded into FastPath for each link, node or logistics component. From FastPath, we obtained corridor level performance results, which were then compared against status quo baseline to estimate impact.

3 FASTPATH | improving transport logistics performance

FastPath is a proprietary diagnostic tool developed in a partnership between USAID and Nathan Associates to analyze transport infrastructure and operational inefficiencies in the transport/logistics chains serving import and export traffic. FastPath provides a quantitative basis for monitoring corridor performance. The audit methodology consists of surveys and questionnaires to identify bottlenecks and appropriate improvements to freight corridors.

6. Recalculate corridor and mode shares with improved corridor parameters

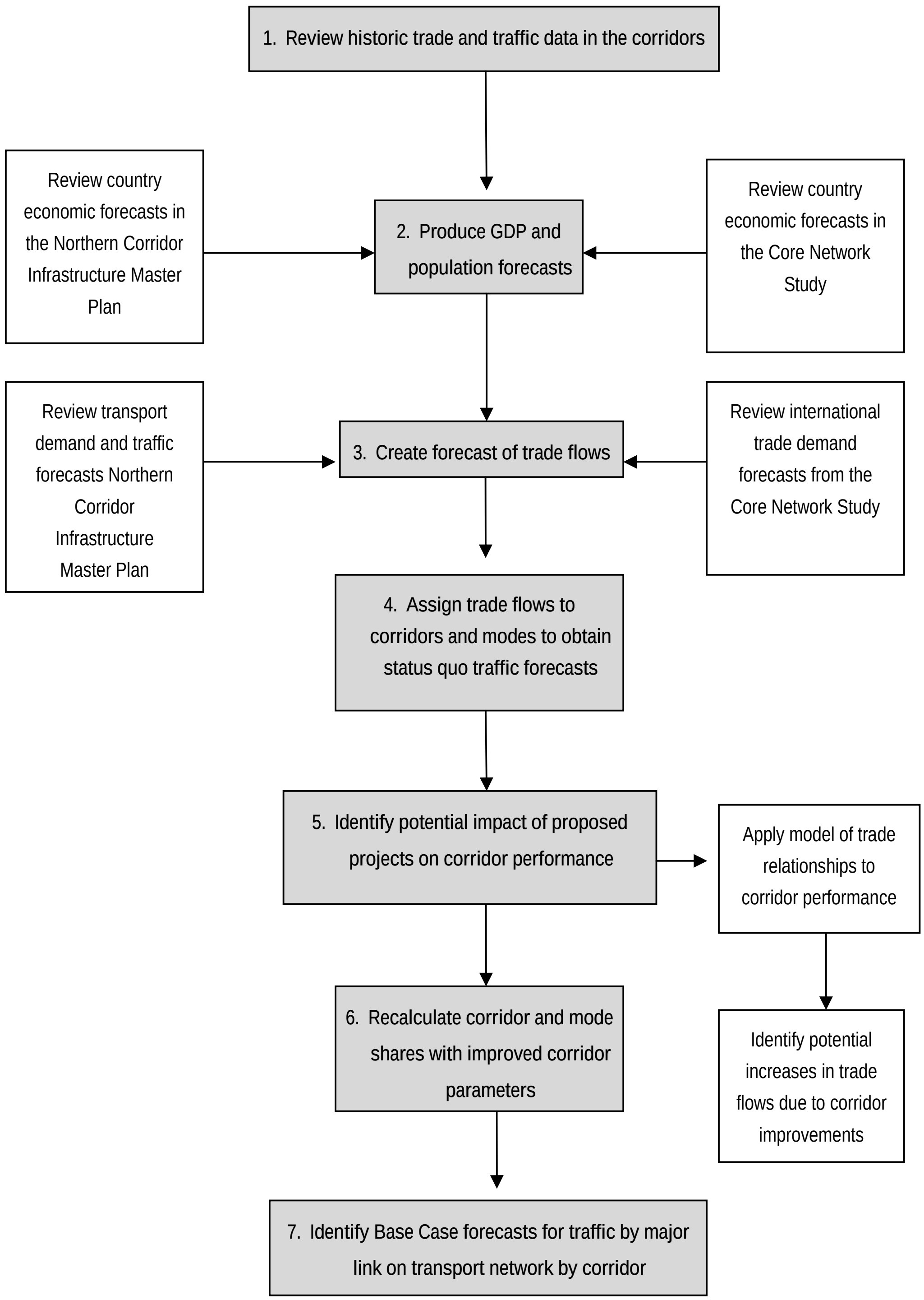
The improved performance based on proposed projects is entered into Corridor and Mode Choice Model to produce new shares. Further discussion of impact of proposed projects, as well as obtaining corridor and mode shares can be found in Chapter 4.

7. Identify Base Case forecasts for traffic by major link on transport network by corridor

The new shares are used by the Corridor and Mode Choice Assignment Model to reallocate traffic to corridors and modes, to obtain Base Case traffic forecasts. Summary tables of the resulting traffic can be found in Chapter 4.

Once the set of Base Case demand forecasts was produced, a separate model was applied to forecast the potential additional trade that might be induced by improvements to the corridor infrastructure and operations. This model estimated the magnitude of the relationship (elasticity) between generalized cost and trade. This elasticity value was applied to the change in generalized cost caused by the improvements in order to find an estimate for the amount of induced trade. The potential induced trade due to improved performance is presented in Chapter 5.

Figure 1-2. Traffic Forecasting Methodology



Organization of this Paper

Following this introductory chapter, Chapter 2 presents the historic trade and traffic flows in the two corridors. Chapter 3 presents the trade demand projections by country for 2015 and 2030. Chapter 4 shows how trade is assigned to corridors and modes; then presents forecasts for status quo and Base Case scenarios. Chapter 5 identifies and quantifies how potential improvements in corridor performance affect forecasted traffic.

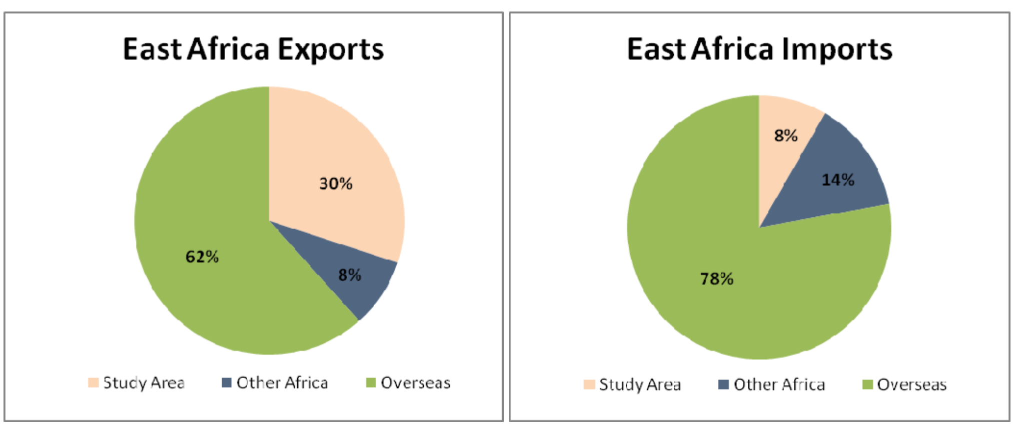
2. Historic Trade and Traffic Flows

This section discusses orientation of East African trade; presents the collected data on East Africa's historic trade between trading partners, which were used as a basis for trade and traffic forecasts; identifies main commodities transported in corridors; presents historical corridor traffic, including past growth of overseas trade with landlocked countries and discusses implications of these trends for corridor infrastructure.

Trends in East African Trade Flows

As in other parts of Africa, East African trade is very overseas-oriented. Total East African trade was 34.5 million tons in 2008, consisting of 27 million of imports (78.4 percent) and 7.5 million of exports (21.6 percent). Most of its exports and imports are with overseas partners (62 and 78 percent respectively), while the rest stay within East Africa region (30 and 8 percent) and with other African countries (8 and 14 percent). This is shown graphically in Figure 2-1[6].

Figure 2-1. Distribution of East Africa Exports and Imports, 2008



Source: : IMF Direction of Trade Statistics and COMTRADE.

[6] The "Study Area" is defined as the following eight countries: Burundi, Congo DR (Eastern), Ethiopia, Kenya, Rwanda, Sudan (Southern), Tanzania, Uganda , while "Other Africa"is defined as the countries in the African continent other than East Africa region.

Trade by Country and Overseas Regions

Initially, trade values (in million USD) were obtained from IMF Direction of Trade Statistics for the years covering 1998-2008. As a first step, historical trade flows with Africa region and with overseas partners were reviewed. Some observations on common characteristics and trends are below:

- Countries with a recent history of conflict and economic crises had very low or negative trade growth in the last decade. The most prominent examples are DR Congo with high negative trade growth rates and Burundi with low import growth rates. Countries that had conflict earlier had high growth rates reflecting recovery, such as Rwanda.
- Export growth rates tend to be faster for overseas trade than those for imports.
- Overseas trade is higher in unit value than trade within Africa. We see a generally increasing trend in overseas trade.
- Europe used to be a major trading partner but its share in total trade seems to be gradually decreasing for most East African countries.
- East Asia is an emerging trading partner for East Africa and its imports from East Africa are projected to increase continuously.
- In the recent past, there are certain countries with high short term growth rates (e.g., 34 percent import growth to overseas regions for DR Congo). However, the growth rates for these countries are expected to stabilize at lower levels in the long run.

As a second step, trade values were converted into tonnages, using factors estimated per commodity group and port tonnage data for overseas trade. The country's mix of commodities was taken into consideration for the conversions. Estimates of trade tonnage values by country and overseas regions are presented in Table 2-1.

The estimates of trade tonnage by country and overseas regions in the Corridor Diagnostic Study are presented in Table 2-1. The estimates are based on conversions of trade values from IMF Direction of Trade Statistics using factors by commodity group, supplemented by port tonnage data in the case of overseas trade. The data includes trade with major overseas partners, which were derived from trade value data adjusted for the mix of commodities. However, it excludes trade with Southern Sudan and the Ethiopia trade with Kenya is shown for all trade including trade which uses the Port of Djibouti.

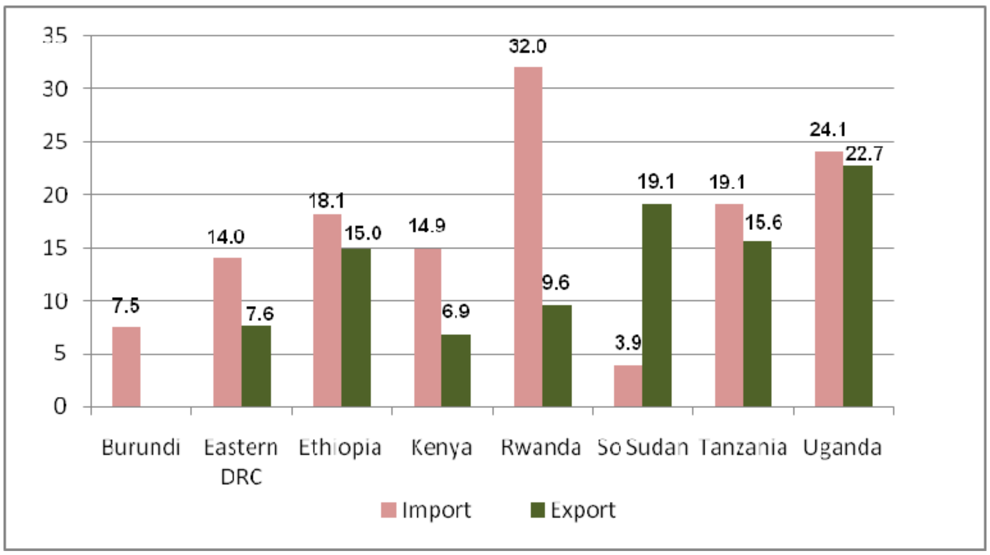
Table 2-2 presents similar data from the NCIMP report, which was derived from an analysis of trade tonnage volumes. This involved reconciling the international trade statistics in tonnages using a surplus-deficit analysis technique. This table gives more detail on the origins and destinations of this trade within Kenya (three regions) but it only includes trade with overseas partners that passed through the Port of Mombasa (i.e., no overseas trade that used the Central Corridor). Ethiopian trade is shown only for Kenya, since that is the trade that uses the Port of Mombasa and/or the Northern Corridor. This is the main difference between the total volumes in Tables 2-1 and 2-2.

Table 2-3 consolidates the two data sets, showing the detail of trade with overseas partners for both Northern and Central Corridors and trade for Southern Sudan but limiting Ethiopian data to trade with

Kenya and Tanzania. The Sudan data also includes trade between Kenya and Northern Sudan which comes through the Port of Mombasa (primarily Kenyan exports to the Sudan). The 2007 data consolidated from the NCIMP table was increased slightly to arrive at 2008 values. The overall change is that exports to overseas partners increased by 6 million tons over the NCIMP figures for the Port of Mombasa to account for flows through Dar es Salaam port, and imports increased by about 300,000 tons over the NCIMP figures for the same reason.

The consolidated data table was created in by adding data from Ethiopia and Sudan to the CDS data set and adjusting all data to match port traffic statistics for transit traffic by country in the base year. The total tonnage in the consolidated table (24.2 million tons) is less than the total NCIMP figure of 28.1 million tons due to the subtraction of internal trade between regions in Kenya from the consolidated total, which represents only imports and exports.

Figure 2-2. Average Annual Growth of Imports and Exports by Country, 2005-2009 (percent)



Source: Nathan Associates Inc.

The average annual growth in trade from 2005-2009 is presented in Figure 2-2. Import growth exceeded export growth in all countries but Sudan. The highest growth in imports was Rwanda (32 percent), followed by Uganda (24.1 percent) and Tanzania (19.1 percent). Uganda (22.7 percent), Sudan (15.6 percent) and Ethiopia (15 percent) had the highest growth in exports. The difference in import vs. export growth was more significant in Rwanda, Burundi and Kenya, where import and export growth were closer in speed in Uganda and Tanzania.

During this period, Kenya's imports increased at an average annual rate of 15 percent whereas exports grew by only 7 percent. Tanzania imports and exports increased at an annual rate of 19.1 percent and 15.6 percent, respectively.

Table 2-1. Estimates of Import and Export Tonnages, 2008 (000 tons)

Destination	Burundi	Eastern DRC	East Asia	Ethiopia	Europe	Kenya	Latin America	Middle East	North America	Other Africa	Rwanda	South Asia	Tanzania	Uganda	Total
Origin															
Burundi		2	32	0	69	2	0	1	0	7	6	0	0	1	120
Eastern DRC	9		67	-	40	41	0	0	12	2	167	4	7	10	359
East Asia	45	94		1,056	731	1,203	-	-	-	-	46	-	330	872	4,377
Ethiopia	-	-	352		140	1	0	44	52	16	0	9	0	0	614
Europe	114	659	-	307		952	-	-	-	-	55	-	221	469	2,777
Kenya	408	490	10	58	371		11	500	254	195	473	58	913	1,197	4,938
Latin America	0	14	-	35	-	177		-	-	-	1	-	19	41	287
Middle East	69	40	-	6,117	-	2,054	-		-	-	362	-	740	1,296	10,678
North America	19	37	-	108	-	390	-	-		-	9	-	86	83	732
Other Africa	85	57	-	146	-	445	-	-	-		445	-	103	81	1,362
Rwanda	12	13	27	0	4	34	0	5	4	1		0	0	4	104
South Asia	22	11	-	551	-	4,343	-	-	-	-	24		1,507	710	7,168
Tanzania	87	132	10	0	54	86	0	50	2	31	55	10		149	666
Uganda	406	318	14	0	263	204	0	14	14	-	176	29	28		1,466
Total	1,276	1,867	512	8,378	1,672	9,932	11	614	338	252	1,819	110	3,954	4,913	35,648

Source: Nathan Associates Inc.

