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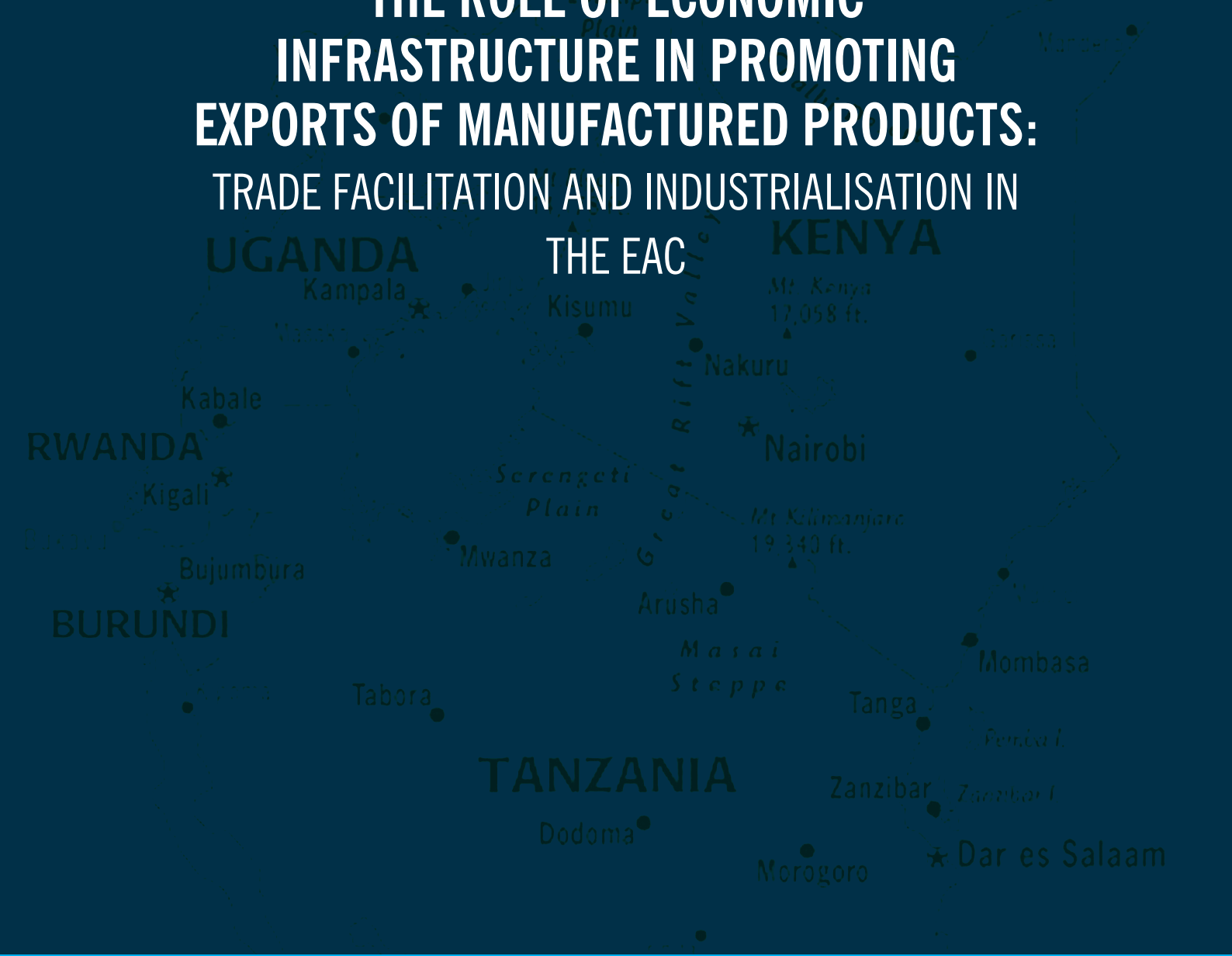
THE ROLE OF ECONOMIC INFRASTRUCTURE IN PROMOTING EXPORTS OF MANUFACTURED PRODUCTS:

TRADE FACILITATION AND INDUSTRIALISATION IN THE EAC



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ABSTRACT

The paper estimates the impact of economic infrastructure on the exports of manufacturing products for the East African Countries, specifically, Uganda, Tanzania and Kenya. It departs from the literature that looks at infrastructure and development in general to facilitation of exports of manufactured products. An augmented gravity model is used to estimate the elasticities through which the proportion of economic infrastructure development required to generate a given proportion of exports of manufactured exports is calculated. Data used covers the period from 2001-2014 and is drawn from various sources including: COMTRADE, WEF, WDI and CEPII. Results provide evidence that that improvement in economic infrastructure generates huge gains in terms of export of manufactured exports; and there are more gains from hard infrastructure compared to soft infrastructure. Therefore the electricity, rail, road, airports infrastructure is paramount in boosting exports of manufactured products in the EAC region. It emerges that, transparency and accountability, internet connectivity and telephone subscription improve the efficiency and business environment which support the exportation of manufactured products. It is concluded that the mobilization of resources for investment in economic infrastructure to promote exports of manufactured products is inevitable for the EAC region.

Key words: *Soft, hard, infrastructure, exports gravity, manufacturing, trade, facilitation, elasticity and industrialisation*

1. INTRODUCTION

Infrastructure forms the basic physical systems that countries rely on to foster development. A number of definitions for infrastructure do exist; among which are social, economic, hard and soft. This paper defines economic infrastructure as infrastructure that promotes economic activity, such as roads, highways, railroads, airports, sea ports, electricity, telecommunications, water supply and sanitation (Fourie, 2006). Most infrastructure has both economic and social components and in fact social services like schools and hospitals as well as businesses and enterprises often benefit from economic infrastructure as well. However, with a focus on industrialisation, this paper specifically looks at the economic components of infrastructure as defined by Fourie (2006); components which directly impact commerce, manufacturing, trade etc. This infrastructure plays a positive and significant role in the growth performance of countries to the extent that countries that have developed economic infrastructure have reaped significant benefits and the opposite is true. For the purposes of trade, in an international environment where tariffs are declining, trade facilitation[1] has been salient in policy debate as the next key option to reduce trade costs in developing countries. This arises from the fact that non-tariff barriers and costs have taken centre stage in increasing the cost of doing business and impeding the flow of imports and exports for Africa. Infrastructure development is therefore key in the process of reducing the identified costs of doing business on the continent.

Quality infrastructure and infrastructure services are well recognised as fundamental elements of productivity and economic growth (Calderon and Serven, 2004, 2014). Investments and improvements in infrastructure can significantly lower production and transaction costs, thereby increasing competitiveness and expanding market access (Yogo and Verdier-Chouchane, 2015). The work of Portugal-Perez and Wilson (2012) quantifies infrastructure and categorizes it into hard and soft infrastructure in the realm of trade facilitation. Accordingly, hard infrastructure covers ports, airports, roads and rail lines– all critical for connecting a country internally and to the outside world. On the other hand, soft infrastructure constitutes border and logistics management (shipping, air transport, and telecommunications and business environment). This work constructed four new indicators, covering 112 countries over the 2004-2007 period, and conducted an estimation which demonstrated the kind of trade facilitation required to improve the export performance of developing countries. Table 1 presents estimates drawn from Portugal-Perez and Wilson (2010) where the authors use a standard gravity model to simulate the impact of these indicators on trade facilitation and export growth. The results suggest spectacular potential trade gains which indicate that improvement in trade facilitation increases the chances of boosting merchandise exports. With trade facilitation improving, the gains for the regions were equivalent to US$ 1.137billion.

