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Evans Mupela and Adam Szirmai

Maastricht Economic and social Research institute on Innovation and Technology (UNU-MERIT)
email: info@merit.unu.edu | website: http://www.merit.unu.edu

Maastricht Graduate School of Governance (MGSoG)
email: info-governance@maastrichtuniversity.nl | website: http://mgsog.merit.unu.edu

Keizer Karelplein 19, 6211 TC Maastricht, The Netherlands
Tel: (31) (43) 388 4400, Fax: (31) (43) 388 4499

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Communication Costs and Trade in Sub-Saharan Africa

by Evans Mupela* and Adam Szirmai**

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Abstract

This paper investigates the effects of connectivity charges (communication costs) on bilateral exports in Sub Saharan Africa (SSA). Data from 19 exporter countries was used together with communication costs data in a gravity model of trade setup. The export data derive from the IMF Direction of Trade and the COMTRADE databases, while the communication cost data was collated from a variety of sources including direct contact with service providers. We find that communication cost is an important factor in bilateral trade in the region. Communications have a significant negative effect on export intensity. The study also reveals that countries with high communication costs generally have lower export intensity than countries with low communication costs. The results suggest that investment in ICT infrastructure that brings down international communication costs will have a positive effect on regional trade in the long run.

Key Words: Trade, gravity model, communication cost, connectivity, export

JEL Classification: O25, 041, O43, O47, F15, F43

* UNU-MERIT Keizer Karelplein 19, 6911 TC, Maastricht, The Netherlands, Corresponding author, email: emupela@wsu.ac.za
** Professorial fellow UNU-MERIT, email: szirmai@merit.unu.edu

1. Introduction

Communication costs are an important aspect of the barriers to trade often referred to as trade costs. These are costs that have to be overcome in order to actualize a trade transaction or more formally stated: Trade costs are "all costs incurred in getting a good to a final user other than the cost of producing the good itself" De (2007, p.4). The higher these costs are, the more difficult it is to carry out trade and the smaller the volume of trade. Some of the more often researched barriers to trade are transport costs, exchange rates, freight charges and border related trade barriers. The impact of the cost of information gathering and transmission of messages has often been neglected or has been subsumed under transport costs or border related trade barriers. It is however important to model these costs separately as the share of services in world trade has increased dramatically over the last two decades and advances in information and

communication technology (ICT) have made distance less important in the setup of trade transactions. A steady reduction in communication costs has resulted in a dramatic shrinkage of the time and space barriers which inhibit economic exchange over vast distances (Harris, 1995; Melvin, 1990).

These developments have led researchers to take communication costs more seriously and treat them differently from transportation costs, which largely constitute the costs involved in getting a finished product from point A to point B.

Harris (1995) points out three reasons why communication costs are different from transport costs and why they should be treated differently. One of the major differences according to Harris, is that from a supply point of view, communication costs, as opposed to transport costs are almost always a fixed cost, because the marginal cost of transmitting a message once the network is in place is zero. This is in contrast to Samuelson's iceberg model (Samuelson, 1952) used for transport costs, where part of the good is assumed to `melt away' in the course of transportation. However, It is important to take cognizance of the fact that this refers to the supply side of the equation and that from the demand side communication costs are still a variable cost. While suppliers of communication infrastructure may not necessarily incur marginal costs for transmitting messages between users, they charge users for using the infrastructure based on either time or the amount of bandwidth transmitted.

Secondly, the natural monopoly and public good properties present in communication networks are another reason to consider these costs separately. Although the non-rivalry aspect of public goods is present in most communication networks, excludability is easily enforced by data encryption technologies and passwords that limit access to only these that are authorized or that have paid to do so. Harris (1995) also points to the presence of network externalities in communication networks as a defining difference between transport and communication. The concept of a network as a growing pool of links between a growing number of connected users makes it very distinct from a transport link between two points.

The new economic geography literature driven by Krugman (1997) and Venables (2003) has attributed the emergence of internationally distributed production networks to improvements in communication technologies that have made coordination of geographically dispersed production processes possible in more developed countries. SSA has seen very little of these dispersed production processes with most of the investments in the region heavily falling into extraction of primary resources and erection of retail outlets for finished products from more developed countries.

While earlier studies focused on the effect of country specific communication infrastructure on trade, they did not offer much evidence on how international communication costs affect trade flows. Fink, Matoo and Neagu (2002) take an early lead in expressly investigating the effect of international communication costs on trade flows by assuming that communication costs affect trade primarily by influencing

variable trade costs between nations. More recent literature has studied variations of the problem in relation to specific markets and products (Freund and Weinhold, 2004; Tang, 2006). We follow Fink, Mattoo and Neagu and investigate the effect of bilateral communication costs on trade flows in SSA by employing bilateral cost of communication between countries in an augmented gravity model setting.

The contribution to this literature is that communication costs in SSA are linked to international gateways dominated by private foreign owned and operated satellites and show the effect of this on trade. The paper examines whether the cost of communications is an important variable in the realization of higher volumes of trade between SSA countries. The affordability of communications facilities and services for both the corporate world and the general population in SSA has become an imperative for participation in the new global world order.[1]

The objective of this paper is to empirically investigate whether bilateral communication costs matter for trade among SSA countries. It empirically tests the hypothesis that high communication costs in SSA have a negative impact on the volume of trade between countries. International communication costs in SSA are heavily influenced by the cost of access to international gateways dominated by foreign privately owned satellites (i.e. the foreign privately owned `public infrastructure'). If the hypothesis is confirmed this would imply that having a privately owned foreign `public' infrastructure has negative economic effects on SSA countries and that a publicly owned infrastructure would be more beneficial for economic development, reducing trade costs and enabling more trade, as argued in van Zon and Mupela (2010).

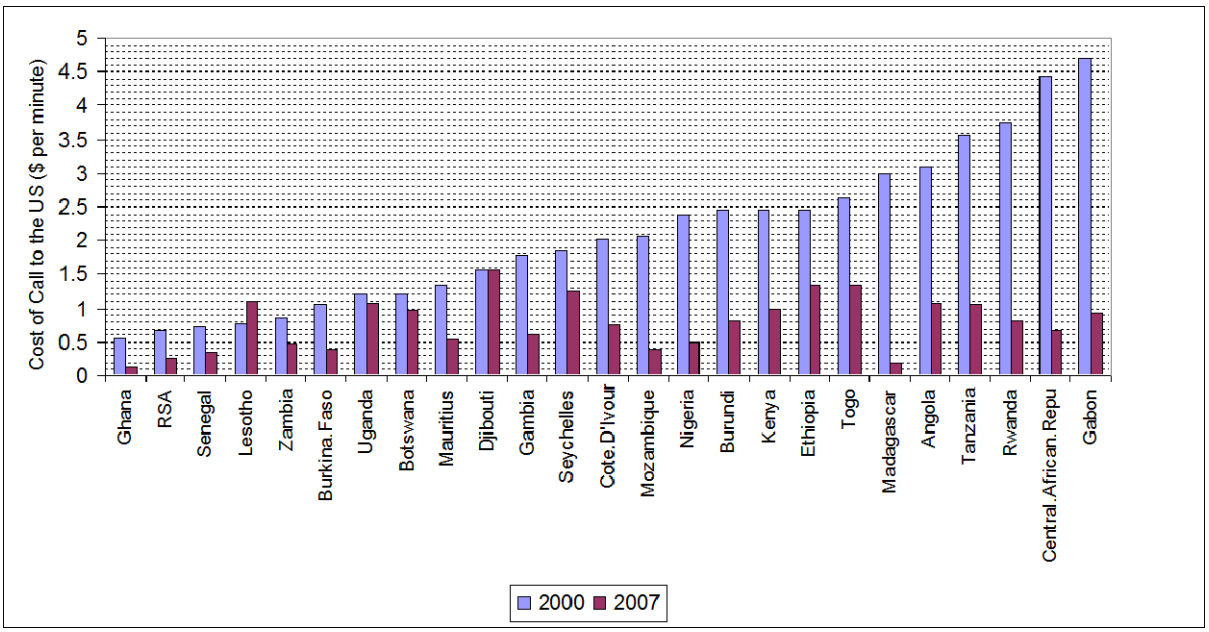
Communication cost cuts across all phases of the life cycle of a product, from initial product design to marketing and after sales services. This aspect of communication is almost always neglected in studies of trade costs in a bid to compartmentalize costs to broader categories that make them easier to study. An example of this is the study by Anderson and Wincoop (2004) that finds that 44% of trade costs in developed countries are due to border related barriers, a broad category that includes communication costs. We isolate communication costs in this study and look at the cost of gathering, transmitting and receiving information across international barriers through international telephone and internet services. These are represented by cost of broadband and the cost of making international phone calls. These are the communication costs that are likely to affect international trade. So in general we argue that international communication costs are a function of international calling rates and internet broadband costs. International calling rates are measured in US dollars per minute while internet bandwidth is measured in dollars per Megabit per second (Mbps). This represents the variable cost aspect of communication.