Table 2-2. Estimates of Import and Export Tonnages in 2007 from NCIMP Study (000 tons)

From/To	Port of Mombasa*	Kenya Coast	Kenya Central	Kenya West	Tanzania	Uganda	Rwanda	Burundi	DRC	Sudan	Ethiopia	Total
Port of Mombasa*		2,205	2,869	4,140	183	2,972	250	51	207	185	0	13,062
Kenya Coast	95		1,076	4,072	290	1,083	76	21	39	74	3	6,827
Kenya Central	462	1,630		482	80	272	26	14	58	27	21	3,071
Kenya West	1,450	0	1,728		30	45	13	3	11	12	16	3,309
Tanzania	70	14	217	17		60	0	0	0	0	0	379
Uganda	316	64	110	150	49		124	97	181	186	0	1,276
Rwanda	40	0	0	2	0	9		9	15	0	0	76
Burundi	7	0	0	2	0	6	8		24	0	0	47
DRC	31	0	0	11	0	0	7	4		0	0	54
Sudan	1	0	0	0	0	0	0	0	0		0	-
Ethiopia	0	0	13	0	0	0	0	0	0	0		13
Total	2,474	3,914	6,013	8,875	633	4,447	503	198	534	484	40	28,116

* This includes only trade with overseas partners that use the Port of Mombasa.

Source: NCIMP Study Interim Report Table 4-4.

Table 2-3. CDS Consolidated Estimates of Import and Export Tonnages in 2008 (000 tons)

Destination	Burundi	Eastern DRC	East Asia	Ethiopia	Europe	Kenya	Latin America	Middle East	North America	Other Africa	Rwanda	South Asia	Soutern Sudan	Tanzania	Uganda	Total
Origin																
Burundi		1	32	0	69	1	0	1	0	7	2	0		0	0	112
Eastern DRC	2		67	-	40	10	0	0	12	2	42	4		2	3	184
East Asia	45	94		-	731	1,203	-	-	-	-	46	-	25	330	872	3,346
Ethiopia	-	-	-		-	15	-	-	-	-	0	-		0	0	15
Europe	114	659	-	-		952	-	-	-	-	55	-	17	221	469	2,487
Kenya	45	123	10	40	371		11	500	254	70	150	58	120	430	1,500	3,682
Latin America	0	14	-	-	-	177		-	-	-	1	-	1	19	41	253
Middle East	69	40	-	-	-	2,054	-		-	-	362	-	56	740	1,296	4,617
North America	19	37	-	-	-	390	-	-		-	9	-	7	86	83	631
Other Africa	30	57	-	-	-	140	-	-	-		140	-		35	30	432
Rwanda	3	3	27	0	4	9	0	5	4	1		0		0	1	57
South Asia	22	11	-	-	-	4,343	-	-	-	-	24		114	1507	710	6,731
Southern Sudan					5	0										5
Tanzania	22	33	10	0	54	260	0	50	2	31	14	10			37	523
Uganda	102	80	14	0	263	350	0	14	14	-	44	29	200	7		1,116
Total	473	1151	160	40	1537	9903	11	570	286	111	888	101	540	3377	5042	24,189

Source: Nathan Associates Inc.

Main Commodities Transported

Major commodities shipped via the Northern Corridor in are presented in Table 2-4. Petroleum and petroleum products, grains and flour, clinker and stones (construction materials) and vegetable oils make up half of the traffic of the Northern Corridor. These are mainly imports. A similar list is provided for the Central Corridor in Table 2-5. Petroleum and petroleum products, rice, cement, shop goods and mineral sands make up 50 percent of Central Corridor traffic. This composition is illustrated in Figure 2-3 for the Northern Corridor and in Figure 2-4 for the Central Corridor.

Table 2-4. Main Commodities Transported on the Northern Corridor, 2007

Commodity Type	**Commodity**	**Volume (000s tons)**	**Share in Total Trade (%)**
Commodities Mainly Imported	Oil	4,973	26
	Grains and flours	1,894	10
	Clinker and stones	1,338	7
	Vegetable oils	951	5
	Cast iron, Iron and Steel	787	4
	Sugar	532	3
	Fertilizer	429	2
Mainly local production	Cement	719	4
	Tea	465	2
	Soda	387	2
	Vegetables	310	2
	Coffee	263	1
	Various ores	26	0
	Total Selection	**13,074**	**68**

Source: NCIMP Interim Report.

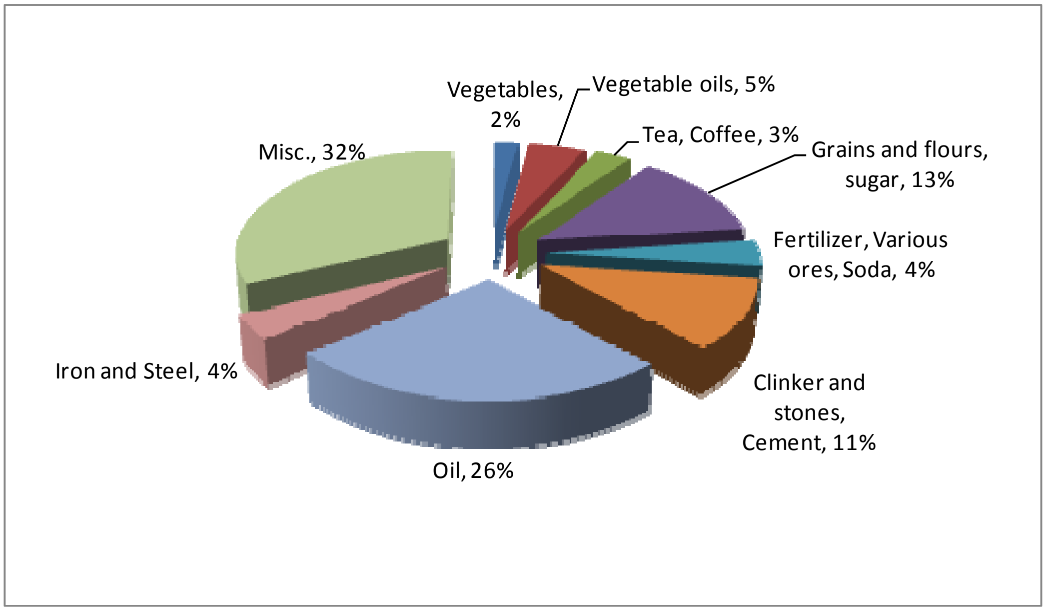
Table 2-5. Commodities Transported on the Central Corridor, 2010 (percent)

Commodity Name	**Share in Total Trade**
Petroleum and petroleum products	22.1
Rice	8.5
Cement	7.5
Shop Goods	6.7
Mineral Sand	6.2
Building Materials	3.9
Beer	3.9
Wheat	3.5
Other Agri. Products	3.1
Soda	2.9
Clothing	2.6
Cooking Oil	2.5
Flour	2.4
Salt	2
Equipment	1.8
Sugar	1.6
Steel and Steel Products	1.6
Chemicals	1.3
Bitumen	1.2
Coffee	1.2
Cassava	1.2
Fish	1.1
Tobacco	0.8
Bananas	0.7
Maize	0.6
Malt	0.6
Cattle	0.5
Furniture	0.4
Misc.	8
Total	100

Note: Results of 12 hour survey unadjusted for seasonal factors. This may understate agricultural product and fertilizer shares as well as other seasonal flows.

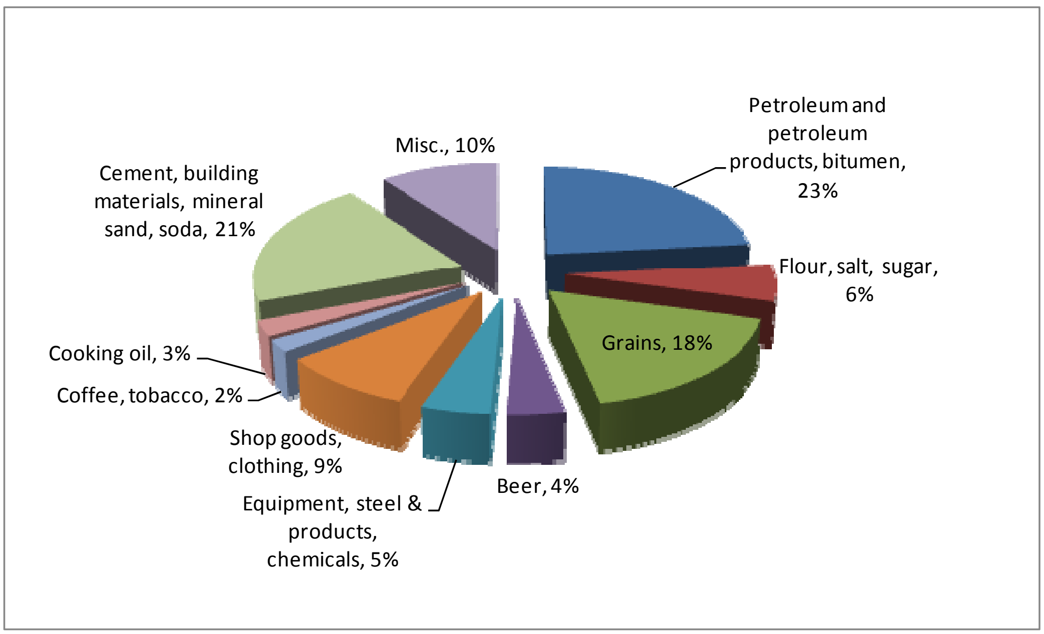
Source: Origin-destination surveys conducted by CDS in June 2010.

Figure 2-3. Main Commodities Transported in the Northern Corridor, 2007 (percent)



Source: Table 2-4.

Figure 2-4. Commodities Transported in the Central Corridor, 2010



Source: Table 2-5.

Trends in Landlocked Country Trade

There has been rapid growth in overseas transit traffic for countries using the Northern and Central Corridors as shown in Table 2-6. The average growth rate of imports has been 13.3 percent per year during the period 2005-2009 and for exports it has been 5.6 percent. This rate was even higher for the period 2005-2008, but it slowed in 2009 due to the international recession. This higher growth is expected to resume in the period 2009-2015.

Table 2-6. Trade Volumes of Landlocked Countries, 2005-2009 (000 tons)

Country	2005	2006	2007	2008	2009	AAGR (%) 2005-2008	AAGR (%) 2005-2009
Imports							
Burundi	103	177	212	270	335	37.9	34.3
Eastern DRC	467	592	653	736	834	16.4	15.6
Ethiopia	11	12	13	15	17	10.9	11.5
Rwanda	244	320	371	487	550	25.9	22.5
Sudan	141	130	145	220	156	16	2.6
Uganda	2,449	2,578	3,151	3,471	3,730	12.3	11.1
Total	3,416	3,809	4,546	5,199	5,622	15	13.3
Exports							
Burundi	56	57	65	72	59	8.7	1.3
Eastern DRC	63	77	98	122	145	24.6	23.2
Ethiopia	30	35	40	45	50	14.5	13.6
Rwanda	34	40	31	39	41	4.7	4.8
Sudan	1	1	1	1	1	0	0
Uganda	293	282	318	334	299	4.5	0.5
Total	478	491	553	612	595	8.6	5.6

Source: Nathan Associates Inc.

Corridor Traffic

As presented in Table 2-7, total traffic on the Northern and Central Corridors in 2009 is estimated at 28.6 million tons, of which 21.5 million tons were shipped via the Northern Corridor (75 percent) and 7.1 million tons on the Central Corridor (25 percent). More than 83 percent of the traffic on the Central Corridor was domestic, that is, Tanzanian trade to overseas countries. Regional trade and transit traffic accounted for 10 percent and 7 percent, respectively of the remaining Central Corridor traffic. On the Northern Corridor, Kenyan overseas trade accounted for 58 percent of the total corridor traffic with transit traffic next at 28 percent and regional trade at 14 percent.

Table 2-7. Northern and Central Corridor Traffic by Type and Mode, 2009 (000 tons)

Corridor and Type of Traffic	Road	Rail	Total	Rail Share (%)
Northern				
Transit	5,509	417	5,926	7.0
Regional	2,974	151	3,125	4.8
Domestic	11,817	622	12,439	5.0
Total	20,300	1,190	21,490	5.5
Central				
Transit	357	111	468	23.7
Regional	658	32	690	4.6
Domestic	5,617	296	5,913	5.0
Total	6,632	439	7,071	6.2
Total	**26,932**	**1,629**	**28,561**	5.7

Source: Nathan Associates Inc.

TRANSIT TRAFFIC

Table 2-8 presents the average trade flow tonnages observed over the 1999-2009 period for major overseas import and export flows of the landlocked countries organized by corridor and mode. Road transport has held the dominant position over rail or lake transport for these flows (primarily due to continuing rail service problems) and the Northern Corridor roads have historically handled two thirds of total import flows to these countries and 55 percent of export flows. In comparison, the Central Corridor roads have only handled 13% of total import flows and a larger share of export flows, 26%.

There are significant differences in country preferences as DR Congo and Burundi have used more rail/multimodal service in the past decade than the other countries in the region. The longer distances to and from the DR Congo are a factor favoring its use of rail/multimodal services, but road still dominates the transport services to DR Congo with lower transit times and greater reliability, which seem particularly important for imports.

Table 2-8. Transit Traffic by Country: Average Flows for 1999-2009 (000 tons)

Corridor & Mode	Average Tonnage (000)				Total	Share (%)			
	Burundi	Rwanda	Uganda	Eastern DRC		Burundi	Rwanda	Uganda	Eastern DRC
IMPORTS									
NC - Road	20	317	942	43	1322	18	62	82	21
NC– Rail/Lake	4	92	193	30	319	3	18	17	15
CC - Road	73	93	15	85	266	67	18	1	42
CC- Rail/Lake	13	12	4	44	73	11	2	0	22
Total	110	514	1154	202	1980	100	100	100	100
EXPORTS									
NC - Road	1	44	183	8	236	3	64	64	21
NC– Rail/Lake	0	9	45	8	62	1	16	16	21
CC - Road	32	15	49	15	111	83	17	17	37
CC- Rail/Lake	5	2	7	8	22	13	3	2	20
Total	38	70	284	39	431	100	100	100	100

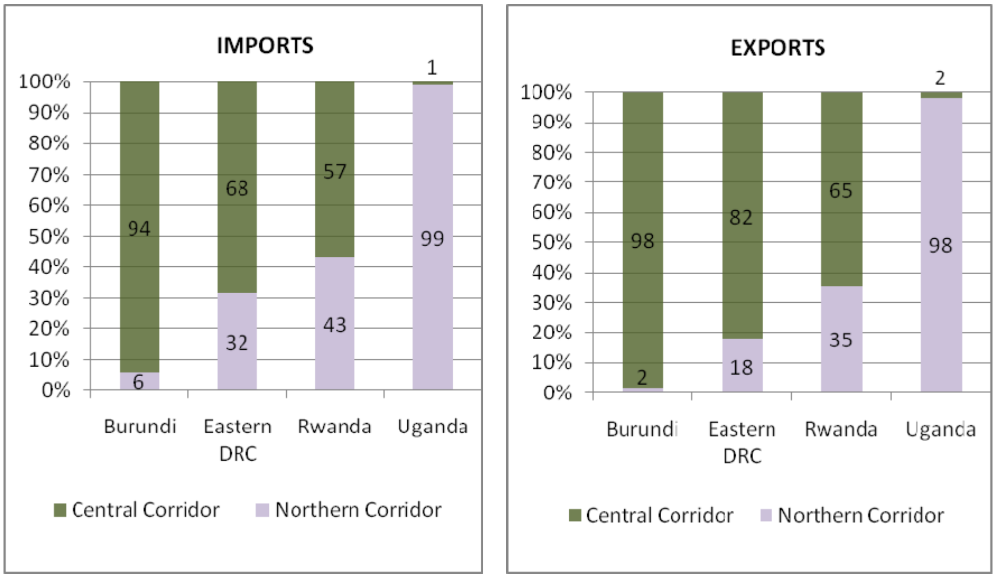
Source: Nathan Associates Inc.