Table 1: Estimated gains from trade facilitation improvements to merchandise exports

Region	Export gains (U$ billion)	Export gains (percentage)
East Asia	534	19.8
East Europe and Central Asia	202	16.7
Latin America and Caribbean	301	29.5
Middle East and North Africa	30	20.0
South Asia	10	2.9
Sub-Saharan Africa	60	27.0
Total	1,137	19.7

Source: Portugal-Perez and Wilson (2010).

The Sub-Saharan Africa (SSA) region which is the most infrastructure deficient makes export gains of 27 percent although the monetary gains in exports is only US$ 60billion- a smaller value in comparison to other regions. This is a suggestive and compelling

1 Trade facilitation is broadly defined as the set of policies aimed at reducing export and import costs

illustration that improving infrastructure increases the chances of increasing exports. In essence –as seen with Gutman *et al.,* (2015) - adequate infrastructure is very crucial and potentially transformational for SSA than other regions. The authors reveal that in in 2009, the World Bank, major donors and multilateral institutions investigated this challenge of addressing the region's infrastructure gap and estimated that the region needed US$93 billion annually to fill the infrastructure gap. Table 2 illustrates the regional transaction costs in international trade arising from deficiencies in soft infrastructure.

Table 2: Selected transaction costs in international trade, regional averages in 2016 (per container)

Region	Time to export: Border compliance (hours)	Cost to export: Border compliance (USD)	Time to export: Documentary compliance (hours)	Cost to export: Documentary compliance (USD)
European Union	8	95	1	16
East Asia Pacific Islands	64	509	72	253
East African Community	70	376	68	166
Sub-Saharan Africa	108	542	97	246

Source: Compiled from Doing Business Database (Reports, 2016)

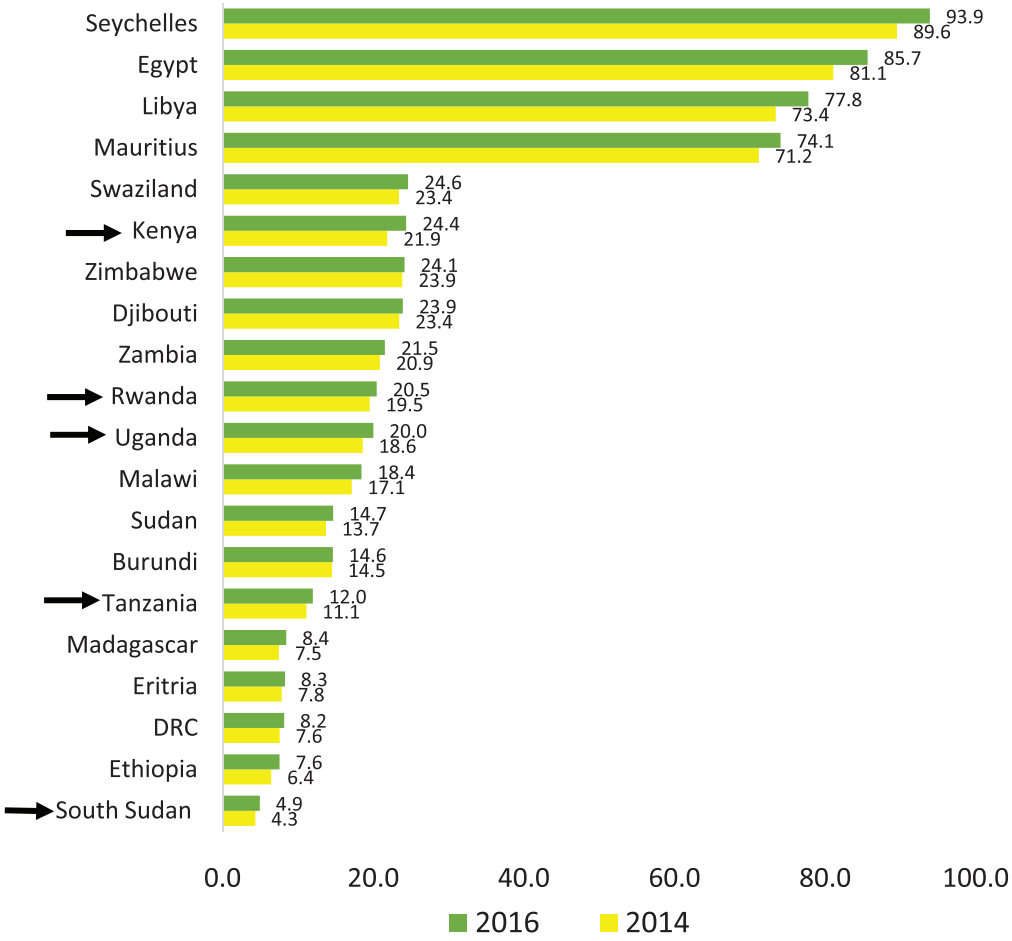
SSA and South Asia have the largest number of documents and days to export. However, in terms of the costs incurred to export, SSA region comes after East Asia Pacific Islands per container. When it comes to time to export and the accompanying compliance costs, the SSA region has the highest followed by the EAC region. Although the EAC region is not the worst in all these cases, it remains well behind the EU.

In essence, one of the largest constraints to intra-African trade is inadequate infrastructure. Given that traditional trade barriers such as tariffs have significantly come down, trade facilitation reforms that address other impediments to trade in goods and services become even more important. It is argued that international trade can be made more efficient (less costly and less time consuming) if countries remove complex and redundant administrative processes that affect trade, for example, customs, the mobility of business people, payments and insurance, and standards and conformance. Following from this, trade facilitation is a mainstay of a number of international forums, including the World Trade Organization (WTO), the United Nations Conference on Trade and Development (UNCTAD), the World Customs Organization (WCO) as well as Asia-Pacific Economic Cooperation (APEC).

The African Development Bank (ADB) produces the African Infrastructure Development Index to: monitor and evaluate the status and progress of infrastructure development; enhance the process of resource allocation; and contribute to policy discourse. The index is composed of; transport, electricity, Information Communications Technology (ICT) and water and sanitation. The index ranges from 1 to 100. Figure 2 illustrates that much of the SSA is trailing at the bottom with the EAC countries hardly reaching 25.