[1] Whether increased intra African trade and trade openness indeed have positive effects on growth in Sub-Saharan Africa is not addressed in the present paper. This remains an important avenue for future research.

The gravity model predicts that SSA countries will trade more with nearer countries in the region. The gravity tendency is likely to weaken when trade with bigger economies outside Africa is taken into account. For instance former colonial ties will result in trade relations with distant countries. The paper concentrates on effects among SSA countries so as to eliminate the effects of former colonial ties as much as possible.

An example of politically moderated trade relations with distant countries is the American government's bold policy initiative to support and promote export-led economic growth on the continent through the African Growth and Opportunity Act (AGOA) of 2000 under President Bill Clinton. The act seeks to promote growth on the African continent by promoting trade between the world's biggest economy and the African continent. AGOA allows SSA countries to export products to the USA duty free among other benefits. During the period 2001 to 2008 exports from the continent to the US increased fourfold. It is interesting to note that call charges between the AGOA participating countries and the US also dropped dramatically during this period, in most cases by more than 50% (see Figure 1). The figure shows a dramatic drop in call charges to the USA between 2000 and 2007 in all countries except Djibouti where they remained the same. This does not necessarily mean that the drop in call charges led to higher exports but rather gives us further incentive to study whether this drop in communication costs could in any way have had a bearing on the increase in trade volumes between the US and the AGOA countries.

Figure 1. International Call Charges between USA and AGOA African Countries



The rest of the paper is organized as follows: section 2 gives a brief overview of the gravity model of trade. The empirical model and the variables in the analysis are discussed in section 3. Section 4 follows with a description of the data, which is followed by a discussion of the results in section 5. The paper closes with some concluding remarks and recommendations in section 6.

2. The Gravity Model of Trade

The gravity equation of international trade tries to predict international trade flows based on the size of the economy and the distance between trading partners (see Harrigan, 2002 for an extensive review of the theoretical foundations of the gravity model of trade as well as Baldwin and Taglioni, 2006, Anderson, 2011 and Anderson and Wincoop, 2003 for gravity theory derivations and useful critiques of the use of the model).

Simply stated the model posits that the amount of trade between two countries is directly proportional to the product of their economic sizes (GDP) and inversely proportional to the physical distance between them. The empirical use of this form is accredited to Walter Isard in his work on Regional Science although lots of other sources credit first use of the equation in economics to Jan Tinbergen (1962).

Despite the wide empirical success that this formulation has had in predicting bilateral trade flows between countries, the early literature criticized the gravity equation for not having any theoretical foundation in economics. This criticism led various authors to try and provide this justification. In 1979 James Anderson wrote "A Theoretical Foundation of the Gravity Equation" specifically to address some of these theoretical concerns. He demonstrated that the gravity equation could be derived from

the properties of expenditure systems especially in countries where the structure of traded goods preferences is very similar. There were more theoretical justifications to follow. In a series of publications on the subject, Bergstrand developed a general equilibrium model of world trade, from which he derived the gravity equation under the assumption of perfect international product substitutability (Bergstrand, 1985; Bergstrand, 1989). He then followed this up with models based on monopolistic competition thus bringing together the two strands of literature on the matter, the product differentiation based literature and the monopolistic competition based models. Deardorf (1998) in proposing his two theories of frictionless and impeded trade notes that:

"I suspect that any plausible model of trade would yield something very like the gravity equation, whose empirical success is therefore not evidence of anything, but just a fact of life" [2]

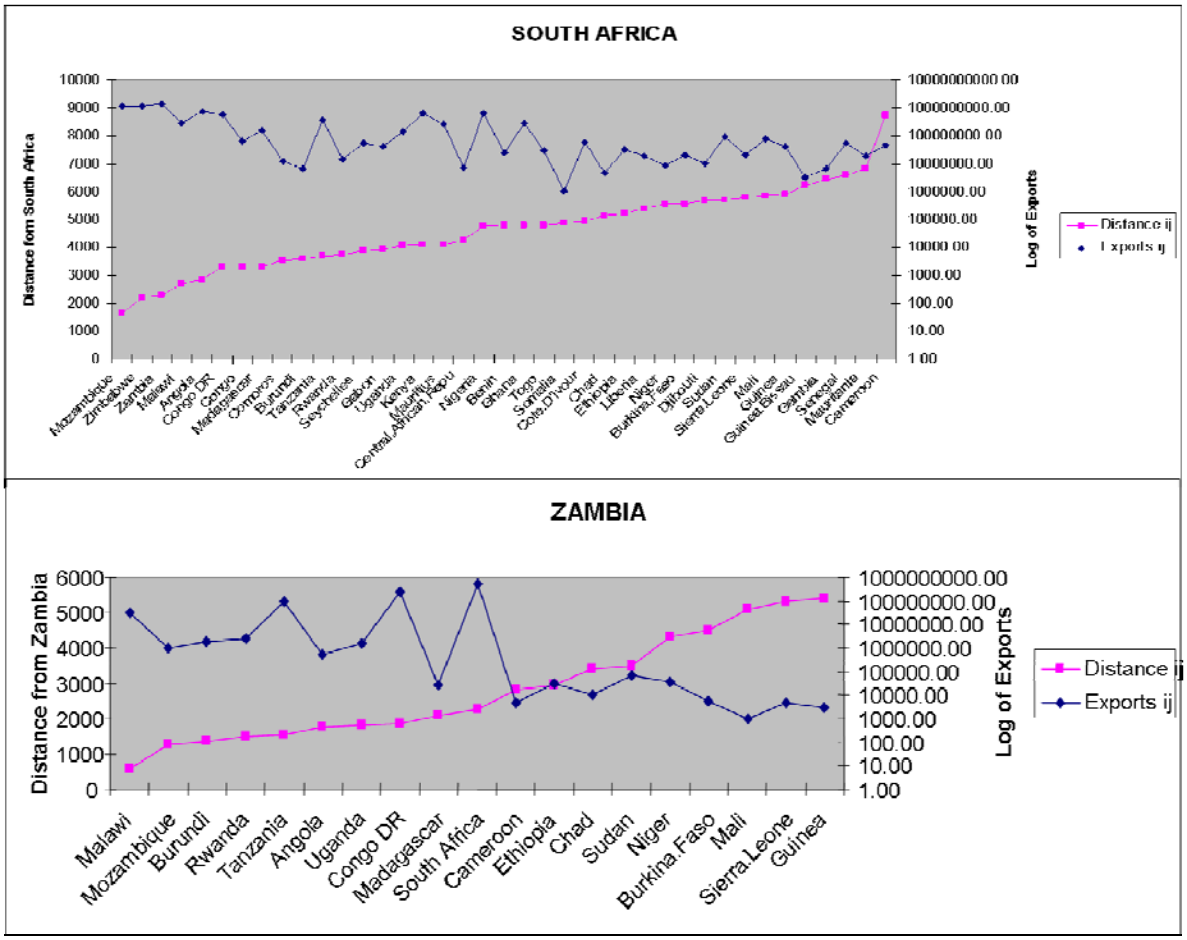
Another criticism of the gravity model is the usual log linearization of the basic form, which is then used to estimate elasticities. Silva and Tenreyro (2006) argue that the log linearization of the gravity model leads to bias by ignoring the zero trade pairs in the data. They propose alternative ways of estimating gravity equations without having to ignore zero-value trading pairs. This stems from the fact that the logarithm of zero is undefined and would therefore not make sense to have ln(0) in the regression. They propose that the gravity equation and all constant elasticity models should be estimated in the multiplicative form using pseudo maximum likelihood regression techniques, as they naturally take care of zero values. Another well-known way around the problem of zero values is the arbitrary addition of the value one (1) to all export values, as all zeros would become ones and there is no problem with the logarithm of one (log(1)=0) in the regression. This is the approach we take in this study.