Historically, the landlocked countries of Burundi, (Eastern) DR Congo, Rwanda and Uganda divide their overseas imports and exports between the Northern and Central Corridors, while Southern Sudan and Ethiopia only use the Northern Corridor. The shares of transport volumes using each port from Burundi, (Eastern) DR Congo, Rwanda and Uganda for import and exports are shown in Figure 2-5 for 2009.

The corridor choice by these countries are somewhat similar across imports and exports; Burundi largely uses the Central Corridor for both types of flow; Eastern DRC mostly uses the Central Corridor, predominantly for exports; Rwanda almost has an equal distribution to corridors in imports, however still favors the Central Corridor; and Uganda almost at all times uses the Northern Corridor. Uganda is closely tied to Mombasa port and has shifted even more exports to Mombasa over this period. Eastern Congo has shifted more toward the Central Corridor in 2009, probably due to recent improvements in port transit operations.

These trade patterns are influenced by a combination of shipping preferences and corridor performance which is described in Chapters 4 and 5.

Figure 2-5. Share of Transit Traffic by Corridor, 2009 (percent)



Source: Nathan Associates Inc., based on data from port statistics.

Regional Traffic

The regional freight traffic (international traffic not through the ports) is also a significant contribution to corridor traffic, amounting to 3.4 million tons. The significant flows of estimated regional traffic on the two corridors for 2009 are shown in Table 2-9, excluding imports and export flows of port countries.

Table 2-9. Regional Trade by Corridor: Estimated Flows, 2009 (million tons)

	Northern Corridor	**Central Corridor**
Regional Flows		
a) Kenya-Uganda	1.85	-
b) Kenya-Congo	0.20	-
c) Other Regional	0.87	0.46
Total Regional Flows	2.92	0.46

Source: Nathan Associates, Inc, from port statistics and estimates of regional flows from value of trade data.

3. Trade Demand Projections

This chapter discusses the methodology used to obtain trade flow projections between country and overseas regional trading partners, through years 2009 to 2030. Then, additional trade from major mining projects is discussed, focusing on important minerals for the region. Trade projections are then used to forecast corridor traffic as described in Chapter 4.

Trade projections were prepared for the flows between eight countries of East Africa region, as well as flows between East Africa countries and overseas regions for the years 2015 and 2030. Trade values were obtained from IMF Direction of Trade Statistics and UN Comtrade for historical total trade between countries and regions. Trade projections were made using a regression analysis, based on GDP and population projections. Consequently, we obtained future GDP and population values and used them as inputs for the regression to obtain trade projections. In order to correct for possible aberrations resulting from the regressions, total imports and exports were considered separately for countries. Trade totals were projected for each country in the East Africa region, called control totals. Then, shares of trading partners over total trade were calculated and applied to control totals in order to increase accuracy of results.

Methodology for Trade Projections

Trade projections for the East Africa region were prepared for 2015 and 2030 based upon a careful review of historical data and a series of regression analysis using GDP and population as key determinants. Projected flows of trade between the eight East African countries were prepared as well as flows between the seven East African countries and six overseas regions[7]. The general approach for the preparation of the trade projections is presented in Figure 3-1. The approach involved the following seven steps:

1. Prepare historical trade data series
2. Prepare GDP forecasts by country
3. Prepare population forecasts by country
4. Project total imports and exports by country
5. Estimate future shifts in trading patterns
6. Prepare projections of trade flows between countries and regions
7. Convert projection of trade flows in value to tons

[7] East Asia, Europe, Latin America & Caribbean, Middle East, North America and South Asia.

1. Prepare Historical Trade Data Series

As a first step, historical trade data for 1998-2008 in current US dollars was collected, reviewed and cleaned for analysis. The primary source of trade data used in this analysis was the IMF Direction of Trade Statistics as it is generally regarded as one of the more reliable sources of trade data. In the case of missing or obvious erroneous data in the IMF series, we replaced the IMF data with information obtained from the United Nations Statistics Division, Commodity Trade Statistics Database (COMTRADE). The resulting trade data series was converted to constant US dollars of 2008 by applying the IMF GDP deflator for each country.

Historical trends in trading patterns were described in Chapter 2.

2. Prepare GDP Forecasts by Country

Trade values were projected using a regression analysis based on GDP and population projections. The IMF World Economic Outlook presents forecasts of GDP growth in each country from 2009-2015. These are presented in Table 3-1 below.

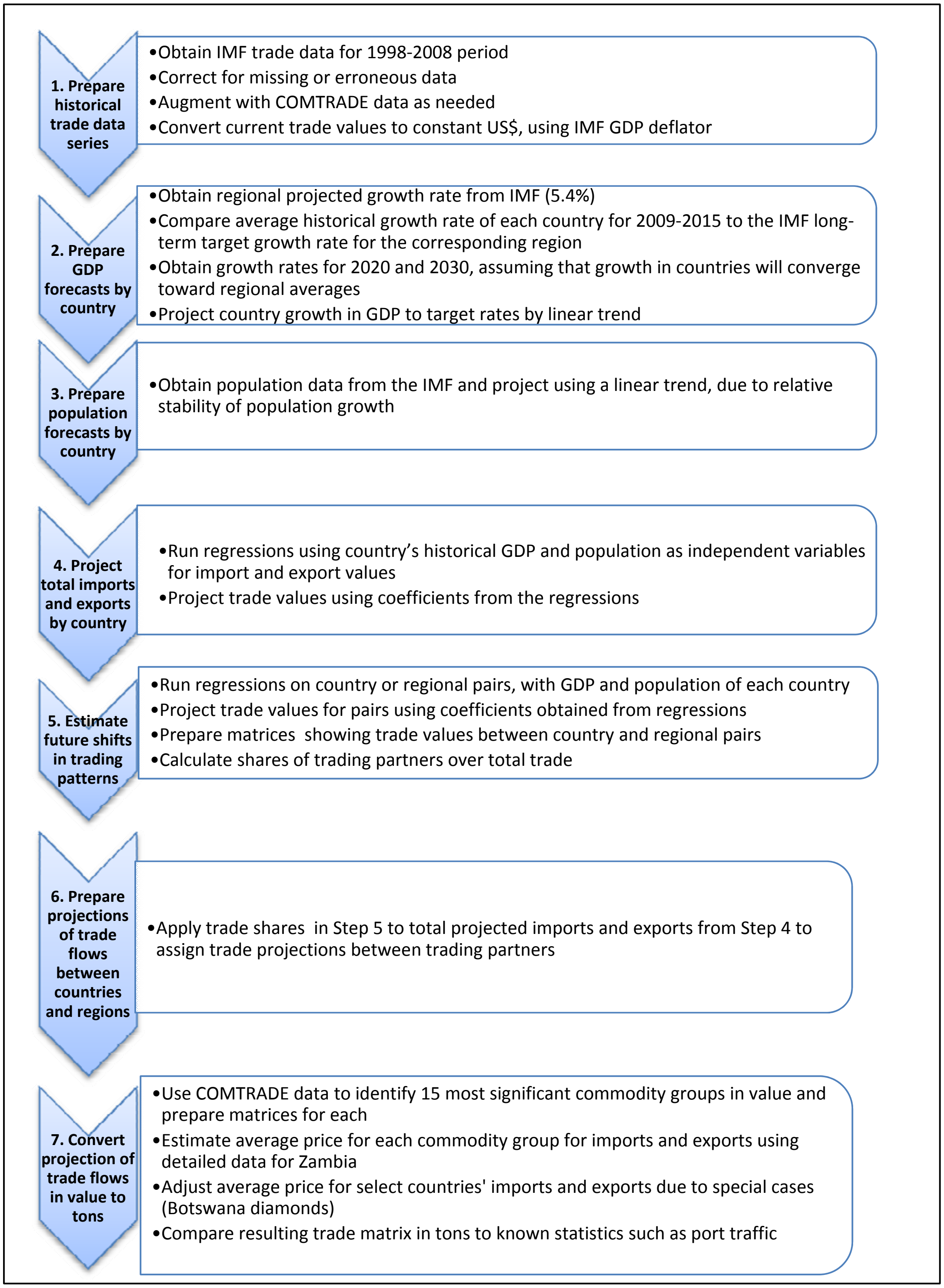
The weighted average regional growth rate for the seven East African countries for the 2009-2015 period is 6.24 percent. This is higher than the IMF growth rate of 5.4 for Sub-Saharan Africa for 2015 which we used as the long-term growth target through 2030. We compared the average historical growth rate of each country for 2009-2015 to the long-term target growth rate. This was done by dividing the country average IMF projected growth rate between years 2009-2015 by the IMF Sub-Saharan growth rate for the same period. For the 2015-2020 period, we assumed that diversity in growth rates by country would remain, however, that they would tend to converge towards the Sub-Saharan average. Thus, we assumed that average growth rate for each country for 2015-2020 would move halfway towards the regional average. Between 2020 and 2030, it was assumed that convergence would continue and that the growth rate for each country would move three-quarters towards the Sub-Saharan average.

Table 3-1. IMF Projected Annual GDP Growth 2009-2015 (percent)

Country	2009	2010	2011	2012	2013	2014	2015	AAGR 2009-2015
Burundi	3.48	3.85	4.47	4.78	5.01	5.01	4.91	4.5
DR Congo	2.83	5.44	6.99	6.77	8.05	6.67	6.99	6.24
Ethiopia	9.95	6.96	7.66	7.47	7.52	7.68	7.68	7.84
Kenya	2.1	4.11	5.78	6.31	6.49	6.54	6.54	5.4
Rwanda	4.14	5.39	5.88	6.37	6.93	6.47	7.06	6.03
Tanzania	5.46	6.18	6.73	7.47	7.47	7.51	7	6.83
Uganda	7.06	5.59	6.4	7	7.2	7.4	7.5	6.88
					Total Average Growth:			6.24

Source: *IMF World Economic Outlook Database April 2010*

Figure 3-1. Overview of Trade Forecast Methodology



For overseas regions, we identified regional growth rates for every region (for 2011) and assumed this growth rate to be the long term target growth rate. We then converged the last projected growth rate from the IMF into the long term target growth rate.

The resulting average annual growth rates for each country and overseas region for the 2015-2020 and 2020-2030 periods are presented in Tables 3-2 and 3-3 along with the IMF forecasts for 2009-2015.

Table 3-2. Projected annual average GDP Growth for CDS Countries (percent)

Country	2009-2015	2015-2020	2020-2030
Burundi	4.5	5.04	5.22
DR Congo	6.24	6.11	5.75
Ethiopia	7.84	6.45	5.92
Kenya	5.4	5.68	5.54
Rwanda	6.03	5.87	5.64
Tanzania	6.83	6.23	5.81
Uganda	6.88	6.12	5.76

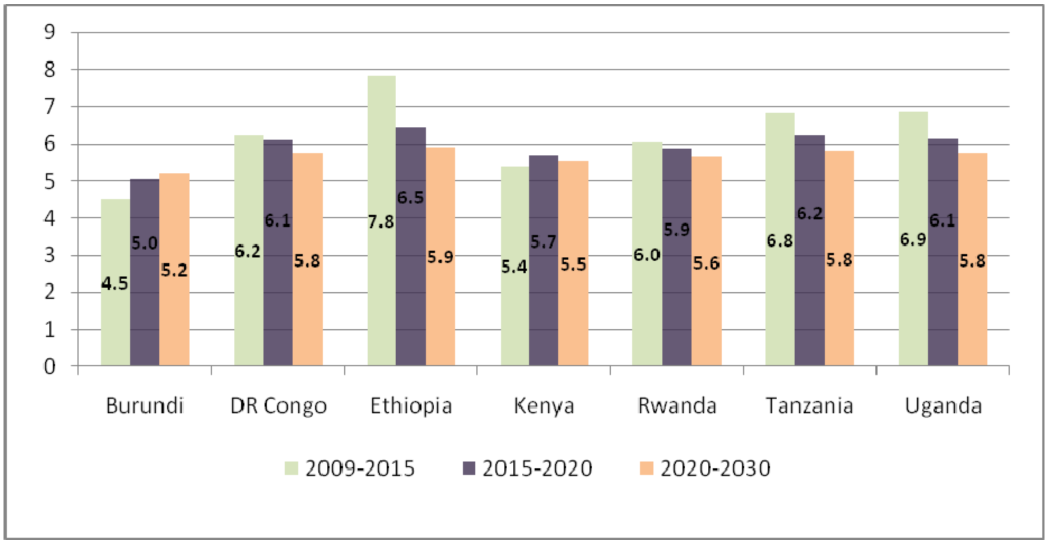
Source: *IMF World Economic Outlook Database April 2010 for 2009-2015 and own calculations for 2015-2030*

Table 3-3. Projected annual average GDP Growth for Overseas Regions (percent)

Overseas Region	2009-2015	2015-2020	2020-2030
Europe	1.92	1.76	2.92
North America	2.84	2.5	2.62
Latin America & Caribbean	2.13	2.06	3.03
Middle East	2.63	5.31	4.77
East Asia	8.36	9.23	8.6
South Asia	4.82	5.87	6.86

Source*: Own calculations from IMF World Economic Outlook Database April 2010*

Figure 3-2. Average Annual GDP Growth Used in the CDS Forecast, 2009-2030 (percent)



The CDS trade growth rates represented by the preceding tables are summarized in Figure 3-2. The growth rates for trade from 2008 to 2009 show that despite the economic turndown, the region as a whole experienced substantial trade growth. This growth is forecast into the future with rapid recovery of exports in the short term and moderating growth in the longer term. Except for Burundi, higher growth is forecast in the 2009-2015 for all other countries shown and a tapering from 2015-20 and 2020-30. For 2009-2015, growth is between 6-7 percent annually except for Ethiopia at 7.5 percent and Burundi at 4.7 percent. From 2015-20 and 2020-30, the average annual growth rate is between 5 and 6 percent generally.

3. Obtain Population Forecasts

Similar to GDP, population has been determined to be a significant variable in determining future trade flows. Population projections were obtained from the IMF World Economic Outlook for the period 2009-2015. Between 1998 and 2015, the population used was directly from IMF projected values. For 2015-2030, the values were projected using a linear trend on historical and IMF projected values from 2009 to 2014. We assumed a linear trend due to the relative stability of population growth.

4. Project Total Imports and Exports by Country

A set of regressions was run in order to project total import and export values by country. The independent variables were GDP and population of the country, and the dependent variables were import and export values. Future trade values were obtained for the 2015 and 2030 period, using coefficients from the regressions and the projected values of GDP and population discussed above.

5. Estimate Future Shifts in Trading Patterns

Country/ overseas regional pair regressions were run in order to estimate future shifts in trading patterns. The independent variables for pair regressions were GDP and population values for the trading partners[8], with the dependent variables being import and export values. Trade values for pairs were projected using regression coefficients. Regression results were checked and re-structured when needed. In order to optimize statistical significance levels and eliminate occasional extreme trends in results, in some cases regressions were run with fewer data points (years) and at other times by aggregating the country variables within the region to a single variable representing the regional GDP and population. The results of the pair analysis were compiled into trade matrices for 2015 and 2030 showing trade flows between country and regional pairs. The trade matrix was then converted into trade flow shares for each trading partner pair by dividing trade for each pair by the total trade in the trade flow matrix.