At the continental level, the drive to industrialize has taken centre stage in the development debate. UNECA (2015) argues that trade is essential to spur African growth particularly through trade induced industrialisation; to this end, UNECA (2014) fronts the role of industrial policy in this process. Similarly, industrial policies and strategies have been developed at the regional economic community level in addition to national level efforts. All these initiatives recognize the lack of or poor quality of infrastructure as a major impendent responsible for the stagnation of intra-African trade at less than 15 percent, a figure that may not be conducive to industrialisation. Although industrialisation is broad and encompasses

Figure 1: African Infrastructure Development index, 2014 and 2016



Data source: AfDB 2016: The African Infrastructure Development index 2016

construction, mechanisation, manufacturing, water and electricity infrastructure etc. This paper uses manufacturing as a proxy for industrialisation because manufacturing generally entails most of the other elements that constitute industrialisation.

The East African Community (EAC) being part of the SSA region is not an exception to the infrastructure deficiency trend. The EAC has recognized infrastructure development as a priority and strategic focus area that requires special attention. The strategic objective to be pursued, therefore is, to effectively address constraints related to the improvement of infrastructure and services in the region in order to reduce the cost of doing business and to enhance competitiveness, through fostering physical regional connectivity and deepening infrastructure integration. A holistic and corridor based approach to infrastructure development was adopted based on three key pillars i.e. policy and regulatory harmonization, development of priority regional physical infrastructure covering transport, ICT and energy. The transport sector covers civil aviation, surface transport (covering road and rail) and water transport covering maritime and inland water transport subsectors. The ICT comprises telecommunications, broadcasting and postal services subsectors, whilst energy covers electricity, fossil fuels and renewable energy subsectors. The development and improvement of these is expected to enhance trade facilitation in the region and spur industrialisation.

Based on the above background, this paper makes a contribution by estimating the impact of improving economic infrastructure in the EAC region on exports of manufactured products. The paper departs from most analyses in the literature that look at the impact of

infrastructure (trade facilitation) on exports in general and specifically delves into exports of manufactured goods. This is because most literature on infrastructure focuses on development in general leaving a gap. Thus, the paper focuses on the role of economic infrastructure on the proportion of manufactured exports from the EAC region. In this way the paper makes an empirical contribution in assessment of the role of economic infrastructure in promoting manufactured exports in the EAC region.

The remaining part of the paper is organised as follows: Section II presents the status and development plans for the EAC regional infrastructure. Section III examines the literature related to the role of infrastructure in development. Section IV gives the analytical framework, the methods used and the estimation procedure in general. Section V is the presentation and discussion of the results. Finally section VI concludes the paper and makes some recommendations.

2. INFRASTRUCTURE STATUS AND DEVELOPMENT IN THE EAC REGION

Infrastructure is one of the key building blocks for regional integration because of its role in facilitating communications, trade, Industry, agriculture, tourism and the movement of labour. As such, the treaty for the establishment of the EAC recognises the provision of basic infrastructure as one of the operational principles of the community. This section provides the current state of infrastructure development in the EAC region pointing out the plans, implementation status and existing gaps.

2.1 Transport Infrastructure:

The transport systems in the coastal countries (Kenya and Tanzania) are a vital transit linkage for the landlocked countries (Uganda, Rwanda, Burundi, Ethiopia, South Sudan and the Democratic Republic of Congo (DRC)) in the broader East African region. In a bid to lower the high transportation costs, the Member states of the EAC have undertaken various sector reforms. With a view to support and regulate infrastructure development, a number of Tripartite Agreements concerning road transport and inland waterway transport on Lake Victoria have been reached. The EAC 2010-15 Transport Strategy has a specific focus on railways, having identified a number of related obstacles to trade integration. On the whole, the strategy lists up to 247 projects in all transport modes that will cost up to US$21 billion (EAC, 2011).

2.1.1 Road transport

The EAC currently has two main transit corridors that support the trade activities in the region: (i) The northern corridor; stretching 1,700 km from the port of Mombasa in Kenya; serves Kenya, Uganda, Rwanda, Burundi South Sudan and Eastern DRC. (ii) The central corridor; starting at the port of Dar es Salaam in Tanzania, is 1,300 km long and serves Tanzania, Zambia, Rwanda, Burundi, Uganda and Eastern DRC. The EAC road infrastructure development plan highlights and identifies a total of five transport routes or corridors covering up to 12,000 km that will be upgraded and revitalised. These are:

- Mombasa (*Kenya*)–Malaba (*Kenya-Uganda border*)–Kigali (*Rwanda*)–Bujumbura (*Burundi*);
- Dar es Salaam (*Tanzania)*–Rusumo (*Tanzania-Rwanda border*) with branches to Kigali, Bujumbura (*Burundi*) and Masaka (*Uganda);*
- Biharamulo (*Tanzania)* – Sirari (*Tanzania-Kenya border*) – Lodwar (*Kenya*) – Lokichogio (*Kenya*)- eventually continuing into South Sudan;
- Nyakanazi (*Tanzania)* – Kasulu (*Tanzania)* – Tunduma (*Tanzania)* with a branch to Bujumbura; and
- Tunduma (*Tanzania)* – Dodoma (*Tanzania)* – Namanga (*Tanzania-Kenya border*) – Isiolo (*Kenya*) – Moyale (*Kenya*)- eventually continuing on to Ethiopia.

These corridors are also part of a large chain of transit and trade facilitating road networks in the COMESA

region and Africa as a whole. The Northern Corridor which starts in Mombasa and ends in Bujumbura is part of the Mombasa – Lagos Trans-African Highway. In addition the road from Tunduma to Moyale is part of the Cape to Cairo Highway. The development of these corridors is supported through initiatives and projects like the East African Trade and Transport Facilitation Project (EATTFP) and the East African Road Network Project (EARNP).

2.1.2 Railway transport

After road transport, railway transport is the most important mode for long distance freight and haulage across the EAC region. The biggest development in this sector has been the upgrading of the current railway tracks to a Standard Gauge Railway (SGR). Under the East African Railways Master Plan, the SGR project will primarily follow the northern corridor from Mombasa to Malaba with a spur to Juba and to Kigali and ultimately to Bujumbura. Table 3 gives some statistics on the number of stations, the passenger numbers and most importantly, the volume of cargo from the existing rail infrastructure over the last 8 years. There has been limited investment in new routes making the number of stations stagnant for close to a decade for Kenya and Tanzania. Uganda has a dysfunctional railway network and Rwanda and Burundi do not have any at all.

In terms of passengers, both Kenya and Tanzania initially experienced an overall increase from 2006 to 2009 and thereafter, a steady decline suggesting that railway transport for passenger movement has been on the decline in the region. For the EAC Member states, specifically Uganda, Tanzania and Kenya, the trends fluctuate without any particularly discernible pattern. This suggests that even though the volume of cargo has generally increased over the years, the proportion transported by railway has not; implying that there is increasing reliance on road transport (for cargo) which is considerably more expensive and time consuming. Among the three countries Kenya has the largest volume of cargo ferried by rail followed by Tanzania with Uganda trailing.

Overall, the statistics suggests that unless major investments are made, the usage of railways for cargo and passenger handling will continue to decline. However, the advent of the Standard Gauge Railway is expected reverse this trend.