It is interesting to note the implications of the gravity formulation for SSA countries. Figures 2 shows strong gravity tendencies for trade amongst SSA countries.[3] The figure shows the total volume of trade from South Africa and from Zambia decreasing with distance from the exporting country. With a few exceptions, we see this trend in other countries as well to varying degrees (See Annex 3 for more examples).

[2] page 12 in Chapter "Determinants of Bilateral Trade: Does Gravity Work in a Neoclassical World?" appearing in Volume entitled "The Regionalization of the World Economy" from the from the National Bureau of Economic Research

[3] As mentioned in the previous section, only SSA countries are included in the analysis, in order to avoid the confounding effects of strong trade ties to former colonial countries. The focus is on intra-African trade.

Figure 2. Distance from RSA (top), Zambia (bottom) to other African Countries and Level of Exports



The figure shows that distance seems to matter for trade in SSA. Even South Africa, which seems to have easier and relatively cheaper access to international connectivity, seems to keep the gravity trend (falling exports with increased distance) for trade with other African countries, although with much higher levels of exports than Zambia. South Africa has direct access to the sea and undersea fiber cable, which until recently was not available to most countries in SSA, which had to rely on expensive satellite capacity for their international connectivity. In spite of this South Africa still exhibits the gravity tendency in trade with other African countries. Communication has the capacity to make trade easier between far away countries. But if this communication is not affordable or is not easily accessible, then the problems of distance are compounded by the inability to communicate, which may affect trade intensity volumes downwards.

3. The Empirical Model

We model the effects of communication costs on trade using an augmented version of the basic empirical gravity formulation (1)

$$\ln X_{ij} = \beta_0 + \beta_1 \ln Y_i + \beta_2 \ln Y_j + \sum_m \beta_{ij}^m \ln Z_{ij}^m + \varepsilon_{ij} \quad (1)$$

where X_{ij} is the volume of exports from country *i* to country *j*, Y_i and Y_j and the economic masses of the trading partners and Z are all the barriers to trade between the pair including distance. The following is the multiplicative form of our empirical model:

$$X_{ij} = A \cdot \frac{GDP_j^{\beta_1} \bullet GDP_i^{\beta_2}}{Dist_{ij}^{\beta_3}} \cdot Fixed_{ij}^{\beta_4} \cdot Bband_i^{\beta_5} \cdot MA\_OTRI_i^{\beta_6} \cdot OTRI_j^{\beta_{76}} \cdot Outgoing_i^{\beta_8} \quad (2)$$
$$\cdot Landlocked_i^{\beta_9} \cdot ComBorder_{ij}^{\beta_{10}} \cdot Satellite_i^{\beta_{11}}$$

GDP_i and GDP_j take the place of Y_i and Y_j. GDP is measured in measured in current 2007 dollars[4].

The following are the different components of Z_{ij}^m from equation from equation 1:

$Dist_{ij}$ is the geographic distance between exporter country i and importer country j, measured as the distance between their capital cities in kilometers. Distance has been used in gravity estimations as a proxy for cost of transport in trade models. It has traditionally been found to have a strong negative effect on trade flows and we expect a similar result ($\beta_3 < 0$).

$Fixed_{ij}$ is the cost of an international call from a fixed landline telephone from country i to country j. This variable is critical information to our study as we have surmised that most international connections in SSA go over satellite or fiber cable gateways (sometimes even for neighboring countries). This variable, like distance, is a direct measure of communication related obstacles to trade and we expect its effect to be negative and significant.

$InBband_i$ is the cost of broadband in the exporter country, *i*. It is used as an additional indicator of the hurdles to communication that are likely to have a negative impact on modern trade. Its effect is expected to be negative, like that of the cost of fixed-line telephone calls.

$ComBorder_{ij}$ is a dummy variable signifying whether countries i and j share a common border or not. The common border category is related to the distance variable but refers to more than distance alone. It is expected that sharing borders will in most cases include sharing languages and cultures, common infrastructure etc., which together are expected to facilitate rather than hamper trade between country pairs. We therefore expect a positive sign on this variable.

$Landlocked_i$ is another dummy showing whether the exporting country i is landlocked or not. Landlocked countries are limited by not having access to the sea. In terms of communications, which is our prime concern, the fiber connection to the outside world,

[4] We tested the results using PPP Dollar GDP figures and found similar results. We show the results obtained using current dollar figures because these were more readily available in a consistent format than the PPP Dollar GDP figures.

which is supposed to be cheaper than satellites, is not easily accessible from inland. This makes landlocked countries more dependent on satellite connectivity to the extent that all landlocked countries in Africa are dependent on direct satellite links for international connectivity. We expect a negative sign on this variable.

Satellite is another dummy variable showing whether a country is dependent on satellite for international connectivity or not. It takes the value one for countries dependent on satellites and zero for countries not dependent on satellites. All landlocked countries are dependent on satellite connectivity but then so are some coastal countries that do not have access to the fiber cable or who face prohibitive price structures from neighbors with fiber cable access. We expect this variable to also enter negatively into the model. Due to the high cost of satellite access, we expect the coefficient on this dummy to be negative and significant.

Outgoing is the total number of outgoing international calls made in 2007 from country i to the rest of the world. We expect a positive sign on this variable assuming that a higher volume of outgoing calls from country i in the face of high international calling costs indicates important business communications.

$MAOTRI_i$ is the Market Access Overall Trade Restrictiveness Index, which measures both tariff and non-tariff barriers to trade in country i. The original Trade Restrictiveness Index was constructed by the IMF in 1997 (IMF,2005; Nicita and Olareaga, 2006; Perez and Wilson 2008) and has been refined over the years to its current form[5]. We use this estimation to represent the obstacles that selected trade barriers offer to a country's access to outside markets. This index effectively accounts for tariff and non-tariff barriers imposed by the rest of the world on each country's export bundle.

In order to capture obstacles posed by the receiving country j, we include a similar index, the Overall Trade Restrictiveness Index ($OTRI_j$), which is calculated differently to capture a country's protective policies' effect on its import bundle.[6] With this we basically capture trading partner j's resistance to country i's export efforts. We expect both variables to have negative signs.