6. PREPARE PROJECTIONS OF TRADE FLOWS BETWEEN COUNTRIES AND REGIONS

The trade shares resulting from the pair analysis in Step 5 above were then applied to the total projected imports and exports from Step 4 to obtain trade projections for the selected year between trading partners.

7. CONVERT PROJECTION OF TRADE FLOWS IN VALUE TO TONS

The 2008 trade flows in tons between the East Africa countries and with overseas regions were estimated using a combination of trade values by key commodity with conversion factors and selected transit tonnage data. These estimates are necessary because there is no reliable or comprehensive source of tonnage information for all the countries involved. Some ports in the study area publish information regarding the transit cargo to landlocked countries in tons; however, this is not done by all ports and also does not include regional trade by land transportation between the countries in the study area. The ideal information to estimate this information is the customs data at all the border posts, which includes the commodities, country of origin or destination and tonnage information. That data, however, is very difficult to obtain for all the countries involved and would require extensive data manipulation.

In order to make the conversion factors as accurate as possible the 15 most relevant commodity groups for imports and exports for each country were determined based on trade flows in value reported by COMTRADE for 2008. Table 4 below shows the most relevant commodities for import and export flows. Matrices with the trade flows (value) were prepared for each of these commodities.

[8] For the regional overseas regressions, two or three countries were selected to represent a region and the same independent variables were used for each country.

Table 3-4. Conversion Factors for Commodities Used to obtain Tonnages

IMPORTS	
Commodity	**Factor ($/ton)**
Cereals	372
Vegetable Oils	930
Ores	112
Oil and Fuel	506
Org Chemicals	2,508
Pharmaceutical	24,511
Fertilisers	844
Plastics	2,358
Precious Stones, gold	18,849
Iron and steel	1,272
Articles of iron or steel	3,148
Mechanical appliances	5,616
Electrical machinery & equipment	3,388
Vehicles and parts	1,731
Optical & precision instruments	23,767

EXPORTS	
Commodity	**Factor ($/ton)**
Fish	3,317
Tea/Coffee	2,471
Sugar	483
Tobacco	1,885
Oil/Coal	506
Cotton	1,530
Textiles	414
Textiles	6,807
Textiles	13,595
Diamonds/Gold	18,849
Iron	1,272
Copper	3,172
Nickel	56
Manganese	37,810

Source: Nathan Associates Inc.

The next step was to estimate commodity group-specific conversion factors for imports and exports using the most relevant commodity groups identified in the previous step. The commodity group conversion values were compared against value and tonnage information obtained for Rwanda, Burundi and Uganda and further adjustments made to conversion factors for country pairs that showed larger than expected flows that indicate a concentration higher than normal of a more expensive commodity within a commodity group.

Once the trade matrices of the selected commodity groups are aggregated for a given country, the difference between the total country trade flows and the total of the selected commodity groups is designated "other" commodities. The goal is that the selected commodities represent most of the country trade and as a result the "other" category is relatively small, increasing the accuracy of the analysis.

We then estimated 2008 trade flows in tons for the selected commodity groups using the calculated conversion factors for each commodity. For the "others" category we used an average factor of overall conversion factor for imports and exports. The aggregation of the respective matrices gives a rough estimate of 2008 Trade Flows in tons. This estimate was further refined by adjusting tonnage flows for overseas partners to match known port trade flows and regional flows in tons.

Finally, we estimated conversion factors by country and overseas regional pairs that reflect the current commodity mix by dividing the 2008 Total Trade matrix (value) over estimated 2008 Total Trade matrix (tons). These factors were then used for the trade projections for 2015 and 2030.

Results of Trade Projections

Despite the economic turndown in 2009, the region as a whole experienced substantial trade growth. This growth is forecast into the future with rapid recovery of exports in the short term and moderating growth in the longer term. The CDS trade growth rates are summarized in Table 3-6. High growth rates in both imports and exports are observed in the upcoming period 2009-2015. The regional annual average growth rates for imports in this period is expected to be 11.9%, while the average for exports is expected at 10.9%. Burundi and Eastern DRC are expected to have import growth at around 16%, followed by Rwanda and Kenya. Highest growth in exports is expected to be in Sudan (although from a very low base) and Rwanda (23.3%). Growth is expected to slow down in the period 2015-2030 in relation to the upcoming period, however regional averages still display relatively high rates in our forecasts: 6.1% for imports and 8.2% for exports.

Table 3-6. East Africa Average Annual Growth Rates of Imports and Exports (percent)

Country	2009-2015		2015-2030	
	Imports	Exports	Imports	Exports
Burundi	16.5	19.6	3.2	6.6
Eastern DRC	16.0	13.6	7.2	13.4
Ethiopia	6.1	3.5	0.9	13.1
Kenya	13.0	7.2	6.8	4.6
Rwanda	14.4	23.3	6.1	12.2
Sudan	5.0	66.1*	5.0	5.0
Tanzania	11.2	12.7	7.1	6.7
Uganda	10.6	13.6	4.1	5.5
Total	11.9	10.9	6.1	8.2

** Trade with Kenya and Tanzania only growth, from a small base*

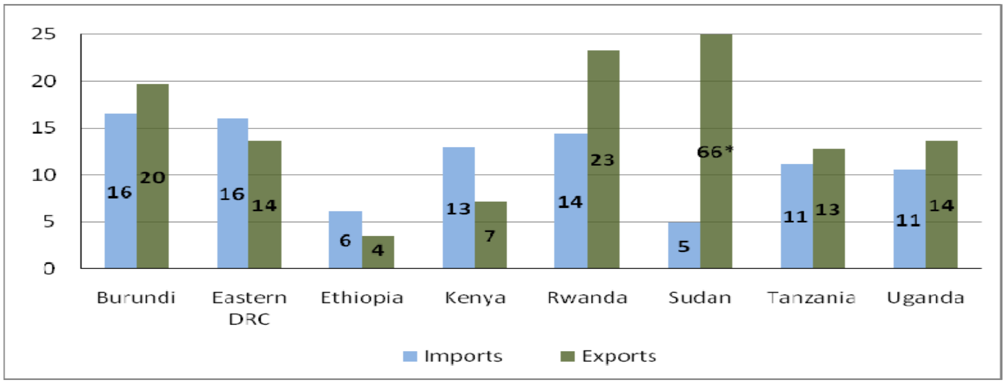
Source: Tables 3-6 and3-7.

Figure 3-3 presents the average annual growth in imports and exports by country for the periods 2009-2015 and 2015-2030. Expected trade growth in the period 2009-2015 exceeds that of 2015-2030; in some cases more than by double: in Burundi, Rwanda and Uganda for exports and imports; and in Eastern DRC and Ethiopia for imports. The highest growth expected in imports is in Eastern DRC (16 percent), Rwanda (13 percent) and Kenya (13 percent) for 2009-15; and Eastern DRC, Kenya and Tanzania in the period 2015-2030, with an expected growth rate around 7 percent. For exports, Rwanda and Burundi are expected to have the highest growth in 2009-2015[9]. After 2015, export growth is expected to overtake import growth in most countries, Eastern DRC (13 percent), Ethiopia (13 percent), Rwanda (12 percent) and Burundi (9 percent).

[9] The reason Sudan is not mentioned here although the graph shows 66% export growth, is due to the fact that this growth is from a small base and therefore

Figure 3-3. Average Annual Trade Growth by Country, 2009-2015 and 2015-2030 (percent)

2009-2015



**The value for Sudan Exports (66%) is not to scale*

2015-2030

Source: Nathan Associates Inc.

Potential for Additional Trade from Major Mining Projects

In addition to the trade figures presented above, there are several major mining projects that can generate substantially further trade flows over the next two decades. These development projects are normally seen as anchors for additional transportation projects.

MINERALS SECTOR OVERVIEW

In this section, we review minerals mined or extracted in eastern African that are highly dependent on the transport sector for inputs and outputs. Transport demand from the minerals very often provides anchor projects to justify major infrastructure investment and developments.

There is a common perception that provision of transport infrastructure leads directly to new mining projects, but it is almost always the other way around: the decision to proceed with a mining project, based on estimated or calculated logistics costs, is the basis for infrastructure financing. For example, the construction of a standard gauge railway on the Central Corridor will not necessarily lead to implementation of planned nickel mining ventures. Governments can decide to invest in road, railway, and port projects on the basis of projected economic and social benefits. The private sector, however, will only invest on the basis of agreed contracts and/or income guarantees. Failure to take this into account is one of the main reasons for the general collapse of the railway concessions, despite the terms of the concession agreement and the commitments made. Thus the infrastructure investments required to serve various planned mining projects—coal, iron ore, nickel, mineral sands—will have to be preceded by a decision to proceed with the mining projects and the willingness to enter into a long-term transport contracts.

Copper. The main producer is the Zambia copper belt, with current production of 0.7 mtpa, increasing to 1.2 mtpa of copper metal, mostly transported by road to Durban via South Africa, a distance of 3,000 km at about US$ 180/ton. About 0.2 mtpa goes by rail via Dar es Salaam, about 2,000 km at US$ 100/ton. The DRC production of about 0.2 mtpa, increasing to an estimated 0.5 mtpa, will likely mostly go via Lobito by rail after 2011. Possible new railway links from Lumwana/Solwezi to Chingola and Kolwezi will change traffic patterns. The previous inter-mine railway traffic, about 1 mtpa, is now all by road. Transport by rail to Dar es Salaam and to Lobito seems to be the most likely long term scenario.

Iron Ore. The only regional iron ore project that could affect transport demand in the East Africa Region is the Mt. Kodo iron deposit in eastern DRC. The railway distance to the nearest port is about 1,800 km, either Mombasa or a new port at Lamu. Very large volumes will be required, up to 50 mtpa, to achieve low railway tariffs of the order of US$ 30/ton or less, and very low interest financing will be required for financial viability of the railway. If a long-term contract at today's high iron ore prices could be secured this project could be viable. This will require a new rather than an upgraded railway alignment, which will bring major regional economic benefits.

Nickel. Nickel is produced together with copper in smaller quantities, using the same transport methods. It seems likely, on the basis of recent feasibility studies, that several major nickel mines will be established in Burundi and north western Tanzania, and these will serve as anchor projects for upgrading or building a railway line on the Central Corridor. Transport volumes will depend on the degree of processing required. It seems most likely that the export product will be nickel concentrate, from 200,000 to 700 000 tpa, exported by rail to Dar es Salaam, with a tariff of about US$ 60/ton over a distance of more than 1,000 km. The value of the nickel concentrate will likely vary between US$ 3,000 and US$ 5,000/ton, depending on the percent concentration and the nickel metal price, which was high at US$26,000/ton in April 2010, but also volatile.

Other--Precious metals, oil. The main transport demand from gold and diamond mining operations relates to inputs, mainly fuel, consumables, processing chemicals, and heavy equipment. Volumes depend on the size of the mining operations and can be considerable. Inputs for a very large mining operation could fill one to two trains per day, or 200,000 to 500,000 tpa or up to 50 road trucks per day, excluding fuel imports. The very high cost of transporting heavy industrial equipment by road, mainly as a result of a "road damage compensation fee" is a major development constraint, particularly in Tanzania.

Additional details for those mining projects that will have the greatest potential impact on the Northern and Central corridors (iron ore and nickel) are presented below:[10]

Iron Ore

Location. The main iron ore deposits in Africa are in South Africa, Liberia, and Eastern DRC. Those in the DRC are not yet being mined. In relation to the Northern Corridor, the DRC deposits at Mt. Kodo close to Lake Albert are of interest, because they could provide an anchor project for a rail and port terminal system for exports through Mombasa or Lamu. The total world production of iron ore is about 1,700 million tpa, of which about 50 percent is carried by seaborne trade. Preliminary studies indicate that the Mt. Kodo deposit could yield exports of up to 50 mtpa (ref Northern Corridor SDI study).

Process and Products. Iron ore is sold as lumpy ore and fines, with a benchmark of 63.5 percent iron content. Processing may include crushing, grinding, and gravity or magnetic separation to achieve the desired iron content. Further processing could include the production of direct reduced iron (DRI), using gas or coke to reduce the iron ore to achieve and iron content of more than 90 percent, and to obtain higher prices and to reduce transport sensitivity.

Mining Activity and Marketing. There is no mining at Mt. Kodo, but Chinese steel producers are interested, subject to the provision of transport infrastructure and acceptable transport costs. It seems likely that the Chinese market could accept 50 mtpa. A long-term export contract (10+ years) would be required to secure financing for mining and transport infrastructure.

Transport Demand and Infrastructure. Large volumes of iron ore, typically tens of millions of tons per annum, cannot be transported economically by road over long distances. Ore is traditionally carried by heavy haul rail at very low unit prices, less than US$0.02 per ton-km (less than the cost of fuel by road) in dedicated wagons, and shipped in very large bulk carriers (Cape Size vessels, more than 120,000 DWT), requiring special bulk port terminals with a quayside depth and port access depth of more than 18m (for example, Saldanha Bay port in South Africa . Mombasa port has a depth of 10m, but is being upgraded to 15 m. The rail distance from the eastern DRC to Mombasa is about 1700 km.

Prices and Transport Sensitivity. Iron ore is traded at US$183/ton C&F China port (April 2010), up from US$ 132/ton in February 2010, and up from about US$70/ton in 2006. It seems unlikely that long-term supply contracts will exceed US$80 to 100/ton C&F—there is no shortage of iron ore reserves, only a current mining capacity constraint. Bulk ocean freight rates vary considerably according to demand, but tend to correct fairly quickly with market response. Assuming a shipping freight rate of US$ 15/ton, a port handling cost of US$ 4/ton, and a railway tariff of US$ 45/ton, would yield a unit tariff of US$ 0.025 per tkm over a distance of 1,800 km. Transport costs are therefore likely to make up to 80 percent of the C&F price of the iron ore, which is unlikely to be a viable operation in the short to medium term. The South African iron ore exports have a rail distance of about 860 km to Saldanha Bay.

[10] The copper mining projects in Zambia will affect the demand on the Dar Corridor and must be considered for the future performance of the port of Dar es Salaam.

Nickel

Location. Nickel is produced as part of most copper production. Big nickel deposits have been discovered and explored in Burundi (Musongati, Waga, Nyabekere) and in north western Tanzania, with a potential production of nickel concentrates of more than 700,000 tpa. It is most likely that this will be exported through Dar es Salaam via the Central Corridor railway system, which will require upgrading or replacement with a new standard gauge railway.

Mining Activity and Marketing. The most significant potential development is the likely start up of mining projects in Burundi and Tanzania though the decision to proceed has not yet been made and will depend on the provision of suitable transport infrastructure, mainly railway upgrades and extensions on the Central Corridor.

Process and Products. Nickel deposits are found mostly as sulphide deposits or as laterite deposits. Sulphide ores are treated by roasting and reduction processes to produce a nickel matte with about 75 percent nickel. Further purification is often by leaching and electro-winning – adequate electricity supply in remote regions is often a constraint.

Transport Demand and Infrastructure. Nickel ores and nickel concentrates are ideally transported by rail, whereas the pure metal, with a typical value of US$15,000 to US$28,000/t is not transport sensitive, and more likely to be transported by road. The proposed new standard gauge railway on the Central Corridor is partly based on the projected traffic from the planned nickel mines, but with a projected demand of less than 1mtpa (depending on whether ore or concentrates are to be transported) is unlikely to make the new standard gauge railway viable without another anchor project as well.