2.1.3 Air transport

Air transport is critical to the movement of perishable, non-bulky and high value exports like flowers and fish. Furthermore, air transport plays a significant role in the development of the tourism sector, especially for

Table 3: Access to rail transport facilities/services

	Country	2006	2007	2008	2009	2010	2011	2012	2013	2014
Stations (number)	Tanzania	216	216	216	216	216	216	216	216	216
	Kenya	172	172	172	172	172	172	172	172	172
Passengers ('000)	Tanzania	1,484	1,635	1,506	1,540	1,057	1,306	1,298	1,027	1,130
	Kenya	4,348	4,500	3,226	8,861	3,411	6,004	4,077	4,016	3,845
Volume of cargo	Tanzania	1,376	1,084	1,033	836	779	631	1,383	1,196	1,128
('000 tonnes)	Uganda	645	624	585	460	645	680	536	473	-
	Kenya	1,891	2,304	1,628	1,532	1,572	1,596	1,394	1,214	1,509

Source: EAC Member States (EAC Facts and Figures 2015)

Notes: - Stands for missing data; also cargo information for Rwanda and Burundi is not available

international arrivals and their movement within the region. Air transport is the most underdeveloped part of the transport sector in the region (Table 4).

Table 4: Access to air transport, number of airports and aerodromes

	Country	2006	2007	2008	2009	2010	2011	2012	2013	2014
Airports	Burundi	1	1	1	1	1	1	1	1	1
	Tanzania	3	3	3	3	3	3	3	3	3
	Uganda	1	1	1	1	1	1	1	1	1
	Kenya	4	4	4	4	4	4	4	4	4
	Rwanda	2	2	2	2	2	2	2	2	2
	East Africa	11	11	11	11	11	11	11	11	11
	Burundi	1	1	1	1	1	1	1	1	1
	Tanzania	59	59	59	59	59	59	59	59	59
Aerodromes	Uganda	45	54	54	54	54	54	54	54	54
	Rwanda	3	3	3	3	3	3	3	3	3

Source: EAC Member States (EAC Facts and Figures 2015)

With the exception of Kenya that has 4 international airports, Tanzania with 3, and Rwanda with 2, Uganda and Burundi only have one. Improvements and increases in the existing stock help to facilitate the movement of goods and persons within and outside the region. This can draw from the large number of aerodromes existing in EAC Member states. There are plans to develop aerodromes into national and international airports but this is yet to be realized.

2.2 Communication infrastructure

The main ICT indicators currently available on a regular basis are related to fixed telephones, mobile subscriptions, and the number of radio and television stations. Communication services are dominated by mobile phone technology and mobile phone ownership has increased significantly across the region with Kenya having the highest proportion of the population owning mobile phones. Encouragingly, the number of internet hosts per 1000 persons has also steadily been on the rise. This is keeping in tandem with the spectacular growth in broadband ICT infrastructure in the EAC, largely attributed to the connections to four under-sea cables (EASSY, SEACOM, TEAMS and LION 2) on the East African Coast. This was achieved through the EAC Broadband ICT Infrastructure Network (EAC-BIN) which aims to establish and operate a cross-border broadband infrastructure network within the EAC. Table 5 gives the mobile cellular subscription per 100 persons and secure internet servers per 1 million persons.

Over the years, there has been a tremendous increase in mobile phone subscriptions going from as low as less than ten to over 50 in every 100 persons for Kenya, Rwanda, Tanzania and Uganda. Even though Burundi lags behind the rest of the EAC Member states, it has experienced significant increases in mobile phone subscriptions.

Although the EAC region has significant mobile cellular subscriptions, the use of internet is still low by international standards, with Kenya leading followed by Rwanda, Uganda, Tanzania and Burundi. This is an area that needs a lot of attention in a world where communication is leading trade and commerce to new frontiers.

2.3 Electricity

Electricity generation and consumption is a very critical indicator of industrialisation world over. Countries with high per capita consumption of electricity are likely to be more industrialised than those with lower per capita consumption. However, consumption of given

Table 5: Access to communication services

Country	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Mobile cellular subscriptions (per 100 people)										
Burundi	2	2	3	6	10	18	20	23	25	30
Kenya	13	20	30	42	49	61	67	71	72	74
Rwanda	2	3	6	13	23	33	40	50	57	64
Tanzania	8	14	20	31	40	47	55	57	56	63
Uganda	5	7	14	27	29	38	48	45	48	52
Secure Internet servers (per 1 million people)										
Burundi	0.1	0.1	0.2	0.1	0.2	0.2	0.1	0.3	0.3	0.6
Kenya	0.3	0.5	0.8	1.1	1.3	2.6	3.2	4.2	4.9	7.8
Rwanda	-	-	-	0.3	0.6	0.7	0.9	2.1	2.7	3.9
Tanzania	-	0.0	0.1	0.2	0.2	0.4	0.5	0.7	1.1	1.5
Uganda	0.0	0.1	0.1	0.2	0.3	0.9	1.5	1.5	1.2	1.6

Source of data: WDI

Notes: - Stands for missing data

levels of electricity is partly a function of generation with few exceptions of importation. Throughout the EAC, installed capacity for electricity generation has been increasing and has actually doubled for thermal electricity generation (Table 6). These increases are in line with vast investments made in electricity generation infrastructure in the EAC region. Hydro-electric generation is the main source of power and while its installed capacity in the EAC has increased over the ten year period from 1616 MW in 2003 to 2182 MW in 2013, the actual amount produced has been declining and was lower at 6409 GWh in 2013 compared to 7957 GWh in 2003. Compared to industrializing and more industrialised economies, the EAC regional electricity generation is extremely low and still requires massive investment.

Table 6: Installed Capacity (MW)

Indicator	Country	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Hydro	Burundi	32	32	32	32	32	32	32	32	32	32	32
	Tanzania	577	577	561	561	561	561	562	562	562	566	566
	Uganda	303	303	303	303	315	315	408	432	432	582	692
	Kenya	677	677	677	677	677	719	730	728	735	770	767
	Rwanda	27	27	27	27	42	42	42	51	57	57	71
	EAC	**1616**	**1616**	**1600**	**1600**	**1627**	**1669**	**1774**	**1805**	**1818**	**2007**	**2182**
Bagasse	Tanzania	-	-	-	-	-	-	3	3	20	20	20
	Uganda	-	-	-	-	-	12	17	17	17	17	36
	Kenya	-	-	-	2	2	2	2	26	26	26	22
Thermal	Burundi	-	-	-	-	-	6	6	6	6	6	6
	Tanzania	161	161	111	119	119	121	229	190	228	263	322
	Uganda	3	3	3	3	101	200	150	170	170	120	100
	Kenya	407	393	351	370	390	419	422	469	583	611	693
	Rwanda	7	15	25	30	12	13	33	33	33	33	33
	EAC	**578**	**572**	**490**	**522**	**622**	**758**	**839**	**867**	**1019**	**1032**	**1154**
Geothermal	Kenya	58	128	128	128	128	128	158	189	191	200	237