Dividing both sides of equation (2) by GDP_i and then taking logs gives us an intensity version of the dependent variable X_{ij},

[5] See Review of the IMF's Trade Restrictiveness Index , 2005 on http://www.imf.org/External/np/pp/eng/2005/021405r.htm

[6] Details of how these indices are formulated and calculated can be found in Hiau Looi Kee, Alessandro Nicita and Marcelo Olarreaga's work in CEPR Working papers entitled "Estimating Trade Restrictiveness Indices" from 2006 and later revisions www.cepr.org/pubs/dps/DP5576.asp)

$$\ln X\,\text{int}\,ensity_{ij} = \beta_0 + \beta_1 \ln GDP_j + (\beta_2 - 1)GDP_i - \beta_3 \ln Dist_{ij} + \beta_4 \ln Fixed_{ij} +$$
$$+ \beta_5 \ln Bband_i + \beta_6 \ln MA\_OTRI_i + \beta_7 \ln OTRI_j + \beta_8 \ln Outgoing_i + \quad (3)$$
$$+ \beta_9 Landlocked_i + \beta_{10} ComBorder_{ij} + \beta_{11} Satellite_i$$

X*intensity* is the value of exports relative to the GDP of the exporting partner (X_{ij}/GDP_i). Along with the geographical variables of distance, landlockedness and sharing a common border we introduce the costs of bilateral communication and the cost of broadband in the exporter country into the equation.

We expect the export intensity in exporter country *i* to be correlated with the amount of information exchanged and exchangeable between traders in different countries. In this regard any variable that impacts the acquisition and transmission of this information in a country will also impact the volume of trade[7].

Traditional gravity studies have consistently found that the economic masses of trading pairs matter, such that we expect bigger economies to trade more than smaller ones. We therefore expect positive signs on the coefficients of GDP_i and GDP_j[8].

We retain GDP_i as an explanatory variable in spite of the fact that it is the denominator of the dependent variable, because we also need to account for the effect of GDP size of exporting country on export intensity separately.

We take care of the zero trade values by adding 1 to the export series before calculating the export intensity, $Xintensity_{ij}$ series and taking logs, see Linders and Henri (2006).

The variables and expectations with regard to the signs of the coefficients are summarized in table 1.

Table 1. Variable Descriptions and Expected Signs

Variable	Description	Expected Sign
$Xintensity_{ij}$	Intensity of exports from country i to country j in current dollar values for the year 2007.	Dependent variable
X_{ij}	Level of exports between country i and country j	
GDP_i	GDP of country i in current 2007 dollars.	
GDP_j	GDP of country j in current 2007 dollars.	+ positive
$Dist_{ij}$	Geographic distance between capital cities of exporter country i and importer country in km	- negative

[7] If the share of communication cost in total trade costs is low but still has a significantly negative impact on trade, then communication costs could be capturing other factors that lead to poor communications e.g. poor infrastructure. Communication costs then become a proxy for the physical ability to make connections.

[8] Note that both $\beta_1, \beta_2 > 0$, but not necessarily $\beta_2 < 1$(cf. equation (6) and so finding a negative value for GDP_i would not necessarily be inconsistent with the basic assumptions of the gravity model.

$Fixed_{ij}$	Cost of an international call from a fixed landline telephone from country i to country j in PPP $ per minute.	- negative
$InBband_i$	Cost of entry level broadband connection, PPP $ per month	- negative
$ComBorder_{ij}$	A dummy variable signifying whether countries i and j share a common border or not.	- negative
$Outgoing_i$	Total number of outgoing international calls made in 2007	+ positive
$Landlocked_i$	A dummy variable indicating whether a country is landlocked or not.	- negative
$Satellite_i$	An infrastructure dummy indicating whether country is dependent on satellite connectivity	- negative
$MAOTRI_i$	The Market Access Trade Restrictiveness Index for country i	- negative
$OTRI_j$	The Overall Trade Restrictiveness Index in country j	- negative

Normally the cost of satellite connectivity is very much higher than the cost of fiber connectivity. We expect the effect of communication costs on trade to be more pronounced in landlocked countries than in coastal countries due to their dependence on more expensive satellite international connectivity. The alternative scenario is the imperfect market scenario, where we have monopolistic rents being charged on fiber connectivity as well, due to the presence of monopolies along the SAT3 fiber cable operation. If the alternative scenario obtains, we should find no significant differences between the effect of communication costs in landlocked countries and in coastal countries.

Things are further complicated by the fact that not all countries along the coastline have access to undersea optical fiber cable. Countries along the coast without a fiber landing point also use satellite or buy capacity from neighboring countries that do have a landing point. In the latter case they have no control over how much they pay. If the countries with landing points are able to charge monopoly rents in the alternative scenario, being on the coast does not necessarily guarantee cheaper access to the international backbone. Again this should lead to no significant differences between coastal and landlocked countries.

It remains to be seen, however whether the continuing roll out of more fiber optic cable along the East and West African coastline will change this dynamic in the near future in response to more competition.

4. The data

Several data sources were used to construct the main matrix of country pairs. Bilateral exports data was sourced from the IMF Direction of Trade database and the United Nations COMTRADE database. Distance data between countries' capitals was sourced from John Byers site chemical ecology[9].

[9] http://www.chemical-ecology.net/java/lat-long.htm

Another important source of data was the World Development Indicators database of the World Bank. Publications of the International Telecommunications Union (ITU) provided most of the data for ICT indicators particularly the broadband cost in SSA countries. These included the 2009 publication "Africa Telecommunications Indicators 2008" and "Measuring The Information Society 2008 ITU". GDP figures were sourced from the Word Development Indicators database of the World Bank for the year 2007. These figures were matched with the corresponding 2007 levels of export and international calling prices. Various sources were used for this data depending on availability. Most of it was sourced directly from different countries national telecommunications web sites, directories and Communications Authorities.

A cross section of 2007 data for 19 exporting countries in SSA was used mainly due to the fact that it was difficult to construct a time series data set because fixed telephony tariff data was difficult to collect retrospectively. In countries where time series data was available like Zambia, Togo, and Malawi, there was very little fluctuation, if any, in the price of international calls charged by the fixed service providers between successive years. In certain countries like Nigeria, the incumbent fixed telephone operator had been recently privatized and the ensuing state of transition made it difficult to collect any meaningful series of retrospective data. Massive movements were evident in local call tariffs, mainly due to competition from cheaper local mobile cellular providers, but international call charges did not change much for successive years.

The implication of using a cross sectional data set for this study is that it is not possible to carry out explicit causality tests on the data.

Of the nineteen exporter countries thirteen were landlocked and thirty pairs of trading partners had common borders. All landlocked countries depended on satellite infrastructure for their international connectivity.

5. Results and Discussion

Ordinary Least Squares (OLS) regressions show that distance and communication costs matter for trade in SSA. OLS was applied to the dataset for all countries and then to two sub-samples of landlocked countries and coastal countries. Though some variables change signs and lose significance when more variables are added to the regression, the overall result seems to be that distance affects export intensity negatively as does the cost of fixed line and broadband communication in both coastal and landlocked countries.

The results reveal the expected signs on most of the variables. $\ln Dist_{ij}$ is negative and significant at the 1% level. $\ln GDP_i$ and $\ln GDP_j$ both come out positive and significant at the 1% level as well. These variables all keep their signs and significance after more variables are added to the model. Although $lnOutgoing_i$ enters the model significantly with the expected positive sign, it drops its significance when $lnBband_i$ and $lnFixed_{ij}$ are added to the model. This was not expected. The volume of outgoing calls was expected to be positively correlated with export intensity and negatively correlated

with the cost of making a fixed call as seen from the correlation matrix in Annex 2. The sub samples of coastal and landlocked countries also display erratic results for *lnOutgoing* and *lnfixed*, which is not significant in the coastal sub sample. Whereas *lnOutgoing* comes out with a negative sign (not expected) in the coastal countries, it keeps the positive expected sign in the landlocked sample. This is difficult to explain as the volume of outgoing calls was expected to affect export intensity positively in both samples. This is an area where further research will be required.