Prices and Transport Sensitivity. Nickel metal prices are highly variable, between US$18,900 to $26,000/ton from February to April 2010. The question of transport demand depends on the degree of processing at the mine—whether it is large volume of low priced ore, or a much lower volume of high priced concentrate or matte. The feasibility of the nickel mining project will have to be established, and a decision to proceed made, before the related infrastructure upgrades and extensions can be financed.

Iron, nickel and copper concentrates are likely to move in the two corridors in the future. Movements of equipment for operations and other imports to support these developments would accompany this development. This movement may be closely tied to rail system developments.

4. Traffic Forecasts and Corridor/Mode Allocation

In this chapter we discuss how estimated trade forecast values are assigned to each corridor and mode. We then consider the potential impact of proposed projects on corridor performance and reallocate traffic based on new performance parameters. We present the resulting traffic forecasts as a Base Case scenario; which is defined as an improved and unconstrained scenario.

Methodology

STATUS QUO SCENARIO

Corridor choice depends on the following factors: corridor performance from an importer or exporter's point of view; ship service for overseas trade and any preferences of the shipper for a specific transit country or port. Performance is determined by price, time and reliability for shipping via a given corridor and/or mode. These data were gathered for the Northern and Central Corridors for 2010, and analyzed using our Fast Path model[11].

Based on statistical analysis of historic trade data by corridor and mode as well as performance data, a Corridor and Mode Choice Model was developed. Socioeconomic and policy indicators were also taken into account as factors of this model. The model produces shares for each country/region trading pair on the expected distribution of trade between corridors and modes. These shares are then multiplied by the trade volumes in an allocation model, which in turn aggregates individual flows into corridors and modes for status quo traffic forecasts.

Status quo scenario implies that the performance parameters of the corridors will remain unaltered; they will neither improve nor deteriorate. The corridor would undergo regular upgrades, maintenance and expansion that would preserve current performance parameters but no projects are assumed to be planned, which could improve price, time or reliability conditions of the corridor. At the end of this process, we would have corridor and mode shares for all possible transport alternatives for each country.

[11] See CDS Technical Paper entitled "Corridor Diagnostic Audit and Results" for more details.

BASE CASE SCENARIO

It would not be realistic to leave the traffic forecasts at the status quo scenario, since proposed projects to improve the Northern and Central Corridors actually exist. Therefore, we considered a second scenario, named "Base Case scenario", which takes into account the possible diversion in traffic due to improvements from proposed projects and is assumed to be unconstrained in terms of capacity.

For the Base Case scenario, we first had to identify the potential impact of proposed projects on corridor performance parameters; namely price, cost and reliability. For this, the new estimated parameters for road, rail segments and ports were coded into FastPath, which produced corridor level aggregate performance parameters. These were compared against the status quo baseline to estimate impact.

Based on the improved performance parameters of corridors, the traffic assignment to different corridors and modes would shift. Incorporating the estimated impact of new performance parameters, corridor and mode shares are recalculated for the Base Case scenario; once again using the Corridor and Mode Choice Model. The new shares are applied to future trade values in order to estimate the traffic allocation of corridors and modes for years 2015 and 2030.

The corridor and mode choice analysis is unconstrained since it does not take into account any capacity constraints which would limit the flows. This is based on the assumption that capacity additions will be implemented to meet demand.

Base Case Corridor Traffic

Tables 4-1 to 4-3 present the forecast of Northern and Central Corridor traffic for 2009, 2015 and 2030, respectively. Total traffic on the two corridors is forecast to increase from 28.6 million tons in 2009 to 52.5 million tons in 2015 and to reach 143.1 million tons by 2030. Those volumes correspond to an average annual growth rate of 11 percent between 2009-2105 and 7 percent between 2015 and 2030. In both corridors, for most of the years considered, domestic traffic makes up more than half of corridor traffic.

Table 4-1. Base Case Traffic by Corridor and Mode 2009 (000 tons)

Corridor and Type of Traffic	Road	Rail	Total	Rail Share (%)
Northern				
Transit	5,509	417	5,926	7.0
Regional	2,974	151	3,125	4.8
Domestic	11,817	622	12,439	5.0
Total	20,300	1,190	21,490	5.5
Central				
Transit	357	111	468	23.7
Regional	658	32	690	4.6
Domestic	5,617	296	5,913	5.0
Total	6,632	439	7,071	6.2
Total	**26,932**	**1,629**	**28,561**	5.7

Source: Nathan Associates Inc.

Traffic on the Northern Corridor is forecast to increase at an annual rate of 9 percent form 2009-2015, increasing from 21.5 million tons to 35.3 million tons. Growth by type of traffic is relatively balanced with transit, regional and domestic traffic each growing at an annual rate of 8-9 percent. Even though the annual rate of growth decreases to 6 percent from 2015 to 2030, traffic on Northern Corridor is forecast to increase from 35.3 million tons in 2015 to 54.0 million tons by 2030 (See Table 4-3).

Northern Corridor had a total of 21.5 million tons of traffic in 2009, as opposed to 7.1 million tons of Central Corridor. These volumes are expected to increase to 89.6 million tons for Northern Corridor and 53.6 for Central Corridor in 2030. Although currently a larger volume of traffic uses the Northern Corridor, a trend that will continue as can be seen on Figure 4-1; it is expected to lose some of its share to Central Corridor over time. The share of Northern Corridor is expected to shift from 75 percent in 2009 to 63 percent in 2030. This means that the share of Central Corridor is expected to reach 37 percent share from 25 percent in 2009.

Table 4-2. Base Case Traffic by Corridor and Mode, 2015 (000 tons)

Corridor and Type of Traffic	Road	Rail	Total	AAGR (%) 2009-2015	Rail Share (%)
Northern					
Transit	6,883	3,142	10,025	9.2	31.3
Regional	4,764	202	4,966	8.0	4.1
Domestic	19,259	1,014	20,273	8.5	5.0
Total	30,906	4,358	35,264	8.6	12.4
Central					
Transit	1,584	1,440	3,024	36.5	47.6
Regional	1,417	58	1,475	13.5	3.9
Domestic	12,138	639	12,777	13.7	5.0
Total	15,139	2,137	17,276	16.1	12.4
Total	**46,046**	**6,495**	**52,540**	**10.7**	**12.4**

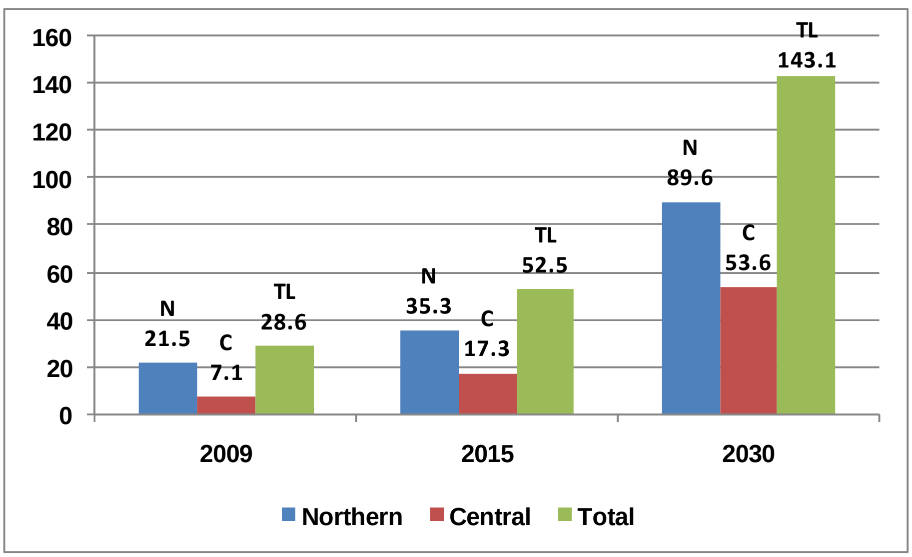
Source: Nathan Associates Inc.

Table 4-3. Base Case Traffic by Corridor and Mode, 2030 (000 tons)

Corridor and Type of Traffic	Road	Rail	Total	AAGR (%) 2009-2015	Rail Share (%)
Northern					
Transit	16,524	8,145	24,669	6.2	33.0
Regional	10,517	442	10,959	5.4	4.0
Domestic	51,253	2,698	53,950	6.7	5.0
Total	78,294	11,285	89,578	6.4	12.6
Central					
Transit	6,341	4,450	10,791	8.9	41.2
Regional	2,479	91	2,570	3.8	3.5
Domestic	38,320	1,888	40,209	7.9	4.7
Total	47,140	6,429	53,570	7.8	12.0
Total	**125,434**	**17,714**	**143,148**	**6.9**	**12.4**

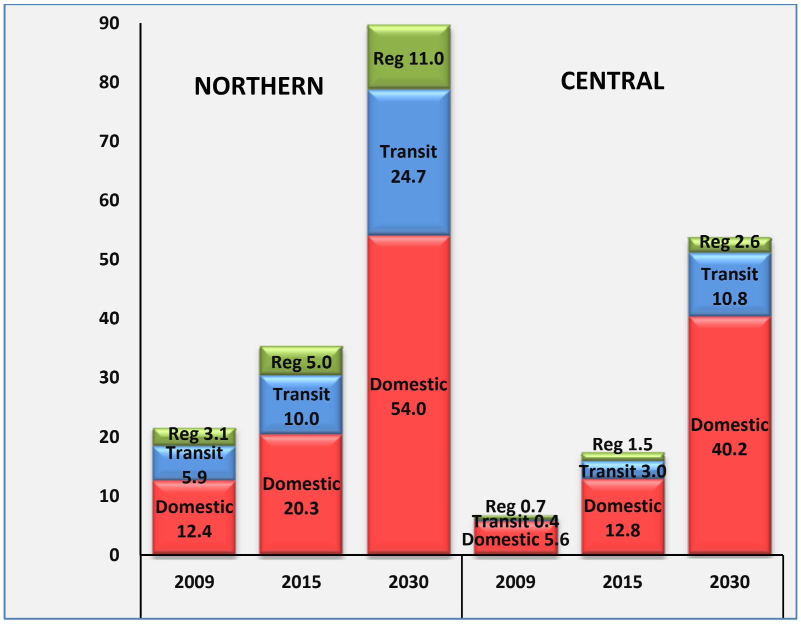
Source: Nathan Associates Inc.

Figure 4-1. Traffic Growth Forecast by Corridor, 2009-2030 (million tons)



Source: Nathan Associates Inc.

Figure 4-2. Base Case Corridor Traffic by Type, 2009-2030 (million tons)

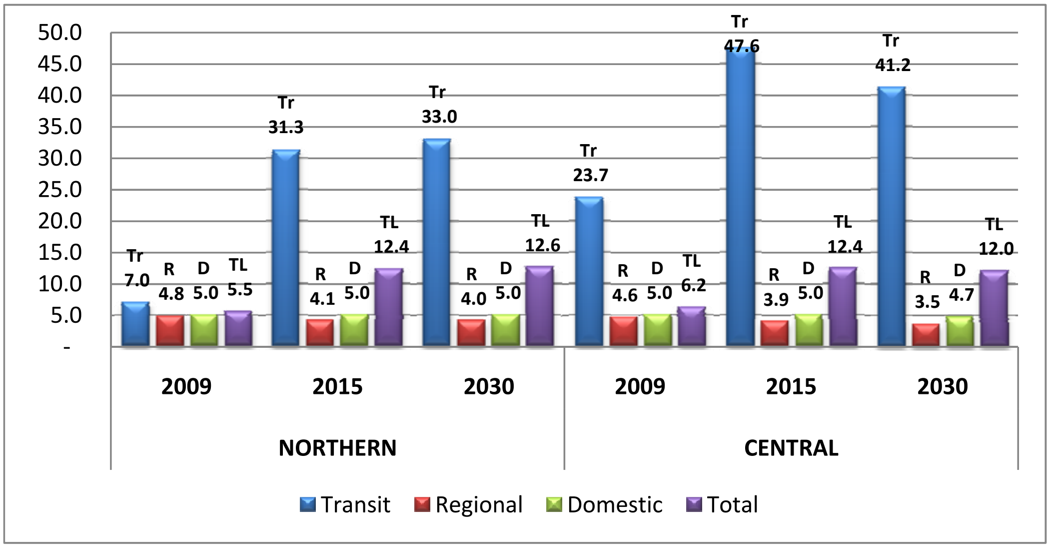


Source: Nathan Associates Inc.

Traffic in Northern and Central Corridors is expected to grow significantly in a span of 20 years: 7% average annual growth for Northern Corridor and 18% average annual growth for Central Corridor are expected. This translates into traffic increasing by at least three-fold. Traffic volume that goes through the Northern Corridor in 2030 is expected to be 67% higher than that of Central Corridor. In both corridors, for most of the years considered, domestic traffic makes up more than half of corridor traffic. Regional traffic has a slightly higher share in the Northern Corridor and higher volumes.

During the forecast period, there is an overall increase in share of rail as a mode in the total corridor traffic from 6 percent in 2009 to 12 percent for 2015 and 2030. For transit traffic of Northern Corridor, the share of rail is expected to increase from 7 percent in 2009 to 33 percent in 2030.

Figure 4-3. Rail Share in Total Corridor Traffic by Type, 2009-2030 (percent)



Source: Nathan Associates Inc.

Figure 4-3 portrays the overall increase in share of rail as a mode in the total corridor traffic. In the transit traffic of Northern Corridor, the share of rail is expected to increase from 7% in 2009 to 33% in 2030. For the Central Corridor, the rail share increases to 48% from a relatively higher share compared to Northern Corridor, 24%, although it is expected to drop slightly by 2030. For regional and domestic traffic, the rail share does not change significantly over time. The "Total" column in the graph is an average of preceding columns showing types of traffic. The fact that we see higher averages for both corridors in 2015 and 2030 is due to the fast increase of rail share in transit traffic.

Both Figures 4-2 and 4-3 display a jump in transit traffic from the year 2009 to 2015 and 2030 for both Northern and Central Corridors. For the Central Corridor, this could be explained by 2009 transit share being depressed due to operational problems encountered by TRL. For the Northern Corridor, the expected improved performance of RVR will allow it to capture a greater share of Ugandan transit traffic. This traffic is currently constrained because of track problems between El Doret and Kampala.

Implications for Corridor Infrastructure

The amount of traffic forecast for the Northern and Central Corridors will overwhelm the existing infrastructure and will obvious require substantial investments throughout the forecast period. Some of the implications of the traffic forecast are highlighted below:

- Unconstrained traffic growth implies large future demand on ports, highways and rail
- Port capacity will need to increase by 50.3 million tons by 2015 and 143.4 million tons by 2030 as shown in Table 4-4
- Road network needs to be able to handle **80 percent** more traffic by 2015 and **4 times** more traffic by 2030

- If capacity is not increased, **congestion** at ports and on roads will reach epic levels and constrain economic growth

There is a clear need for substantial and targeted investment in regional transport infrastructure now and continuing for the next several decades.