Source: East African Community Facts and Figures – 2014

Notes: - Stands for missing data

Table 7: Electricity Tariffs by Type of Customer, US dollar

Type	Country	2005	2006	2007	2008	2009	2010	2011	2012	2013
Commercial	Burundi	0.10	0.09	0.10	0.10	0.09	0.09	0.11	0.11	0.11
	Tanzania	0.08	0.08	0.08	0.10	0.10	0.09	0.10	0.14	0.14
	Uganda	0.12	0.16	0.23	0.23	0.19	0.19	-	0.19	0.19
	Kenya	-	0.12	0.13	0.13	0.13	0.13	0.16	0.15	0.14
	Rwanda	0.14	0.20	0.19	0.19	0.19	0.19	0.19	0.19	0.19
Medium Industrial	Burundi	0.10	0.10	0.10	0.10	0.09	0.09	0.09	0.08	0.08
	Tanzania	0.08	0.07	0.07	0.08	0.09	0.09	0.09	0.10	0.10
	Uganda	0.10	0.14	0.21	0.22	0.18	0.18	-	0.18	0.18
	Kenya	-	0.08	0.09	0.08	0.13	0.12	0.15	0.15	0.14
	Rwanda	0.14	0.20	0.19	0.19	0.19	0.19	0.23	0.23	0.23
Large Industrial	Burundi	0.06	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08
	Tanzania	0.06	0.06	0.06	0.08	0.07	0.07	0.07	0.08	0.08
	Uganda	0.04	0.07	0.11	0.11	0.09	0.09	-	0.12	0.12
	Kenya	-	0.07	0.07	0.07	0.13	0.12	0.15	0.14	0.13
	Rwanda	0.14	0.20	0.19	0.19	0.19	0.19	0.23	0.23	0.23

Source: East African Community Facts and Figures – 2014

Notes: - Stands for missing data

Electricity tariffs for commercial and industrial use have a bearing on the cost of production and therefore on the ability and capacity to manufacture goods. As illustrated in Table 7, while these tariffs remained relatively stagnant in Burundi and Tanzania during 2003-13, during the same period, the tariffs for large industrial users increased significantly in Uganda and Rwanda indicating that the latter have the highest tariff rates for industrial and commercial usage.

3. SURVEY OF LITERATURE

This section surveys the general literature on trade facilitation to primarily demonstrate the gap with regard to exports of manufactured exports within the EAC region. Trade facilitation principally seeks to ease the movement of exports and imports. It aims at facilitating goods to arrive at their final destination at a low cost and at a reasonably high speed. According to Portugal-Perez and Wilson (2012) trade facilitation is inherently multidimensional and is predominantly centred on the reduction of 'intra-border' and 'on-border' transaction costs beyond tariff cuts. Although a number of definitions of trade facilitation exist, Maur's (2008) definition[2] is all inclusive – "the simplification of the trade interface between partners". It is composed in a broad sense of compliance to government rules by traders, enforcement by authorities of these rules (including taxes), exchange of information, financing, insurance, ICT and legal services, transport, handling, measurement and storage. Therefore, trade facilitation looks at factors beyond the border like infrastructure, business climate among others, which may affect trade performance.

Economic infrastructure can be defined as the different factors that promote economic activity and does not exist for its own sake; these factors include but are not limited to roads, highways, railroads, airports, sea-ports, electricity, telecommunications, water supply and sanitation (Jimenez, 1995; Fourie, 2006). For that matter, research by Cooper (1999) as well as Calí and te Velde (2010) suggests that economic infrastructure has the greatest effect on the improvement of exports and competitiveness. There is evidence by Milner *et al.,* (2008) that exports and imports in some developing countries encounter time delays created

2 (Portugal-Perez and Wilson 2012)- "any policies or initiatives aimed at reducing the costs of trade". WTO - "the simplification and harmonization of international trade procedures" - http://gtad.wto.org/trta_subcategory.aspx?cat=33121.

by laborious administrative procedures which prevent local manufacturers from exporting time-sensitive products, and thereby discourage their production. Dominguez-Torres and Fosters (2011) study finds that infrastructure constraints in Cameroon are potentially responsible for about 42 percent of the productivity gap faced by firms.

Studies using varied methods suggest the existence of relationships between the state of economic infrastructure and the levels exports of manufactured products. Using a gravity model Soloaga *et al.* (2006) found that Mexico's unilateral improvements in trade facilitation measures had the potential to increase manufacturing exports by US$31.8 billion. Méon and Sekkat (2006) established a positive relationship between poor institutional quality and low-quality manufacturing exports. Specifically, the lack of transparency and existence of corruption were the most significant factors affecting the export of manufactured goods. Using a gravity model, Wilson *et al.,* (2004) investigated the relationship between trade facilitation and its impact on the trade of manufactured products. They concluded that benefits attained from unilateral trade facilitation reforms are significantly large, and the ensuing gains are distinctly realised in exports. Abe and Wilson (2008) investigate a series of "soft" infrastructure indicators like institutional processes and transparency, among others and conclude that a reduction in corruption and an improvement in transparency in the low performing APEC countries leads to higher gains in trade. Similarly, Levchenko (2007) finds that institutional differences across countries are key determinants of trade patterns, while Limão and Venables (2001) estimate that poor infrastructure accounts for up to 40 percent of expected transport costs for coastal countries and 60 percent for landlocked countries. In their investigation of ICT's effect on bilateral trade flows, Fink *et al.* (2005) found that even a 10 percent bilateral decrease in the cost of phone calls can yield an 8 percent increase in bilateral trade.

Nordås and Piermartini (2004) explore the role that quality of infrastructure (road, airport, port and telecommunication, and the time required for customs clearance) has on a country's trade performance. Their results suggest that poor quality of infrastructure increases the risk of damaging goods therefore increasing the cost of the whole transaction. With specific focus on Africa, Freund and Rocha (2011) found that transit delays have the biggest economic and most statistically significant negative effect on African exports. They establish that even a one-day reduction in the time spent on inland travel results in a 7 percent increase in exports. Likewise, Djankov *et al*., (2010) noted that on average, for every additional time that a given product is delayed prior to being shipped, trade is reduced by at least one percent. Even a small improvement in port efficiency is found to significantly reduce shipping costs (Clark *et al*., 2004). By the same token, USITC (2009) reports that shipment holdups, overcrowding and congestion at the ports in Kenya are reported to have hindered the ability of firms to acquire imported production inputs, resulting in production losses and higher production costs. Crucially though, Iwanow and Kirkpatrick's (2008) work establishes that policies directed at improving chosen indicators have a significantly bigger impact in African countries compared to the same policies implemented in the rest of the world regarding trade facilitation and manufacturing.

Although a number of estimation methods are used, the outcomes of the review do not significantly vary and suggest the significant role of infrastructure in increasing the quantities of exports. Overall, gravity model estimation dominates the methodologies employed in existing literature and this study adopts the same approach. Details about the estimation methods used by different authors are in Table A3 in the Appendix. More importantly there is a notable absence of studies that specifically address the role of infrastructure development in facilitating exports of manufactured products within the EAC region, and it is this gap which this paper seeks to address.