$lnMAOTRI_i$ and $lnOTRI_j$ are both negative and significant. The common border dummy is positive and significant as expected because sharing a common order in most cases also means sharing communication channels and other natural resources that facilitate trade between neighboring countries. The landlocked and satellite dummies also turn out with the expected signs in both regressions.

Table 2. Determinants of Export Intensity. All Countries

OLS All											
lnXintensity	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
$\ln Dist_{ij}$	-1.435***	-1.332***	-1.868***	-1.876***	-1.915***	-1.895***	-2.041***	-2.426***	-2.153***	-2.148***	-2.141***
	(0.216)	(0.206)	(0.186)	(0.187)	(0.184)	(0.184)	(0.185)	(0.254)	(0.287)	(0.287)	(0.287)
$\ln GDP_j$		0.706***	0.704***	0.704***	0.678***	0.683***	0.664***	0.823***	0.803***	0.806***	0.814***
		(0.106)	(0.0920)	(0.0921)	(0.0909)	(0.0906)	(0.0894)	(0.121)	(0.120)	(0.120)	(0.120)
$\ln GDP_i$			1.212***	1.160***	1.257***	1.133***	1.105***	1.021***	0.998***	0.924***	0.893***
			(0.104)	(0.164)	(0.164)	(0.176)	(0.174)	(0.228)	(0.227)	(0.242)	(0.243)
$\ln Outgoing_i$				0.0689	-0.0577	0.0266	0.304	0.367	0.380	0.394	0.418*
				(0.166)	(0.167)	(0.172)	(0.185)	(0.240)	(0.238)	(0.239)	(0.240)
$\ln Bband_i$					-0.409***	-0.381***	-0.156	-0.174	-0.174	-0.126	-0.107
					(0.105)	(0.106)	(0.120)	(0.156)	(0.155)	(0.165)	(0.165)
$\ln Fixed_{ij}$						-0.352*	-0.584***	-0.755***	-0.697***	-0.726***	-0.715***
						(0.188)	(0.195)	(0.258)	(0.258)	(0.260)	(0.260)
$\ln MAOTRI_i$							-0.854***	-0.728***	-0.684**	-0.678**	-0.715**
							(0.228)	(0.275)	(0.274)	(0.274)	(0.276)
$OTRI_j$								-3.897**	-3.554**	-3.611**	-3.616**
								(1.517)	(1.517)	(1.519)	(1.518)
$Comborder_{ij}$									1.149**	1.202**	1.210**
									(0.574)	(0.577)	(0.577)
$landlocked_i$										-0.432	-0.0884*
										(0.483)	(0.641)
$Satellite_i$											-0.679*
											(0.550)
Constant	2.192	17.41***	-6.742**	-6.646**	-4.846	-3.617	-6.725**	-0.158	-2.592	-1.258	-0.746
	(1.679)	(2.784)	(3.194)	(3.205)	(3.186)	(3.244)	(3.301)	(4.254)	(4.399)	(4.647)	(4.661)
Observations	641	641	641	641	641	641	421	421	421	421	421
R-squared	0.094	0.181	0.380	0.380	0.402	0.407	0.426	0.482	0.490	0.490	0.495
Standard errors in parentheses*** p<0.01, ** p<0.05, * p<0.1											

Table 3. Determinants of Export Intensity. Coastal Countries

(OLS Coastal)										
ln $Xintensity$	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
ln $Dist_{ij}$	-1.304***	-1.254***	-1.726***	-1.728***	-1.915***	-1.904***	-1.926***	-1.887***	-1.575***	-1.530***
	(0.233)	(0.228)	(0.206)	(0.207)	(0.201)	(0.201)	(0.204)	(0.204)	(0.229)	(0.231)
ln GDP_j		0.536***	0.568***	0.567***	0.496***	0.503***	0.499***	0.424***	0.463***	0.472***
		(0.138)	(0.121)	(0.121)	(0.117)	(0.117)	(0.117)	(0.121)	(0.121)	(0.121)
ln GDP_i			1.143***	1.119***	2.184***	2.040***	1.847***	1.900***	1.877***	1.466***
			(0.117)	(0.191)	(0.271)	(0.293)	(0.422)	(0.420)	(0.415)	(0.512)
ln $Outgoing_i$				0.0323	-1.122***	-1.022***	-0.688	-0.746	-0.712	-0.0956
				(0.199)	(0.288)	(0.298)	(0.604)	(0.601)	(0.594)	(0.745)
ln $Bband_i$					-1.116***	-1.066***	-0.802*	-0.821*	-0.788*	-0.304
					(0.209)	(0.212)	(0.466)	(0.463)	(0.458)	(0.579)
ln $Fixed_{ij}$						0.190	-0.148	-0.207	-0.154	-0.154
						(0.527)	(0.533)	(0.545)	(0.527)	(0.527)
ln MA_OTRI_i							-0.351	-0.369**	-0.401**	-0.411**
							(0.245)	(0.162)	(0.161)	(0.161)
ln $OTRI_j$								-0.347	-0.278	-0.375
								(0.243)	(0.242)	(0.252)
$comborder_{ij}$									1.646***	1.761***
									(0.573)	(0.579)
$satellite_i$										-0.693*
										(0.507)
Constant	1.715	13.47***	-9.134**	-9.112**	-8.470**	-7.016*	-8.952*	-10.74**	-12.68**	-15.32***
	(1.819)	(3.512)	(3.851)	(3.859)	(3.704)	(3.865)	(4.926)	(4.957)	(4.947)	(5.304)
Observations	322	322	322	322	322	322	322	322	322	322
R-squared	0.090	0.131	0.332	0.332	0.387	0.391	0.392	0.401	0.417	0.420
Standard errors in parentheses										
*** p<0.01, ** p<0.05, * p<0.1										