Table 4-4 Forecast of Port Traffic by Type of Cargo, 2009-2030 (000s tons)

Port and type of cargo	2009	2015	2030	Avg. Annual Growth (%) 2009-2015	2015-2030
DAR ES SALAAM					
Imports					
Container	2,056	5,251	23,789	16.9%	10.6%
General cargo	658	626	1,644	-0.8%	6.6%
Dry Bulk	1,270	3,538	7,420	18.6%	5.1%
Liquid Bulk	2,646	4,554	8,732	9.5%	4.4%
Total	6,630	13,969	41,584	13.2%	7.5%
Exports					
Container	1,067	4,404	19,516	26.6%	10.4%
General cargo	148	621	1,402	27.0%	5.6%
Dry Bulk	-	-	-	-	-
Liquid Bulk	44	961	1,473	67.3%	2.9%
Total	1,259	5,987	22,391	29.7%	9.2%
Total	7,889	19,956	63,975	16.7%	8.1%
Total TEUs (000)	354	966	3,093	18.2%	8.1%
MOMBASA					
Imports					
Container	4,086	6,152	18,513	7.1%	7.6%
General cargo	1,349	2,861	7,221	13.4%	6.4%
Dry Bulk	4,641	4,330	10,705	-1.2%	6.2%
Liquid Bulk	6,431	6,377	11,221	-0.1%	3.8%
Total	16,507	23,055	64,657	5.7%	7.1%
Exports					
Container	1,952	9,615	30,688	30.4%	8.0%
General cargo	269	-	-	-	-
Dry Bulk	62	812	1,051	-	-
Liquid Bulk	167	191	34	2.3%	-10.8%
Total	2,450	7,283	14,777	19.9%	4.8%
Total	18,957	30,338	79,434	8.2%	6.6%
Total TEUs (000)	619	1,314	3,514	13.4%	6.8%

Source: Nathan Associates Inc.

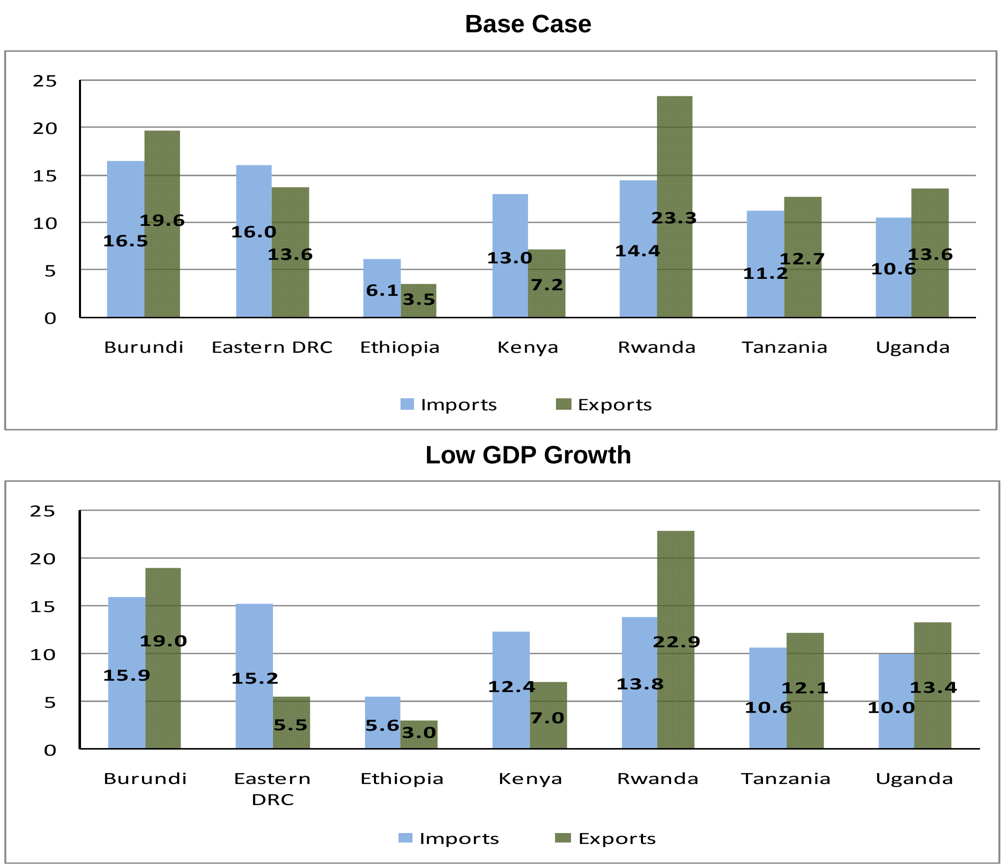
Alternative Trade and Traffic Scenarios

Earlier in this chapter, trade and traffic projections based on expected GDP growth and a "Base Case" scenario were presented, where it was assumed that the proposed projects for corridor improvement[12] are to be implemented in the future. In order to evaluate the sensitivity of this analysis based on different conditions than what is expected, in this section the assumptions on GDP and corridor improvement scenarios are altered.

Low GDP Growth Scenario

First, a scenario with lower GDP growth is considered; 40% less per year than what was assumed to calculate Base Case traffic forecasts. The Base Case assumption on having implemented recommended projects for corridor performance improvement is kept intact. New trade and traffic values were calculated based on lower economic growth. Figure 4-4 and Figure 4-5 show the average annual growth rate for imports and exports by country for the Base Case as well as Low GDP Growth Scenario for the periods of 2009-2015 and 2015-2030, respectively.

Figure 4-4. Comparison of Average Annual Trade Growth by Country, Base Case vs. Low GDP Growth 2009-2015 (percent)



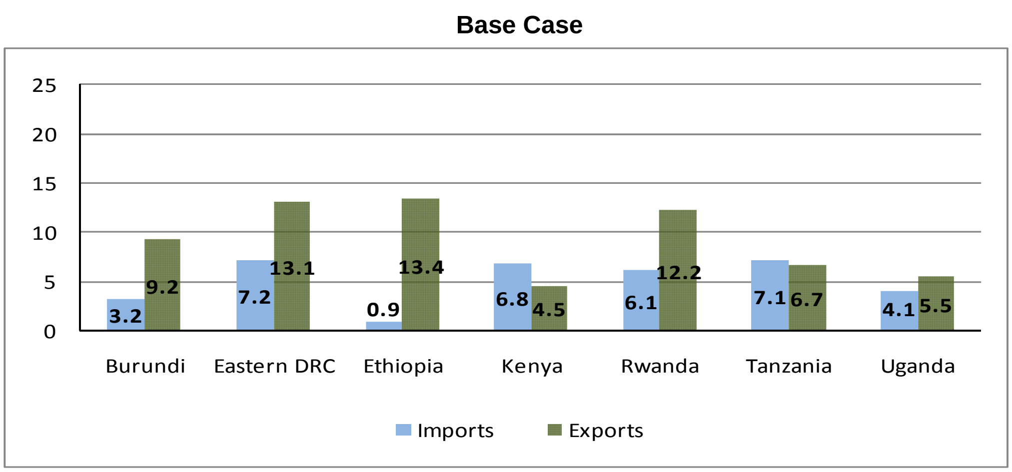
Source: Nathan Associates Inc.

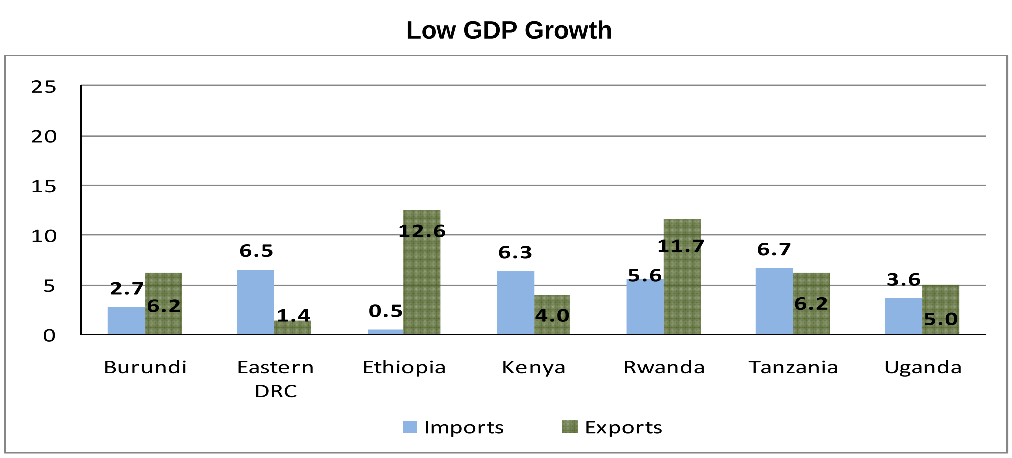
As a result of 40 percent lower GDP growth per year, in 2015, total trade is expected to fall from 90.1 million tons to 86.8 million tons; a decrease of 3.7 percent. The relatively small decline in the

[12] Detailed descriptions of proposed projects can be found in Appendix A of Main Report (Vol I) of CDS Action Plan.

trade forecast for the Low GDP Growth Scenario for 2015 is due to the limited years for the lower GDP growth impact to have a compounding effect. In general, the resulting decrease in trade for the regional economies is in the range of 1 to 4 percent from the Base Case, with the exception of the impact on DR Congo's exports (36 percent). This translates into 8.5 percentage points difference in growth for this country, in the case of lower growth. The impact on imports is uniform across the region, 3 percent decrease in trade compared to the Base Case, with the exception of DR Congo (4 percent). The results vary more for exports than for imports, the change from Base Case being as little as 1 to 2 percent for Kenya, Rwanda and Uganda (see Figure 4-4).

Figure 4-5. Comparison of Average Annual Trade Growth by Country Base Case vs. Low GDP Growth 2015-2030 (percent)





Source: Nathan Associates Inc.

Figure 4-5 compares the Base Case scenario trade to Low GDP Growth Scenario trade for the years 2015-2030. More substantial decreases can be seen in this period; total trade is expected to fall from 237.5 million tons to 194.4 million tons, a decrease of 18 percent. Similar to the 2009-2015 period, a large decrease in Eastern DRC exports are observed; 11.7 percentage points less than growth in the Base Case. Burundi exports follow by an estimated drop of 37 percent from the Base Case scenario. Ethiopia's exports would also see a relatively large decrease of 13 percent. In terms of imports, the decrease across the region is still uniform (9 percent) with the exception of DR Congo (13 percent).

Table 4-5. Low GDP Growth Traffic by Corridor and Mode, 2015 (000 tons)

Corridor and Type of Traffic	Road	Rail	Total	AAGR (%) 2009-2015	Rail Share (%)
Northern					
Transit	6,594	3,013	9,607	8.4	31.4
Regional	4,604	195	4,799	7.4	4.1
Domestic	18,748	987	19,735	8.0	5.0
Total	29,946	4,195	34,141	8.0	12.3
Central					
Transit	1,514	1,348	2,862	33.6	47.1
Regional	1,369	55	1,424	12.8	3.9
Domestic	11,763	619	12,382	13.1	5.0
Total	14,646	2,022	16,668	15.3	12.1
Total	**44,592**	**6,217**	**50,809**	**10.1**	**12.2**

Source: Nathan Associates Inc.

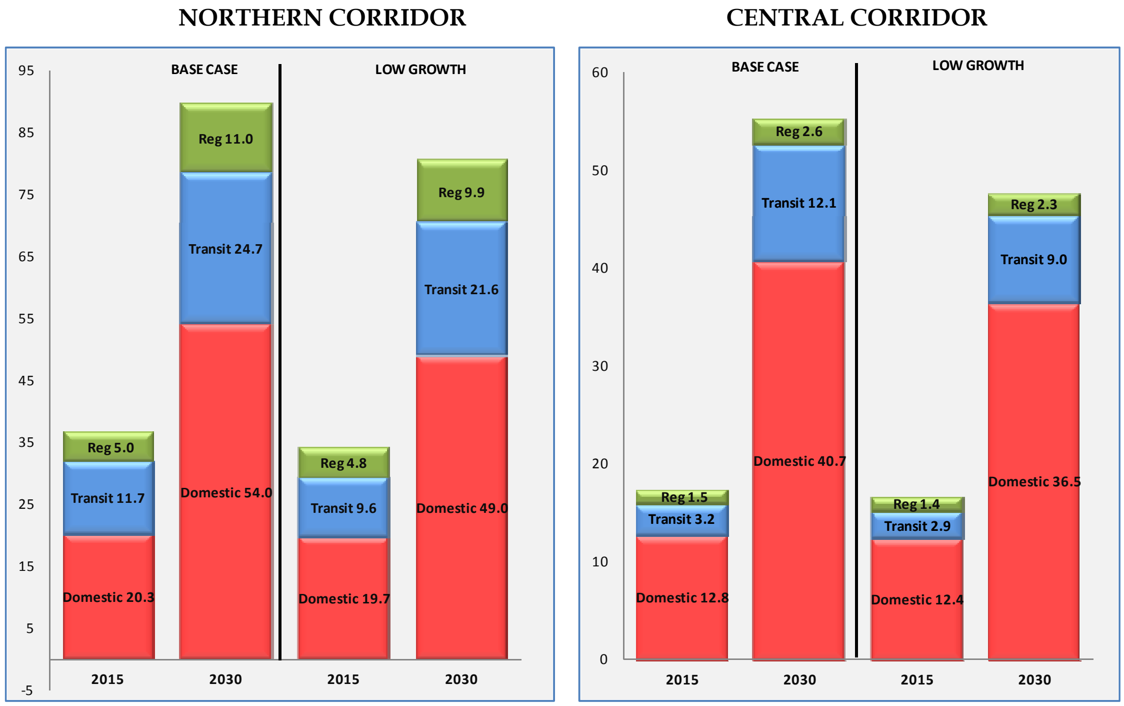
Tables 4-5 and 4-6 show the effect of a Low GDP Growth Scenario on expected traffic values in the future. The total traffic in year 2015 is estimated to drop from 54 million tons to 51 million tons (a decrease of over 6 percent) and in year 2030 the drop is expected to be from 145 million tons to 128 million tons, a decrease of 10.5 percent. Generally, the impact of lower growth on Central Corridor traffic is slightly higher than on Northern Corridor. In terms of modal shares, there is no significant difference from the Base Case scenario.

Table 4-6. Low GDP Growth Traffic by Corridor and Mode, 2030 (000 tons)

Corridor and Type of Traffic	Road	Rail	Total	AAGR (%) 2015-2030	Rail Share (%)
Northern					
Transit	14,585	6,993	21,578	5.2	32.4
Regional	9,501	397	9,898	4.7	4.0
Domestic	46,507	2,448	48,955	6.1	5.0
Total	70,593	9,838	80,431	5.7	12.2
Central					
Transit	5,334	3,666	9,000	7.5	40.7
Regional	2,231	79	2,310	3.0	3.4
Domestic	34,773	1,685	36,458	7.2	4.6
Total	42,338	5,430	47,767	7.0	11.4
Total	**112,931**	**15,267**	**128,198**	**6.1**	**11.9**

Source: Nathan Associates Inc.

Figure 4-6. Comparison of Traffic in Northern and Central Corridors Base Case vs. Low GDP Growth scenario, 2015 and 2030 (million tons)



Source: Nathan Associates Inc.

The decrease in traffic can be clearly seen in Figure 4-6, especially by year 2030: Under the Low GDP Growth scenario, traffic in Northern Corridor by 2030 is estimated to fall from 89.6 million tons to 80.4 million tons; a reduction of more than 10 percent. For Central Corridor by 2030, traffic would decrease from 55.3 million tons to 47.8 million tons, equivalent to about 14 percent decrease. In terms of types of traffic, the largest impact would be expected on transit traffic, which by year 2030 would fall from 24.7 million tons to 21.6 million tons in the Northern Corridor (12.5 percent decrease). In the Central Corridor, this decrease is expected to be even larger, 25.6 percent, a change from 12.1 million tons in 2030 to 9 million tons.