4. METHODS AND ANALYTICAL FRAMEWORK

4.1 Theoretical foundations of the gravity equation

Following the predominant methodology in literature this paper uses a gravity model specification to estimate the impact of economic infrastructure on exports of manufactured goods by the EAC Member states. This model was first used by Tinbergen (1962) and Poyhonen (1963) to assess and analyse international trade flows. The criticism against the model for lack of theoretical foundations of application to economic interchange and trade, even when it exhibited high statistical explanatory power has since been resolved after a lot of empirical work by many authors (Matyas *et al.* 2000). The arguments against the model were that: It lacked the ingredients of the prominent models of international trade, such as the Ricardian model, (differences in technology) and the Heckscher-Ohlin (HO) model (differences in factor endowments) as the basis for trade (UNCTAD and WTO, 2012). As noted in Shinyekwa (2015), this view does not hold anymore given the advancements made in the empirical work and literature (Krugman, 1980; Anderson, 1979; Bergstrand, 1985, 1989; Deardorff, 1995, 1998; Eaton and Kortum,2002; Helpman *et al*., 2008; and Chaney, 2008).

4.2 Gravitational model

The log-linear form of the gravity equation was used to estimate the role of economic infrastructure on exports of manufactured products from the EAC Member States using a panel regression analysis. We use the manufactured export trade flows as the dependent variable, in log form, from country *i* to country *j* at a given time *t* – 2001- 2014. The gravity equation demonstrates the relationship between the natural logarithm of the monetary value of trade between two countries and the log of their GDPs, a composite term measuring barriers and incentives to trade between them.

$$X_{ijt} = f\left(Y_{it}, Y_{jt}, D_{ij}\right) \qquad (1)$$

The standard gravity model explains bilateral trade flows (manufactured exports) as a function of the trading partners' market sizes and their bilateral barriers to trade. In this case, trade flows between countries are explained by their economic size (GDP), population, geographical distance and a set of dummies. The model specification follows conventional paths widely used in the literature, such as Tinbergen (1962), Poyhonen (1963), Eita (2007), and UNCTAD (2012). The general specification of the gravity model is expressed in equation (2).

$$ln(X_{ij})_t = b_0 + b_1 ln(Y_{ij})_t + b_2 ln(P_{ij})_t + b_3 ln(D_{ij}) + b_k(DUM_{ij}) + e_{ijt} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 2$$

Where:
The dependent variable $ln(X_{ij})_t$ is exports of manufactured products from the ith EAC Member State to the jth trading partners at time, t. $Ln(Y_{ij})_t$ is the GDP per capita income of an EAC Member State and the trading partners. $ln(P_{ij})_t$ are the populations of an EAC Member State and the trading partner's population, respectively. $ln(D_{ij})$, measures the distance between the two capitals of an EAC Member State and the trading partners; and $ln(DUM_{ij})$ is a set of dummies that assume value of one and zero, and e_{ijt} is the error term.

The other variables included to capture trade barriers are: transport costs captured by distance between countries; countries being islands, landlocked and border dummies to reflect that transport costs increase with distance following from Zarzoso and Lehmann (2003). It is *a prior* expectation that transport costs are higher for landlocked countries and islands, and are lower for neighbouring countries due to proximity. Furthermore, the model is augmented with information costs captured by a dummy for common language between the trading partners (Nordås and Piermartini, 2004). Accordingly, it is equal to one if

the trading partner is an island, landlocked, borders, has a common language with an EAC Member State, respectively, and zero otherwise.

Although distance has been traditionally used in the absence of transport costs, in this paper, we augument the model by introducing public and private infrastructure variables, such as electricity, telephony, roads, airports, internet, and seaports as espoused by Portugal-Perez and Wilson (2012). They predict a positive relationship between the level of infrastructure and the volume of trade.

$$ln(T_{ijt}) = b_0 + b_1 ln(Y_{ij})_t + b_2 ln(P_{ij})_t + b_3 ln(D_i) + b_4 (Documents_i)_t + b_5 ln(Time_i) + b_6 ln(Public_i)_t + b_7 ln(Telephone_i)_t + b_8 ln(Iternet_i)_t + b_9 ln(Electricity_i)_t + b_{10} ln(Roadinf_i)_t + b_{11} ln(Airinfra_i)_t + b_{12} ln(Portinfra_i)_t + b_{13} ln(Railinfra_i)_t + b_{14}(Lang_{ij}) + b_{15}(Contiguity_{ij}) + b_{16}(Locked_i) + b_{17}(Island_i + e_{ijt} \ldots\ldots 3$$

4.3 The data

The paper uses export trade data from the COMTRADE and World Integrated Trade Solutions (WITS) database which covers 70 countries that each of the EAC Member State exports to manufactured products. The distance data was extracted from the distance calculator website[3] which is defined as direct distance between the capital cities of a pair of trading partners without taking into consideration the actual routes by either forms of transport. World Bank World Development Indicators (WDI) is the source of the per capita income, population and manufactured exports data. The data on whether, a country is landlocked or not, is an island or not, borders a trading partner or not and has the same official language or not were extracted from the Centre d'Etudes Prospectives et d'Informations Internationales (CEPII)[4] gravity dataset. The analysis is done for the period 2001 to 2014. Finally, data on infrastructure quality was extracted from the World Economic Forum and doing Business on quality of infrastructure.

4.4 The estimation procedure

Following from (Eita, 2007), we adopted the Random Effects (RE) model as our preferred panel estimation procedure. Whereas the RE estimation is appropriate for estimating trade flows between randomly drawn samples of trading partners from a large population, the fixed effects (FE) estimation is most appropriate for estimating trade flows between *ex ante* predetermined selections of countries.[5]

The continuous data are transformed into logarithms. The impact of the variables on manufactured exports is determined by the coefficients generated as elasticities after this transformation. The rationale for the transformation into elasticities is to enable us to establish the percentage of economic infrastructure development that generates a given level or proportion of manufactured exports. In this way policy makers can be guided on the best investment path in economic infrastructure development for trade facilitation and consequently growth of manufactured exports.

4.4.1 Diagnostic tests

Unit root tests are critical to the determination of a potentially co-integrated relationship between the variables. When all the variables are stationary, the traditional estimation method is used to estimate the relationship between the variables. In the event that the variables are non-stationary, a test for co-integration is required with potential to change the analysis procedure. We conducted the Levin *et al.,* (2000) test of panel unit roots which assumes that the autoregressive parameters are common across

3 http://www.timeanddate.com/worldclock/distanceresult.html?p1=115andp2=17

4 CEPII make available a "square" gravity dataset for all world pairs of countries, for the period 1948 to 2006. This dataset was generated by Keith Head, Thierry Mayer and John Ries (2010).

5 FE models are best suited for estimating the impact of variables that vary over time. Given that most of the variables in this study are non-varying, the FE is not best suited. Nonetheless, we performed standard tests (notably the Hausman test) to empirically establish that the RE is preferred model.

countries. Levin, Lin and Chu (LLC) used a null hypothesis of a unit root which states that the panels contain unit roots and the alternative that the panels are stationary. The test results indicate that all the variables are stationary at less than 1 percent (the null unit root is rejected) in which case the co-integration test is not required to estimate the model.