Table 4. Determinants of Export Intensity. Landlocked Countries

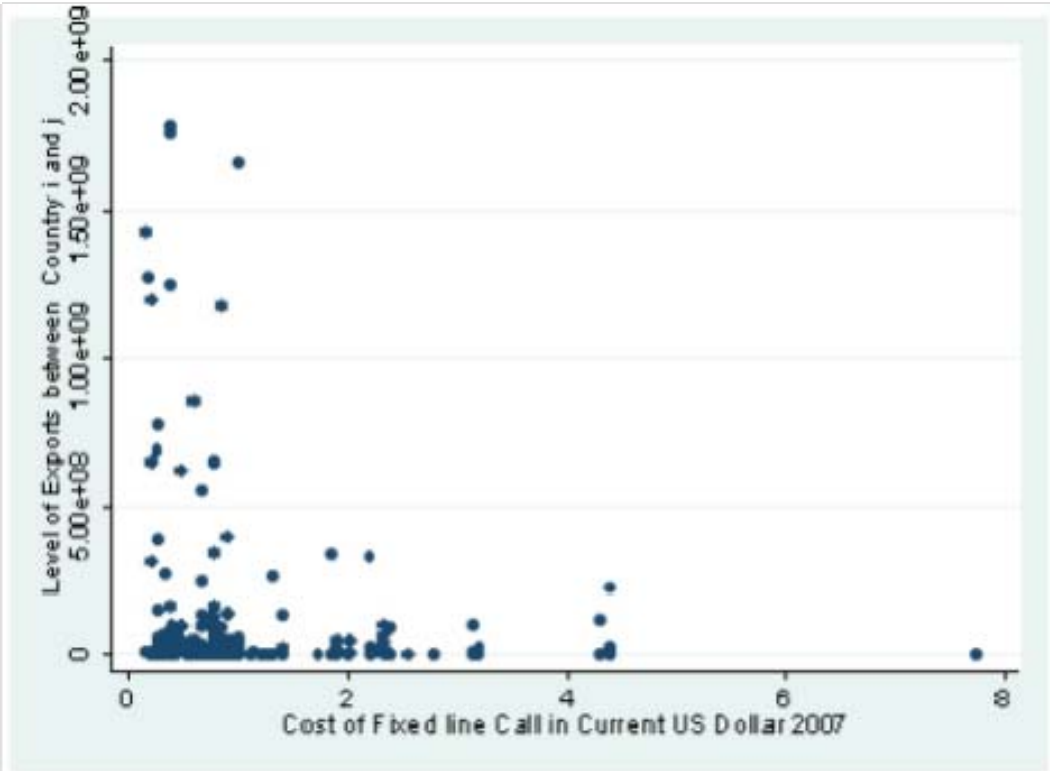
	Landlocked									
$lnXintensity$	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
$lnDist_{ij}$	-2.605***	-2.276***	-2.408***	-2.474***	-2.467***	-2.498***	-2.678***	-2.637***	-1.965***	-1.965***
	(0.471)	(0.404)	(0.409)	(0.418)	(0.411)	(0.422)	(0.419)	(0.427)	(0.478)	(0.478)
$lnGDP_j$		0.875***	0.862***	0.868***	0.884***	0.885***	0.887***	0.904***	0.866***	0.866***
		(0.139)	(0.138)	(0.138)	(0.137)	(0.137)	(0.134)	(0.138)	(0.134)	(0.134)
$lnGDP_i$			0.622	0.440	-0.130	-0.180	-0.501	-0.496	-0.712	-0.712
			(0.384)	(0.446)	(0.524)	(0.544)	(0.547)	(0.549)	(0.536)	(0.536)
$lnOutgoing_i$				0.240	1.115**	1.142**	1.563***	1.542***	1.404**	1.404**
				(0.297)	(0.527)	(0.534)	(0.549)	(0.553)	(0.536)	(0.536)
$lnBband_i$					-0.657**	-0.714*	-0.742**	-0.709*	-0.599*	-0.599*
					(0.329)	(0.367)	(0.358)	(0.364)	(0.354)	(0.354)
$lnFixed_{ij}$						-0.268*	-0.357*	-0.345*	-0.329*	-0.377**
						(0.207)	(0.563)	(0.559)	(0.553)	(0.682)
$lnMAOTRI_i$							-0.859**	-0.866**	-0.797**	-0.797**
							(0.354)	(0.356)	(0.345)	(0.345)
$lnOTRI_j$								-0.172	-0.206	-0.206
								(0.303)	(0.293)	(0.293)
$comborder_{ij}$									2.269***	2.269***
									(0.818)	(0.818)
$Satellite_i$										(dropped)
Constant	9.383**	26.77***	13.60	14.31	16.78*	18.05*	21.42**	21.34**	21.21**	21.21**
	(3.583)	(4.111)	(9.102)	(9.160)	(9.108)	(9.808)	(9.669)	(9.704)	(9.376)	(9.376)
Observations	103	103	103	103	103	103	103	103	103	103
R-squared	0.233	0.451	0.465	0.468	0.489	0.490	0.520	0.521	0.558	0.558
Standard errors in parentheses										
*** p<0.01, ** p<0.05, * p<0.1										

Most important for the study is the result that cost of international fixed line calling and cost of broadband seem to be negatively associated with the intensity of exports from country of origin (See table 2). Further research will be required to verify this result. The costs of international calling in Africa are associated with the use of foreign operated satellite and fiber gateways. This result would imply that any reorganization of these international gateways to bring down the cost of international calling and broadband connections should have a positive effect on exports within SSA.

There seems to be a negative effect of cost of broadband on coastal regions in spite of the presence of fiber optic cable on the west coast of Africa. This would indicate that although the fiber optic cable is present it may not be as accessible as it is meant to be, leaving coastal countries with no option but to connect via satellite. The satellite dummy turns up negative and significant. It will be interesting to note how this dynamic will change with the arrival of more competition in the fiber business on the coast and the rollout of inland fiber networks in SSA.

Figure 1 shows the scatter plot for SSA. Exports are generally very low in countries with high calling rates per minute. The scatter plot shows a clear pattern of high bilateral call charges and low exports and a general trend of low bilateral calling charges and high exports. Although we have a lot of countries in the low cost/low export area of the plot, we do not have a single country in the high cost/high export area of the plot. This pattern is consistent with the regression results in the preceding tables, which show a negative significant coefficient for communication costs generally.

Figure 1. Level of Exports and International Calling Charges in SSA (2007)



Source: Own graph from the compiled data

These findings seem to suggest a possible relationship between affordable connectivity and export intensity of a country in SSA. Apart from the gravity tendency being confirmed in the regression results (negative and significant coefficients on distance in tables 2, 3 and 4) most countries seem to exhibit this tendency in the descriptive graphs as well (Annex 3).

Care should however be taken to note the low R-squared values of the regressions, 0.49 for all countries in the sample. This means that only about 49% of the variations in export intensity can be explained by the independent variables, all things being equal. It is therefore advisable to take the results as indicative findings warranting further research and analysis rather than conclusive findings.

Concluding Remarks

Adding variables representing the cost of international connectivity to a traditional gravity equation, we find that international communication costs have a significant negative effect on the volume of trade in SSA. This implies that efforts aimed at reducing the cost of international communications in Africa may contribute to the

reduction of trade friction between SSA countries and the increase in export intensity among SSA countries. A review of the secondary literature in Mupela (2011) indicates that increased trade has a positive effect on growth. Thus expansion of trade through reduced communication costs will indirectly contribute to economic growth in SSA.

Given present market conditions, the indirect effect of the existing infrastructure of satellites and optical fiber gateways is negative because it results in high international calling rates and high broadband connectivity costs. This study provides a foundation for arguments for local African investments in both technologies and development of policies that will reduce international communication costs across the board in Africa.

Annexes

Annex 1

Data Summary

Variable	Obs	Mean	Std. Dev.	Min	Max
$Xintensity_{ij}$	641	0.0227435	0.464593	0	11.75579
GDP_i	641	3.36e+10	2.01e+11	5.75e+10	7.35e+08
GDP_j	641	1.73e+10	4.00e+10	797	2.83e+11
$Exports_{ij}$	641	1.78e+09	3.89e+07	0	1.80e+08
$Fixedline_{ij}$	641	1.404949	1.161086	0.1466667	7.764706
$Bband_i$	641	524.8855	766.7209	29.08	2674.25
$Dist_{ij}$	641	3291.001	2044.464	84.117	17578.84
$Outgoing_{ij}$	641	7.94E+07	1.33E+08	2256900	5.15E+08
MA_OTRI_i	641	0.2019516	0.0993664	0.012	0.49
$OTRI_j$	641	0.5667207	0.5845199	0.043	11

Annex 2

The Correlation Matrix

Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	1(8)	(9)	(10)	(11)	(12)
$lnXintensity_{ij}$(1)	1											
ln $Dist$(2)	-0.3871	1										
ln GDP_i(3)	0.3559	0.1048	1									
lnGDP_j(4)	0.3163	0.0143	-0.0077	1								
ln $Outgoing_i$(5)	0.2609	0.1143	0.7801	0.0004	1							
ln$Fixedline_{ij}$(6)	-0.2027	0.0259	-0.0505	-0.0270	-0.0758	1						
ln$Bband_i$(7)	-0.1451	-0.0511	-0.145	0.0226	0.0334	0.1555	1					
lnMA_OTRI_i(8)	-0.0498	0.0688	-0.3164	-0.0233	-0.3988	0.2285	-0.3425	1				
ln$OTRI_j$(9)	0.1320	0.0029	0.0052	-0.2685	0.0424	0.0511	-0.0059	-0.0053	1			
commonborder$_{ij}$(10)	0.2864	-0.4685	-0.226	0.0363	-0.0583	-0.0874	0.0084	-0.0108	-0.0440	1		
satellite$_i$(11)	-0.2432	0.0100	-0.3427	-0.0002	-0.2466	0.1511	0.2445	0.0263	0.0033	0.0432	1	
landlocked$_i$(12)	-0.2190	-0.0217	-0.3809	0.0094	-0.3353	0.0823	0.3182	-0.0492	-0.0305	0.0358	0.7814	1

Annex 3

More examples of gravity tendencies among SSA countries

Figure 3. Distance from Kenya (top), Angola (bottom) to other African Countries and Level of Exports.