WORST CASE SCENARIO

An additional alternative scenario was considered to assess the impact on projected corridor traffic if the proposed corridor improvements were not implemented. A "Worst Case Scenario" is evaluated, where it is assumed that none of the proposed projects are implemented and consequently corridor performance deteriorates as traffic volumes increase and the transport network gets increasingly congested. As increasing traffic challenges capacity leading to congestion; transport costs increase along with deteriorating quality of service along the corridor. Due to the deteriorating corridor performance, the forecast of traffic demand assumed for the Base Case Scenario will not materialize. This is due to the reduced competitiveness of the region's exports and the increased cost of imports. Also investment in new or expanded production facilities would be discouraged. Accordingly, this scenario would have a lower GDP growth than the Base Case. For the Worst Case Scenario we have assumed a worsening corridor performance in terms of a 25 percent increase in price, time as well as a 25 percent decrease in reliability coupled with the Low GDP Growth Scenario presented in the previous section that assumed a 40 percent reduction of the Base Case Scenario annual GDP growth rate per country.

As a result of the Worst Case Scenario, the overall traffic in 2030 would decrease from 145 million tons to 116 million tons, a decrease of 20 percent from the Base Case scenario, as can be seen in Tables 4-7 and 4-8. In terms of types of traffic, similar to the Low GDP Growth only scenario, the largest impact would be for transit traffic; 30 percent decrease from Base Case for the Northern Corridor and 35 percent for the Central Corridor by 2030. Regional traffic would follow, with a 30 percent decrease for both corridors. Given the relatively short distances that domestic traffic (Tanzanian and Kenyan) travels, the impact of the worsening performance is less; around 12 percent. In terms of modal shares, different than the Low GDP Growth only scenario, there is a change in the domestic rail traffic share compared to the Base Case. In the Northern Corridor, for 2015 the domestic rail share is expected to increase from 5 percent to 10 percent in the worst case scenario. In 2030, the share remains about the same. In the Central Corridor, the domestic rail share is expected to increase from 5 percent to 8 percent by 2015, while it increases from 6 percent to 11.3 percent in 2030.

Table 4-7. Worst Case Scenario Traffic by Corridor and Mode, 2015 (000 tons)

Corridor and Type of Traffic	Road	Rail	Total	AAGR (%) 2009-2015	Rail Share (%)
Northern					
Transit	5,254	2,401	7,655	4.4	31.4
Regional	3,642	154	3,797	3.3	4.1
Domestic	17,246	1,917	19,162	7.5	10.0
Total	26,142	4,472	30,614	6.1	14.6
Central					
Transit	1,175	1,045	2,220	28.1	47.1
Regional	1,068	43	1,111	8.3	3.9
Domestic	11,016	958	11,975	12.5	8.0
Total	13,259	2,046	15,305	13.6	13.4
Total	**39,401**	**6,518**	**45,919**	**8.2**	**14.2**

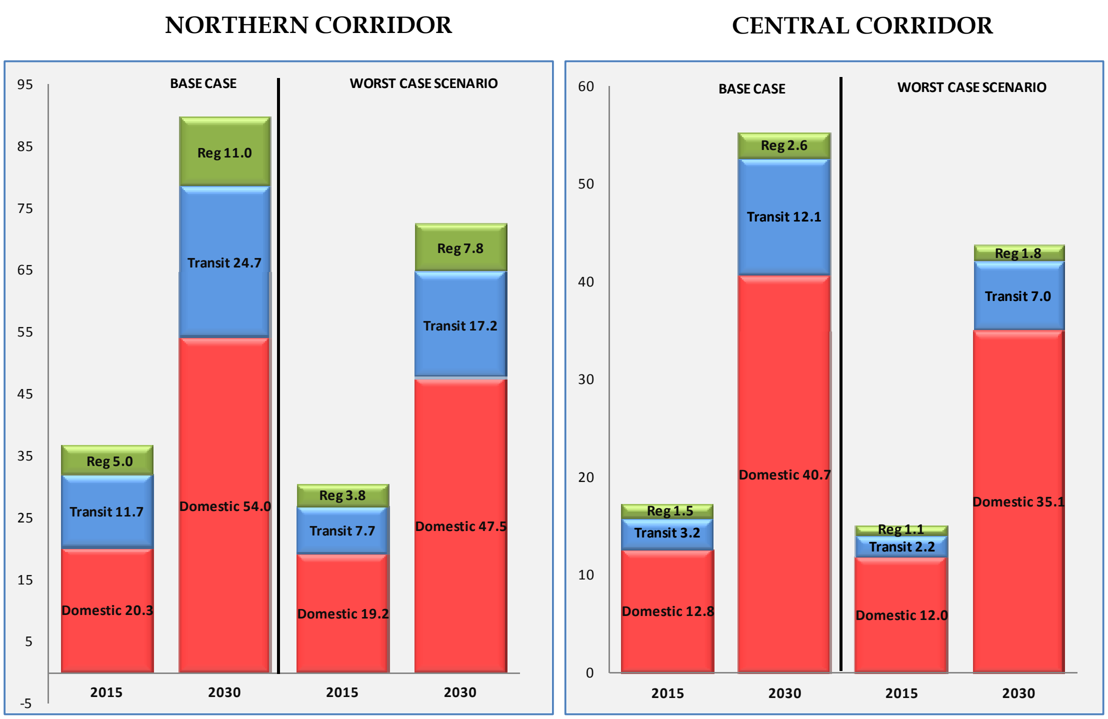
Source: Nathan Associates Inc.

Table 4-8. Worst Case Scenario Traffic by Corridor and Mode, 2030 (000 tons)

Corridor and Type of Traffic	Road	Rail	Total	AAGR (%) 2015-2030	Rail Share (%)
Northern					
Transit	11,622	5,572	17,194	5.5	32.4
Regional	7,516	314	7,831	4.9	4.0
Domestic	41,830	5,704	47,534	6.2	12.0
Total	60,968	11,590	72,558	5.9	16.0
Central					
Transit	4,137	2,843	6,981	7.9	40.7
Regional	1,740	62	1,802	3.3	3.4
Domestic	31,858	3,259	35,117	7.4	9.3
Total	37,736	6,164	43,900	7.3	14.0
Total	**98,704**	**17,754**	**116,458**	**6.4**	**15.2**

Source: Nathan Associates Inc.

Figure 4-7. Comparison of Traffic in Northern and Central Corridors: Base Case vs. Worst Case Scenario, 2015 and 2030 (million tons)



Source: Nathan Associates Inc.

A larger decrease in traffic can be seen in Figure 4-7 compared to the Low GDP Growth Scenario discussed above. Instead of a 10 percent decrease in traffic in Northern Corridor by year 2030, the worsening performance brings that decrease to 19 percent, an additional 9 percentage points. For Central Corridor the difference is 7 percentage points. Compared to the Base Case scenario, total traffic in the Northern Corridor, by 2030, would be estimated to decrease from 89.6 million tons to 72.6 million tons. In the Central Corridor, the traffic would decrease from 55.3 million tons to 43.9

million tons. A more significant decrease can be observed in year 2015 in the WCS scenario for both corridors: For Northern Corridor, the decrease from Base Case values would be about 17 percent and for Central Corridor this value would be 12.5 percent.

5. Potential for Trade Increases with Improved Corridor Performance

Trade flows are expected to increase without a significant improvement in corridor performance, but could increase substantially with performance improvements as noted in Chapter 4 above. These increases are related to the percentage decreases in price, transit time, and variation in transit time (unreliability) for each trade flow. To further quantify this effect, we present an estimate of potential increases in trade tonnages for each corridor in Table 5-1. We made this estimate in three steps:

1. Using FastPath, we calculated benchmark price, time, and reliability for each corridor under good operating conditions, based on best-in-region performance.
2. Determining the percentage change this would make in corridor generalized cost for each trading partner using this corridor. (This generalized cost was calculated using price plus the value of time plus the value of reliability, where the average values of time and reliability are $7 per container hour and $1.50 per container-hour of variability based on the results reported in Appendix A.)
3. We multiplied the percent change by the elasticity of transit trade (-1.9) and the total tonnage forecast for each key year (2015 and 2030) to get the total potential increase in tonnage in that key year.

The elasticity indicating the relationship between traffic and generalized cost was calculated using a gravity model. In this model, the total trade between pairs of trading partners is a function of the economic size of each country (GDP and population) and the disutility of shipping freight between them. This disutility is assumed to be a combination of price, time, and reliability of these shipments and would be inversely related with trade output. Three elasticities were calculated: overseas trade for landlocked countries (transit) (-1.9), overseas trade for coastal countries (-0.8) and trade between countries in the region (-1.0). The results of the model indicate that the generalized cost has significant adverse effects on trade flows analyzed regionally (within East Africa) as well as with overseas partners, as predicted[13].

[13] See Appendix A for details.

The results of the analysis shown in Table 5-1 for 2015 indicate an average potential increase in trade of 15 percent. The total potential trade increase 9.2 million tons is significant on top of the already substantial traffic growth forecasted for the Base Case. Thus total Northern and Central Corridor traffic would be 61.9 million tons by 2015. The largest potential increase in trade is shown for the Central Corridor with transit traffic increasing by 38 percent.

Table 5-1. Potential for Traffic Increases due to Improved Corridor Performance, 2015 (million tons)

Corridor and Type of Traffic	Base Case	Potential Increase	Total	% Change
Northern Corridor				
Transit	10.0	1.6	11.6	14%
Regional	5.0	0.8	5.8	14%
Domestic	20.3	0.9	21.2	4%
Total	**35.3**	**3.3**	**38.6**	**9%**
Central Corridor				
Transit	3.2	2.0	5.2	38%
Regional	1.5	0.7	2.2	32%
Domestic	12.8	3.2	15.9	20%
Total	**17.5**	**5.9**	**23.4**	**25%**
Total	**52.8**	**9.2**	**61.9**	**15%**

Source: Nathan Associates Inc.

Table 5-2 presents the potential for increased traffic due to improved corridor performance for 2030. The impact is similar to that discussed above for 2015. Total Northern and Central Corridor traffic would reach 172 million tons by 2030. Of course, realizing these increases depends on the ability of the region to overcome very challenging capacity constraints at border posts, railways, and ports.

Table 5-2. Potential for Traffic Increases due to Improved Corridor Performance, 2030 (million tons)

Corridor and Type of Traffic	Base Case	Potential Increase	Total	% Change
Northern Corridor				
Transit	24.7	3.9	28.6	14%
Regional	11.0	1.7	12.7	14%
Domestic	54.0	2.5	56.5	4%
Total	**89.6**	**8.2**	**97.7**	**8%**
Central Corridor				
Transit	12.1	7.8	19.9	39%
Regional	2.6	1.3	3.8	33%
Domestic	40.3	10.5	50.9	21%
Total	**55.0**	**19.6**	**74.6**	**26%**
Total	**144.6**	**27.8**	**172.3**	**16%**

Source: Nathan Associates Inc.

This analysis has shown that implementation of the recommended projects will bring major improvements in the cost, transit time and reliability of the logistic chain of the Northern and Central Corridors. These gains will promote and facilitate trade and economic growth to significantly contribute to the attainment of the region's leaders and people development aspirations.

Appendix A. Technical Description of Transport Models

This appendix provides a technical description of the two models which were applied in the Corridor Diagnostic Study. These models are based on research carried out by Nathan Associates, Inc. during the Core Network Study.[14]

Total Trade Model

The total trade between pairs of trading partners is assumed to be a function of the economic size of the trading partners and inversely related to the disutility of shipping freight between them. This disutility is assumed to be some combination of price, time, and reliability of these shipments. Other factors may also be significant. To analyze these relationships, we undertook a gravity modeling exercise to estimate the trade effects of transportation and compared them with geographic impediments and with trade policy variables.[15]

Overview of Gravity Model

For the past 50 years, the basic gravity model has been used to explain aggregate bilateral trade flows in terms of variables that would attract flows of goods between two economies and variables that would interfere with that attraction. Size as measured by GDP and population[16] is posited as the main attraction while distance has been the standard variable used for trade resistance, but there are many variations on the basic gravity model. It is common to add other geographic variables, such as dummy variables for countries sharing a common border, landlocked countries, island countries, countries sharing a common language, and common institutions (Walley). Policy variables in gravity models include average tariff rate, nontariff barrier index, openness indicator,[17] and dummy variables for countries with preferential trade arrangements. Measures of

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[14] More details on these models are presented in the Core Network Study Regional Model Report Appendices C and D.

[15] The term policy variable is used in this chapter in two ways. For gravity modeling, it refers to indicators that reflect government policy, such as tariff policy, openness of the economy, and trading partners with preferential trade agreements. For corridor choice modeling it is used to indicate corridor choice biases that are influenced by government policies as well as by shipper preferences.

[16] Oguledo and MacPhee note that more trade is usually associated with large size but that a large population enables a country to gain from specialization and exchange internally rather than through external trade. Consequently, the sign of the population coefficient may be negative or positive.

[17] The Sachs-Warner indicator is a dummy variable that takes zero value if an economy is closed according to any one of the following five criteria: (i) its average tariff rate exceeded 40 percent, (ii) its non-tariff barriers covered more than 40 percent of imports, (iii) it had a socialist economic system (iv) it had a state monopoly of major

infrastructure distances (Limao and Venables) and price differentials (Geraci and Prewo) as a proxy for transport costs have been used as additional trade resistance factors.

The present study focused on innovative measures of transport performance but included the standard GDP, population, distance, common border, and common language variables as well as policy variables, such as tariff rates and openness and measures of the difficulty of carrying out import and export activities.

Tests of the effects of being landlocked and belonging to trade associations indicated that these variables were insignificant. This result is consistent with other studies that found weak if any effects of regional trade agreements in sub-Saharan Africa (Cassim, Wang and Winters, Winters and Wang). The final variables selected for inclusion in this model are listed in Table A-1.

Table A-1. Variables Selected for the Total Trade Model

Variable	Definition
amt	Value of annual imports in U.S. dollars.
imppop	Importer population.
impgdp	Importer gross domestic product in U.S. dollars.
exppop	Exporter population.
expgdp	Exporter gross domestic product in U.S. dollars.
lng	Common language (0,1) dummy variable.
bord	Border (0,1) dummy variable takes value of 1 when importer and exporter are adjacent .
imptar	Average ad valorem equivalent tariff rate.
impopen	Sachs-Warner indicator (0,1) of openness takes value of 1 when importer is open.
varpct	Percent variability in shipment time defined below.
gencost	Generalized cost of transit defined below.
dist	Distance, direct-line miles between major ports of entry.
time	Average transit time defined below.
price	Average cost of shipping a 40-foot container discussed below.

Source: Nathan Associates Inc.

Three gravity models were estimated, which resulted in three measures of elasticity: (1) Overseas trade for landlocked countries (-1.6) (2) Overseas trade for coastal countries (-0.8) (3) Trade between countries in the region (-1.0).

TRANSPORT PERFORMANCE VARIABLES

The novel variables employed here measure several aspects of transport performance: price, transit time, and variability of transit time (a form of reliability).

exports, or (v) its black-market premium exceeded 20 percent during either the decade of the 1970s or the decade of the 1980s.

Transport Price

Transport price is defined as the average explicit cost of transporting a standard 40-foot container between major shipping points, including the cost of export from origin and the cost of import at destination. Price from coastal countries is calculated as cost of export through the port near the largest city plus the cost of shipping from that port to the destination country. Price to coastal countries is calculated as the shipping cost from the origin country plus the import price for the port of the destination country.

Price for imports to landlocked countries from overseas regions is the weighted average of costs for shipping and for corridor transit (including port import price and land transport) where the weighting is the average percent of historical traffic by corridor and mode (subcorridor). Price for exports from landlocked countries overseas is the weighted average corridor costs (including port costs) in the export direction plus overland shipping costs from each corridor port to the destination. In some cases overland transport costs were based on general prices for road or rail transport in a given year. Where price was not available for the land portion of the corridor in a given year, the price was interpolated from the data in other years. Rail price indices were also created for certain countries based on shipper reports (Cook).