We use the simple correlation test to check multi-collinearity in the model between the explanatory variables. Results show that the values of the correlation coefficients between explanatory variables are lower than 0.80. Studenmund (2001) argues that below such a threshold the model is fine, we concluded that there is no serious problem and thus proceeded with the estimation.

This paper thus seeks to understand what improvements in each individual piece of economic infrastructure would result in an increase in exports of manufactured goods in the EAC region. We define and outline benchmarks for economic infrastructure, develop an econometric model to estimate the impact of economic infrastructure on the export of manufactured goods and layout a counterfactual scenario to approximate the effect of improved economic infrastructure on the export of manufactured goods.

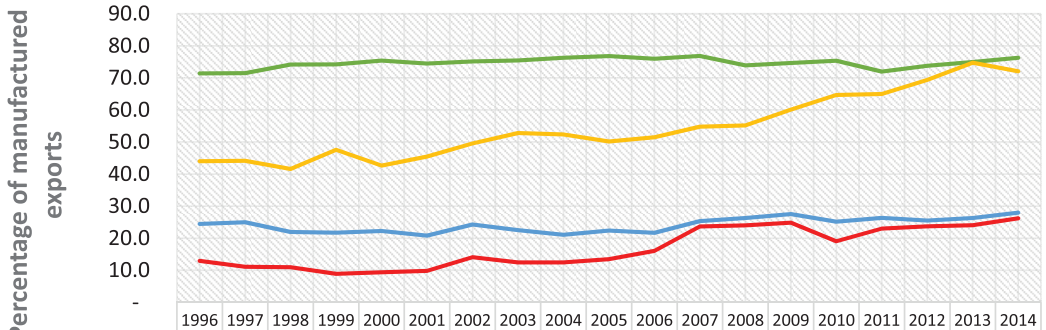
5. FINDINGS

In this section, we present the findings of the study. We first present the descriptive statistics, exploring the variables that the study uses and then the estimated model results, which identifies variables that are significant and establishes their marginal effects. The latter help to gauge the infrastructure gaps in the EAC region. Finally, for policy purposes, using the generated elasticities, we estimate the required economic infrastructural development to generate the desired change in the export of manufactured goods.

5.1 Descriptive analysis

The manufacturing sector in the EAC region is predominantly centred on primary production like agricultural produce in comparison to other less developed regions. For that matter, the proportion of exports that is manufactured is significantly small as illustrated in Figure 2. The manufacturing share of goods exports varies across the examples given over the review period. For both the EAC and COMESA, there has been an increase in the proportion of exports being manufactured. Whereas the EAC region experienced an increase from 13 percent in 1996 to 26 percent in 2014, the COMESA region only registered a 4 percent increase from 24 to 28 percent. Even though the EAC region has a smaller proportion of manufactured exports, the region generally experienced a larger change.

Figure 2: Manufactured exports (% merchandise exports - 1996 – 2014)



	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
COMESA	24	25	21	21	22	20	24	22	21	22	21	25	26	27	25	26	25	26	27
EAC	12	11	10	8.	9.	9.	14	12	12	13	16	23	24	24	19	23	23	24	26
Thailand	71	71	74	74	75	74	75	75	76	76	76	76	73	74	75	72	73	74	76
Vietnam	44	44	41	47	42	45	49	52	52	50	51	54	55	60	64	65	69	74	72

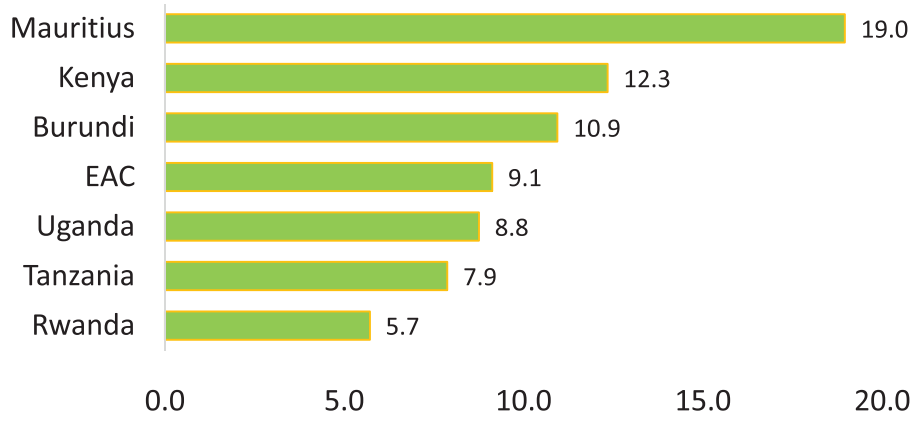
Source of data: WDI

Compared to Thailand and Vietnam, the EAC and COMESA regions have significantly lower shares of manufactured exports. For the last two decades Thailand has maintained an average above 70 percent of exports as manufactured and Vietnam experienced a tremendous growth from 44 to 74 percent. When the individual countries (Appendix A1) are analyzed, it is noted that for the EAC region, much of this proportion is attributed to Kenya whose percentage increased to over 35 percent followed by Tanzania and Uganda. The performance of Burundi and Rwanda was negligible. At the COMESA level, the countries that have the largest proportion of exports that are manufactured include Egypt and Mauritius with averages above 45 and 60 percent, respectively. The results suggest that notwithstanding the progress made in the last two decades, in comparison to other countries the member states of the EAC still lag behind in exporting manufactured products. In this case, the EAC Member States are not as industrialised as other similar countries. There is a preponderance of commodities in the export basket which consequently leads to less revenue generated from exports. Although there are many other factors that need policy attention to increase export of manufactured exports, trade facilitation features prominently.

Regarding the value added of manufacturing as a proportion of GDP, the EAC region exhibits a significantly dismal performance with all the EAC member states having an average of less than 10 percent- only Kenya and Burundi exceed this 10 percent. In comparison to countries like Mauritius which has 19 percent, Thailand at over 26 percent and Vietnam at 18 percent, the EAC Member States still performing poorly. Details in Appendix A2.