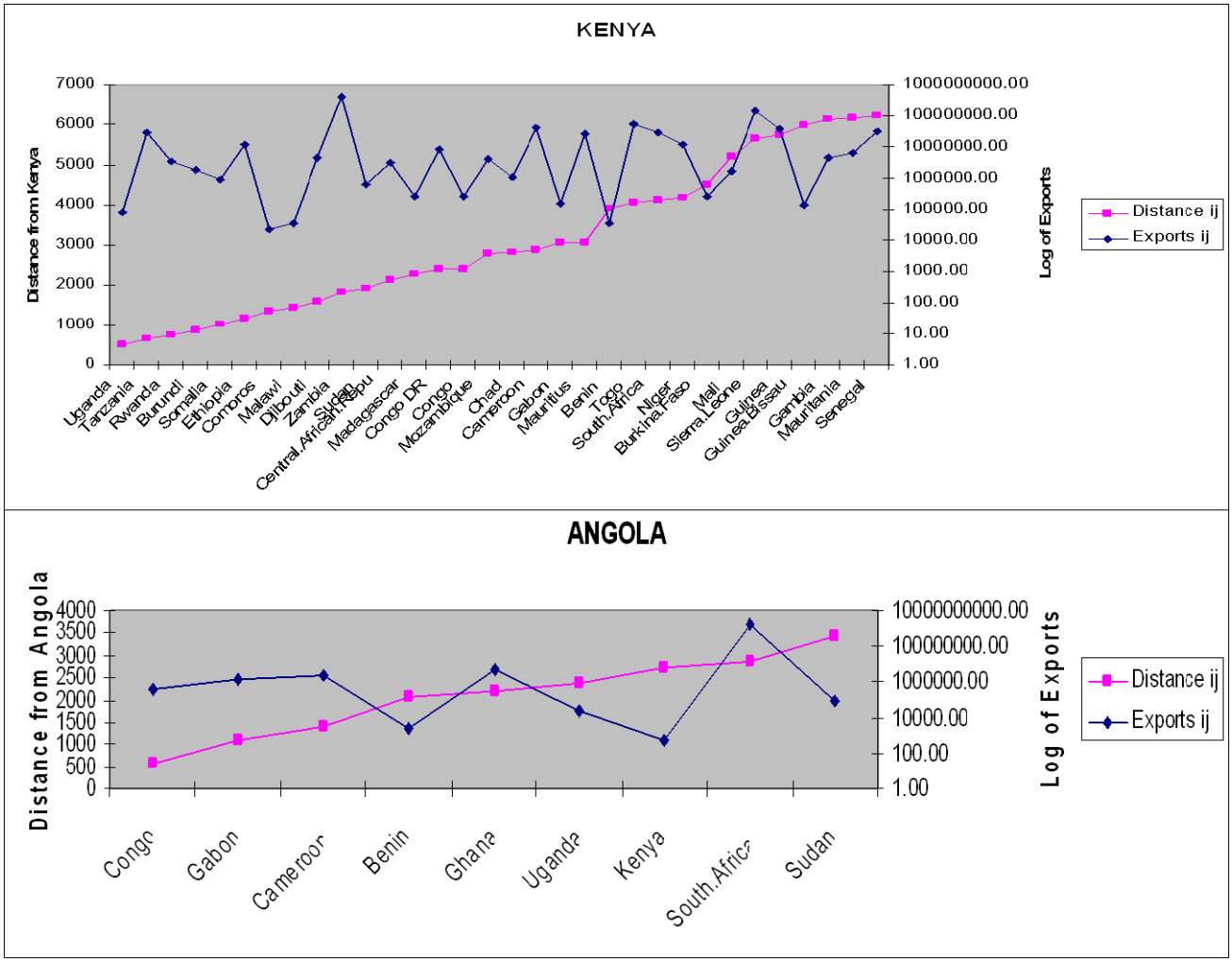


Figure 4. Distance from Togo (top), Namibia (bottom) to other African Countries and Level of Exports

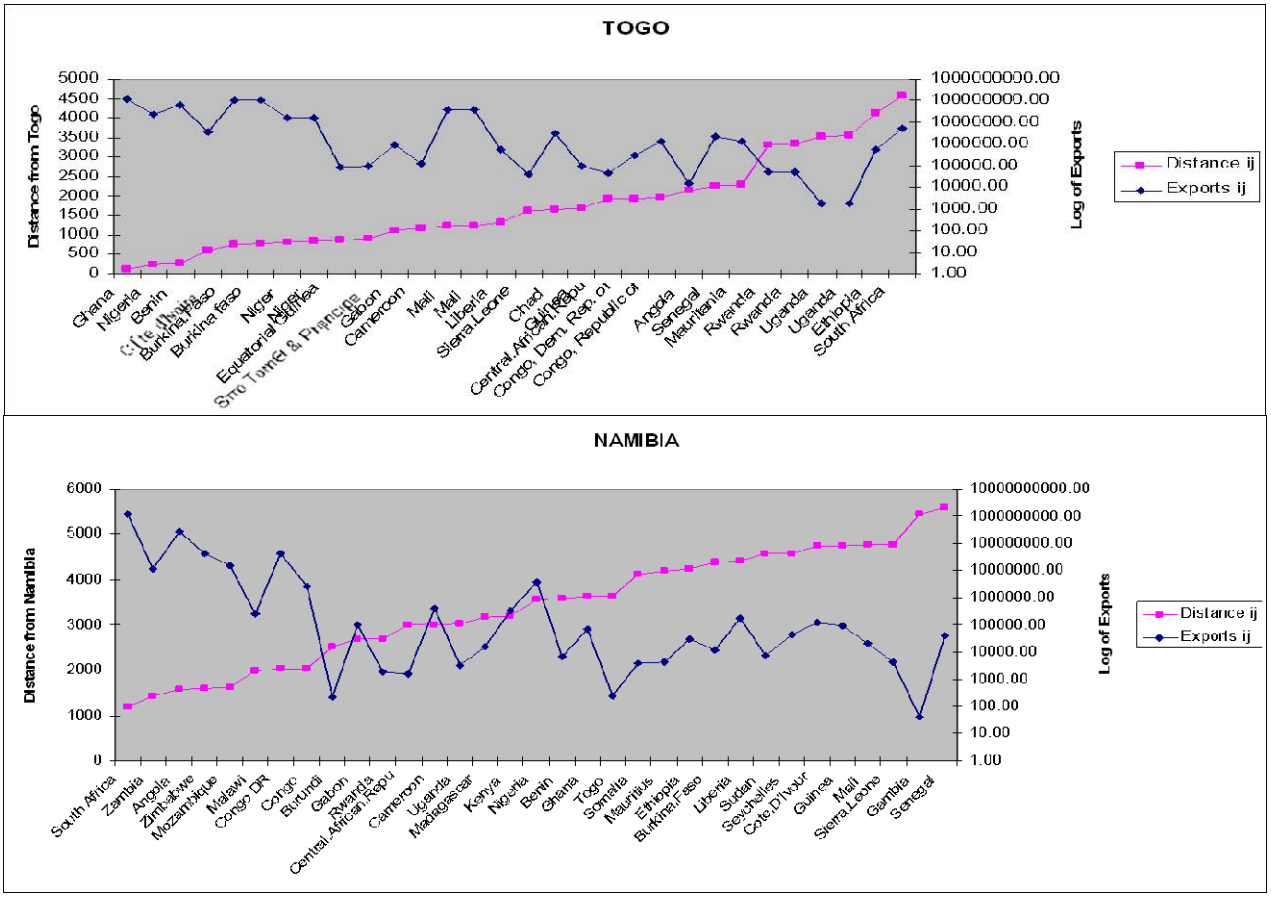


Figure 5. Distance from Cote d'Ivoire (top) Malawi (bottom) to other African Countries and Level of Exports