Pricing for shipping service is dependent on the shipping service and route, which is more important than the distance involved. An index for price was constructed from sample data to give the year-by-year variation (Cook).

Transport Time

As noted by Hummels, shipping delays impose inventory-holding costs and depreciation or spoilage costs that may be magnified if they are incurred at an early stage in the production chain. Moreover, lengthy shipping times may have more severe effects on developing countries such as those in southern and eastern Africa. Most of these countries are farther from foreign customers or suppliers. The shipping volumes for these countries are smaller, and so more stops are required to fill a vessel. Finally, the frequency of ship visits is lower. In the latter case, production times must be adjusted in accordance with the infrequent ship schedules, and domestic transport must be coordinated as well to facilitate the export process.

Time elapsed in the transport of goods is measured in hours and includes

- Loading at the origin
- Transfer between modes
- Border crossing
- En route activities, such as vehicle weight controls
- Port processing and handling
- Customs procedures, and
- Maritime shipping.

Transit time from coastal countries is calculated from shipper reports as time to export through the port near the largest city plus the shipping time from that port to the destination country. Transit time to coastal countries is calculated as the shipping time from the origin country plus the import time through the port of the destination country.

Transit time for imports to landlocked countries from overseas regions is the weighted average of time for shipping and for corridor transit (including port import time and land transport time) where the weighting is the average percent of historical traffic by corridor and mode (subcorridor). Transit time for exports from landlocked countries to overseas destinations is the weighted average corridor transit time (including port time) in the export direction plus shipping time from each corridor port to the destination country.

Shipping time is heavily dependent on the frequency and directness of the shipping service provided to the port used for international freight as well as to the distance to the overseas origin or destination. Ship transit times were assumed to be constant for the ten year period used in the analysis, as were port transit times, except for Dar-es Salaam where import dwell times by year for transit traffic were available.

Variability in Transport Time

Premature arrivals or unexpected delays in the receipt of goods also impose costs on importers that discourage trade. We measure this variability in transport time by calculating the average of the absolute deviations from the mean transit time to find a measure of variability in hours. This measure of variability is highly correlated with the mean time, so we divide variability in hours by the mean time to obtain a percentage measure of variability (varpct). For the coastal countries the variability is calculated as the time-weighted average of the deviations for both ports and shipping. For the landlocked countries the variability is based on deviations for ports, shipping and land transportation.

GENERALIZED COST OF TRANSPORT

Price and time have a correlation of 65 percent. To avoid the statistical problems associated with this high covariance, we combined the two transport measures into a compound variable called generalized cost. The generalized cost is the price as calculated above plus the transit time multiplied by $9, which is the revealed value of time from a logit model estimated for the region (Cook).

YEARS OF OBSERVATION

Data on variables in the gravity model were collected for the latest ten years available (1999-2008). This period is sufficiently long to minimize the effects of transient events unrelated to the economic relationships we are examining. It is also long enough to observe the effects of structural changes in those relationships. In order to see the influence of particular years, each one (2000-2008) was entered into preliminary regressions as a dummy variable. The dummies representing years were found to be almost always insignificant, indicating that the regression constant was not shifting over the period.

GRAVITY MODEL RESULTS

Regression Results

The total trade gravity model regression variables all proved to be highly significant with expected signs. Sizes of both exporters and importers in terms of income and population have a strong positive relation with bilateral trade flows. Common language and borders also appear to promote trade.

In terms of trade policy variables in the truncated world model, it appears that the average tariff rate performs much better than the Sachs-Warner indicator. However, the significant negative impact of the tariff rate disappears when percentage variability is added to the regression. In the regional model, neither variable performed well because there is less variation with respect to trade policy within the region of southern and eastern Africa.

Turning to the novel transport variables that have been introduced in this gravity model, it appears that generalized cost has significant expected negative effects on trade flows. This was true of both the regional and truncated world regressions. The size and significance of the coefficients suggest that the results are robust.

Implications of Results

The modeling results can be interpreted as elasticities, where the 1.9 elasticity estimate for trade with respect to generalized cost implies that a 10 percent decrease in generalized cost of transport is associated with a 19 percent increase in trade. For example, if the generalized cost of $11,377 between neighboring Tanzania and Mozambique in 2008 could be reduced to the $7,203 cost between neighboring Tanzania and Kenya, the model results suggest that Tanzania-Mozambique trade could grow 70 percent.

Another comparison of results is possible by focusing on the time variable, a component of the generalized cost variable. The modeling results show that the elasticity of trade with respect to time was estimated to be -1.8, when generalized cost is not included. This can be compared with similar elasticity derived from the work of Hummels. According to Hummel's estimates for the largest SITC product categories (7 and 8), an average ocean voyage from foreign ports to the U.S. port of Baltimore lasted 20 days and cost 16 percent of the shipment value. Each day added 0.8 percent to Hummel's cost, implying an elasticity of negative one, somewhat lower than the time elasticity of -1.8 in the present study. Hummel did not find any significant time costs for commodities in SITC 0-6 product categories presumably more important to Africa, and the present study's estimate of average transport time is 939 hours or 39 days, almost double Hummel's average. This study's estimate of implicit time cost associated with 939 hours is $8,451(Cook). With a representative African container shipment value of $60,000, southern and eastern Africa time costs amount to roughly 14 percent of shipment value. Reducing the average African transport time to the average American time would, according to our elasticity estimate of -1.8, increase trade by 25 percent.

Corridor and Mode Choice Model

MODEL DESIGN

The corridor choice model was designed to be a generalized logit model that can forecast both corridor choice and mode choice within the chosen corridor at the same time. The choice of corridor also implies a choice of port and port country. These choices may be made for financial/logistics reasons or for policy reasons.

The model assigns traffic to corridor/port combinations and to road or multimodal subcorridors according to (1) subcorridor performance indicators (logistics price, time and reliability, port ship service and efficiency of import/export procedures), (2) socioeconomic indicators (language groupings and economic association groupings), and (3) policy indicators (mode preference for certain types of traffic and preference for or bias against specific ports or countries). Future expectations of change in these indicators or changes in policy are predicted and then applied in the model to examine their impact on traffic flow patterns.

The model parameters were derived from statistical analysis of historical data on trade flows by corridor, estimated measures of corridor performance for each corridor and subcorridor from *FastPath* analysis, empirical measures of shipping service, import and export efficiency and implied policy effects. Analyses of the data suggested several submodels that were calibrated using data from 1999 to 2009.

DATA LIMITATIONS

The model was based on available data sources for traffic flows (historic and current), partial information on historic data and analysis of corridor performance, readily available data on economic groupings and language, and newly gathered data on corridor performance. Unfortunately a complete set of import/export data showing corridor choice by commodity and tonnage for more than one year was only available for one country (Rwanda) while a wide variety of data for total tonnage imports and exports for many corridors was available from PMAESA for 1999-2005[18]. There was also a comprehensive report on rail transport and road-rail comparisons for the East African Community[19] covering the years 2000-2006, which gave some detailed comments on performance data. These were complemented by detailed data collection in 2009 on corridor performance by the study team using the *FastPath* methodology focusing on price time and reliability for each link of the transport/logistic corridors and subcorridors.

Additional data was collated from the IMF trade statistics on the value of trade by trading partner, which allowed some analysis of the percentage of trade by trading partner and year between 1999 and 2008. These percentages were applied to trade statistics in tonnages as an approximation of the direction of trade flows. This was useful for estimating trade flows for modeling purposes, despite the inaccuracies it produces.

CORRIDOR CHOICE MODEL RESULTS

Regression Results

The initial model results lead to the following conclusions for corridor choice in Eastern and Southern Africa:

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[18] PMAESA, Facilitation of Transport in Eastern and Southern Africa Transport Corridors, 2006.

[19] CPCS, Traffic Working Paper, East African Railways Master Plan Study, East African Community, November 2007.

1. Transport/logistics performance, shipping service, economic groupings, and policy choices are all significant factors in corridor choice.
2. Import flows follow a different pattern of corridor, mode, and port choice than export flows.
3. Northern landlocked countries (Rwanda, Burundi, Uganda, and north eastern DR Congo) followed a somewhat different pattern than southern landlocked countries (Zambia, Zimbabwe, and southern DR Congo) due to the wider availability of ports and the influence of South Africa.
4. Corridor choice for exports is more influenced by policy variables than corridor choice for imports, which is closely aligned with corridor cost, time, and reliability.
5. The approximation techniques used to fill in data gaps introduced more uncertainty in model results, but the significance of the model coefficients shows that many parts of the models are robust.

Submodels and Their Variables

The submodels identified for the study are based on the statistical significance of the coefficients of the variables and their overall explanatory power. On the basis of the statistical analysis presented in Appendix E, there appeared seven submodels:

1. Import corridor choice for Northern Corridor countries
2. Export corridor choice for North-South Corridor countries
3. Import corridor choice for Copper Belt countries
4. Export corridor choice for Copper Belt countries
5. Import and Export corridor choice for Malawi
6. Import and Export corridor choice for Zimbabwe
7. Intraregional corridor choice

The variables used in each submodel are presented in Table A-2 along with comments on the direction and relative importance of preference or bias indicated by the variables on corridor choice. The Malawi and Zimbabwe submodels are examples of a more general Southern African submodel. The relative importance of corridor performance and policy variables (bias and/or preference for different ports for transshipment and for the use of rail or road modes) in corridor choice is indicated as well in Table A-2.

Implications of the Submodels

Of the seven submodels, only the two Northern and Central Corridor Import and Export submodels were able to distinguish the separate influences of price, time and reliability, as there were a sufficient number of observations to test these relationships. (The other submodels used generalized cost, which combines price and time to avoid the problem of the high covariance among price, time, and reliability data and lesser number of observations.)

Price to the shippers and transit time are significant in both submodels. Reliability is important only for imports. The bias variable for selection of Dar port vs Mombasa is also significant in both models. However, it is positive for imports and negative for exports. This variable was significant even after the performance measures of price, time and reliability were taken into account.

Table A-2. Variables Used in Submodels for Corridor Choice

Variable	Northern and Central Corridor Submodels	
	Import	Export
Price (per 40-foot cont.)	Yes	Yes
Time	Yes	Yes
Reliability	No	Yes
Common association	Yes	Yes
Tea center bias	n/a	No [a]
Dar port bias	Yes (positive)	Yes (negative)
Kenya rail bias	Yes (very negative)	Yes (negative)
Tanzania rail bias	Yes (very negative)	Yes (negative)
Implied value of time	$5.6/cont-hr (measured)	$7.9/cont-hr (measured)
Implied value of reliability	$0.1/cont-hr of variation (measured)	$1.5/cont-hr of variation (estimated)
Rho squared (0)	0.44	0.28

[a] *This is significant when tea export data is used for Rwanda alone.*
Source: Nathan Associates Inc.

For overseas shipments, Kenya and Tanzania railways experience a negative bias, even after time and reliability factors are taken into account. These indicate major service problems from the shipper's viewpoint. This is not true for regional traffic flows where there appears to be no bias against rail after performance is taken into account.

Economic Association Preference

Being a member of economic communities (SADC, EAC, SACU) has a significant influence on corridor choice for imports but not exports. The value of the coefficient for the dummy variable representing countries with membership in a common community at the beginning and end of the corridor is large and highly significant for imports. Being a member of COMESA was not statistically significant since this association and its benefits to members have changed during the analysis period.

Revealed Value of Time

The revealed value of time from the logit model is an interesting byproduct. This value was measured for both transit time and for variation in time (unreliability) and it is derived from all cargo, containerized and non-containerized.

The Northern Corridor submodels revealed coefficients with the correct sign for price, time and reliability, which allowed for the calculation of a revealed value of time. For these decision-makers the value of time is $5.6 to $7.9 per container-hour of transit time (an average of $7), with the higher value given to Northern Corridor exports (dominated by coffee and tea). Since the longer the time spent on the inland transit routes, the more likely is loss of cargo on that route, this value probably includes a value of cargo security as well as time.

The value of reliability was calculated at $0.10 per container-hour of variation in transit time for the import submodel. Although it was not statistically significant in the export submodel due to the high correlation with transit time and the rail bias variables, it is estimated at $1.50 based on results from submodels for other corridors and countries in the Eastern and Southern Africa region. This value is in the range of the inventory cost for commodities and reflects the fact that inventories may have to be increased if there is greater unreliability in transit time. This may be a logistics consideration for these decision-makers.

Rho Squared Values

Rho squared is an indicator of the model's ability to explain variance in observed data. These numbers are artificially depressed due to the nature of the approximation process that introduced more randomness into the calculations than would be there with more complete information on routing for different trading partners. For this type of model the rho squared for the Northern Corridor import submodel is considered very good at explaining variance in corridor choice; it is considered fair to good for the export submodel. Nonetheless, the significance of the model coefficients in all cases shows that the selected variables will have a reliable influence, even if understated in their influence on the explanatory power of the model.

TESTS OF CORRIDOR CHOICE MODEL PREDICTIVE ACCURACY

To verify that the submodels were working, we tested to see whether the percentages of freight flows predicted by corridor were comparable to the percentages of total freight flows by corridor from the base data. A similar test was carried out for subcorridors. We also examined variation in the percentages for different trading partner pairs to see if the differences were in the right direction, considering corridor performance. Results for the Northern and Central Corridor submodels are presented in Tables A-3 and A-4. The percentage predictions have some differences from the actual estimated tonnages, but they are within acceptable ranges.

Table A-3. Results Analysis for Northern and Central Corridor Country Imports (Total Tonnage 1999-2009)

SubCorridors	Total Burundi	Total Rwanda	Total Northern Congo	Burundi %	Rwanda %	Northern Congo %
Estimated Actual Total Tonnage 1999-2009 (000)						
Mombasa Road	216.3	3482.5	466.4	18	61.7	21
Mombasa Multimodal	40.3	1010.9	331.2	3.4	17.9	14.9
Dar Road	806.4	1025.5	936.9	67.2	18.2	42.2
Dar Multimodal	137.4	126.7	486.1	11.4	2.2	21.9
Total	1200.4	5645.6	2220.6	100	100	100
Model Prediction 1999-2009 (000 tons)						
Mombasa Road	196.7	3557.4	411.1	16.4	63	18.5
Mombasa Multimodal	60	935.8	386.6	5	16.6	17.4
Dar Road	826.1	910.7	1032	68.8	16.1	46.5
Dar Multimodal	117.7	241.8	391	9.8	4.3	17.6
Total	1200.5	5645.7	2220.7	100	100	100

Source: Nathan Associates Inc.

Table A-4. Results Analysis for Northern and Central Corridor Country Exports (Total Tonnage 1999-2009)

SubCorridors	Total Burundi	Total Rwanda	Total No. Congo	Burundi %	Rwanda %	No. Congo %
Estimated Actual Total Tonnage 1999-2009 (000)						
Mombasa Road	12.3	484.7	92.4	2.9	63.8	21.1
Mombasa Multimodal	2.8	94	92.9	0.7	12.4	21.2
Dar Road	349.2	162.5	164.1	83.4	21.4	37.4
Dar Multimodal	54.3	19	89.3	13	2.5	20.4
Total	418.6	760.2	438.7	100	100	100
Model Prediction 1999-2009 (000 tons)						
Mombasa Road	196.7	3557.4	411.1	16.4	63	18.5
Mombasa Multimodal	60	935.8	386.6	5	16.6	17.4
Dar Road	826.1	910.7	1032	68.8	16.1	46.5
Dar Multimodal	117.7	241.8	391	9.8	4.3	17.6
Total	1200.5	5645.7	2220.7	100	100	100

Source: Nathan Associates Inc.