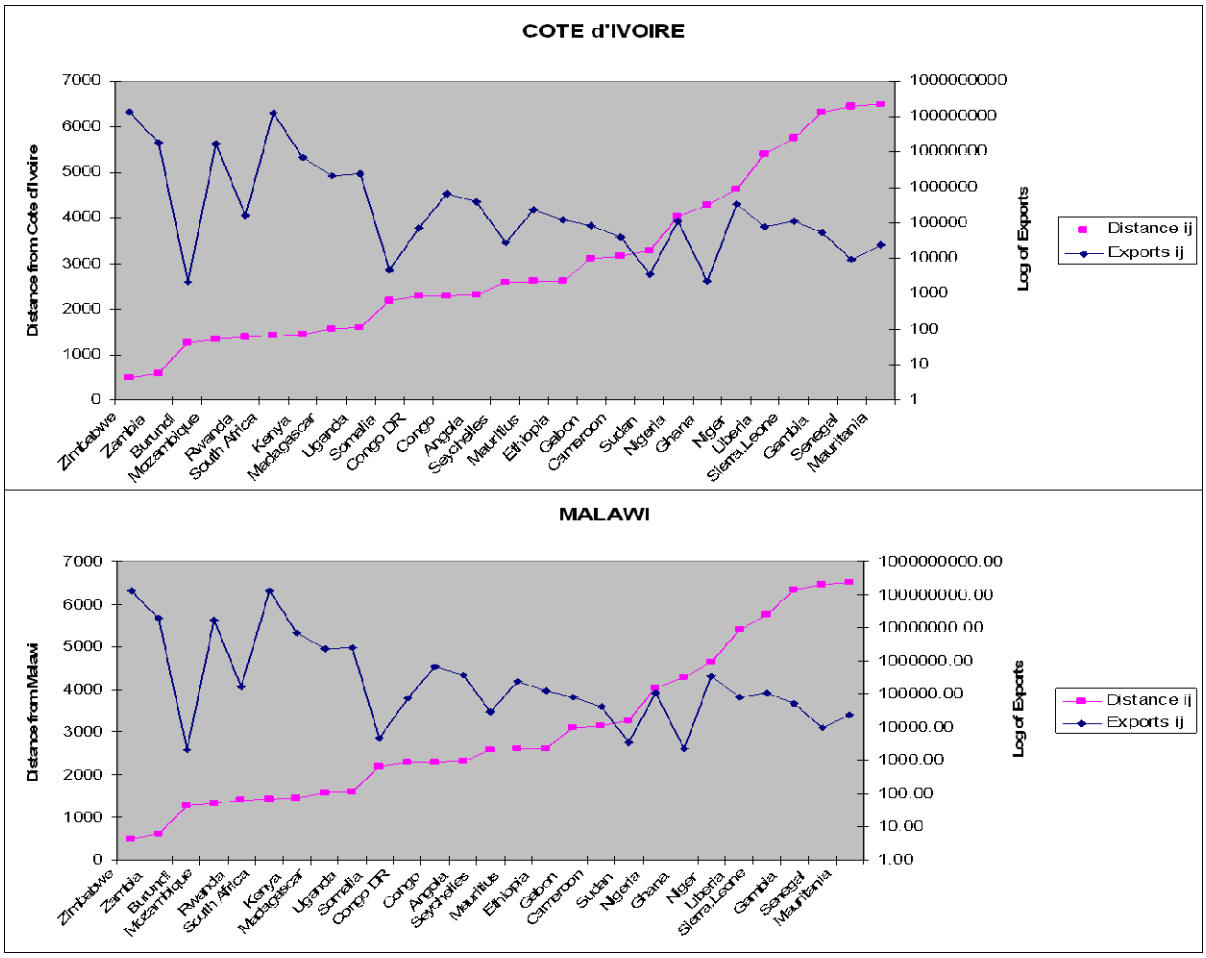
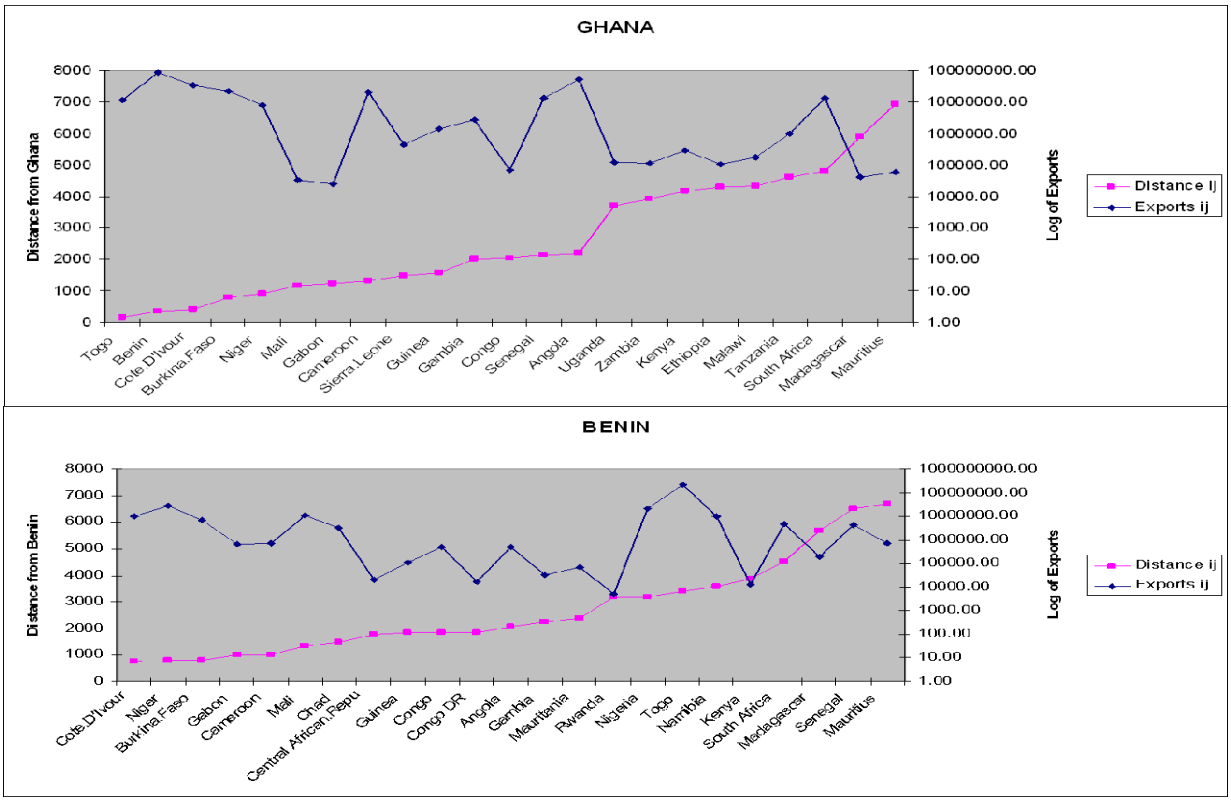


Figure 6. Distance from Ghana (top) Benin (bottom) to other African Countries and Level of Exports



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