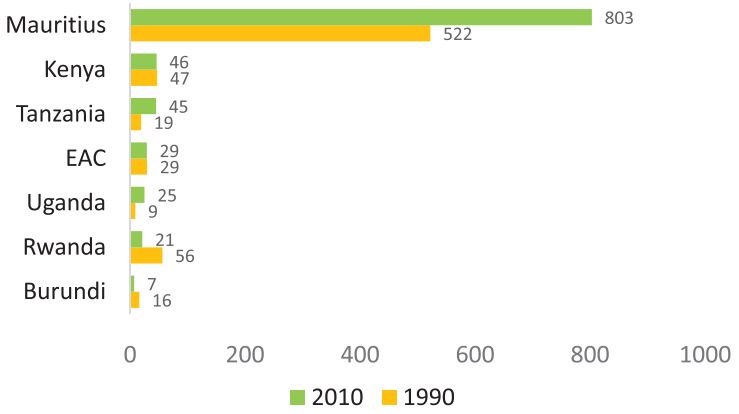
The analysis for value added can further be improved by adding the population dimension to it. In this case we use the Manufacturing Value Added (MVA) per capita and compare the changes between 1990 and 2010. Currently within the EAC region, manufacturing -broadly defined- accounts for a relatively small share of GDP compared to the levels of manufacturing typically associated with industrializing countries. Figure 4 suggests that for the EAC region, MVA varies with Kenya having the highest MVA per capita followed by Tanzania and Uganda. Rwanda and Burundi still have a long way to go to reach what Kenya has so far achieved and they declined during the two review periods. The results suggest unequal patterns among member states. Note that the overall average for the EAC has not changed and has been stagnant at 29 for the two periods. When compared with Mauritius which increased MVA per capita from 522 in 1990 to 803 in 2010, the EAC region is exceptionally far behind.

Figure 3: Average manufacturing value added (% of GDP) 2001- 2014



Data source: WDI

Figure 4: Manufacturing Value Added per capita 1990 and 2010



Source Authors' Calculations based on UNIDO data

The estimation of the empirical gravity model was done using a number of variables, however for convenience Table 8 highlights the means for the infrastructure variables. Country level comparison of the average total value of exports for the period 2001-2014 demonstrates that Kenya and Tanzania are the main export countries in the EAC region. Similarly, regarding the average value of manufactured exports, Kenya and Tanzania take the lead. This is arguably reflected in the average proportion of manufactured exports, although Uganda improves to a level close to Tanzania. The statistics suggest that the overall, the EAC region is sparsely industrialised.

The consumption level of electricity is an indicator of the level of industrialisation of a country. With an average of 71 kWh per capita, the EAC Member States electric power consumption are far below the global consumption levels of industrialised economies. Basic minimum thresholds are yet to be attained, for example, COMESA has an average of 437 kWh per capita and the ASEAN countries are at 2,382 kWh per capita. Since

Table 8: Means of the model estimation variables

	Uganda	Rwanda	Burundi	Kenya	Tanzania	EAC
Total value of exports	18,716	3,951	1,668	56,076	40,838	24,082
Value of manufactured exports	4,564	362	233	19,124	9,987	6,790
Proportion of manufactured exports	20.1	8.5	11.9	32.3	21.9	18.9
Electric per capita	90.0	25.9	21.3	145.4	75.4	71.1
Telephone	0.6	0.3	0.3	0.9	0.4	0.5
Per capita income of exporters*	365	336	147	566	479	378
Per capita income of importers*	17,481	15,134	13,332	15,261	15,734	15,383
Internet connectivity per 100	7.3	4.2	0.7	14.4	2.1	5.7
Population of exporters**	30,800	9,712	8,747	38,000	42,600	25,900
Population of importers**	77,200	80,000	70,800	82,600	81,800	78,500
Public transparency	2.7	3.3	2.4	3.0	3.2	2.9
Number of documents to export	9.1	9.8	9.0	7.6	7.7	8.7
Time taken to export	34.9	45.1	42.1	33.5	24.4	36.0
Quality of roads infrastructure	2.6	3.9	2.3	2.9	2.9	2.9
Quality of rail infrastructure	1.3	0.0	0.0	2.1	2.6	1.2
Quality of port infrastructure	2.9	2.7	2.5	3.4	3.3	3.0
Quality of air infrastructure	3.4	3.3	2.9	4.7	3.0	3.5
Distance between capital cities***	5,671	5,366	5,243	5,021	5,824	5,427

Source: Author calculations using data from WDI and World Economic Forum

Notes* in US $, ** in thousands and ***distance in kilometres

manufacturing requires high consumption of energy, there is need to generate and consume more energy for purposes of industrialisation. The other infrastructure levels similarly suggest that the EAC Member States are yet to reach the desired performance as they are far below the basic thresholds exhibited by other regions.

The quality of roads, ports and rails data was collected on a scale from 1 (low) to 7 (high). The EAC region is on average below half way the rating, that is, between 1.2 and 3.5 for quality of airport and road infrastructure. Railway transport is still poor as its rating is extremely low. On average, the number of days taken to export in the EAC region is 36 and is reasonably higher than the ASEAN with 23 days. This has cost implications given that every additional day of goods in transit increases the costs of managing exports. The number of documents used in exportation partly determines the quality of trade facilitation for a country/region. On average all the EAC Member states are not significantly different. Whereas it takes an average of 8.7 documents for the EAC region to export, it only takes 6.3 for the ASEAN region. This implies that the resulting cost of handling goods is likely to be higher and thereby transferring an additional cost to exportation.

The transparency, accountability, and corruption in the public sector rating (1=low to 6=high) suggests that there are no significant differences among the EAC Member States on average. However, the ratings (2.7 up to 3.3) just about the average indicate that a significant problem exists. It means that there are transparency, accountability and corruption issues in the public sectors signalling additional costs for exporters when transiting goods.

The importance of logistics in the import and export business is irrefutable and can arguably be one of the most important aspects to the success of business. Internet has dramatically lowered communication costs and is one of the primary reasons for the increase in globalization. Internet access increases export opportunities for enterprises given that new information technologies are able to weave the world together. This implies that the state of Internet connectivity and telephone subscription can play a significant role in facilitating trade. Internet connectivity per 100 persons for all the EAC countries is extremely low although it significantly varies among the countries with Kenya performing best and Burundi worst. Managing customs procedures requires internet connectivity in order to expedite the process, and in turn lower the cost of handling. Making entries by both customs officers and traders is significantly eased when using internet processes.

5.2 Econometric estimates

Table 9 reports the results of the model estimates for three EAC countries[6] (Uganda, Kenya and Tanzania) and combined EAC. Standard errors are presented below the coefficients and the stars are the levels of significance. The R^2 for all the models are significantly high for the overall, between and within except for Kenya for the within. We estimated the trade facilitation indicators as logarithms, therefore, the coefficients are interpreted as elasticities. The results demonstrate that coefficients of physical infrastructure are significant and have the expected positive signs. This implies that improving the stock of infrastructure is likely to increase the export of manufactured goods for all the EAC countries. On the other hand, contiguity, and being islands and landlocked do not significantly affect the trade in exports of manufactured commodities by EAC countries.

For the soft infrastructure, the results suggest that an increase in the number of export documents and the number of days to export between partners impedes and slows down the pace of trading, implicitly increasing the cost of exportation. The distance between the trading partners is not significant, perhaps because the destinations for the EAC manufactured products are not particularly far. With respect to exports, in the recent past the EAC is trading more with regional

6 Rwanda and Burundi are not included in the analysis owing to significant data gaps.

countries than the traditional European countries. It is observed that the EAC's manufactured exports end up in the neighbouring countries which are close, compared to commodities that are destined to more developed and industrialised countries. Corruption is observed as a serious problem for exporters of commodities, and results suggest that the variable for soft infrastructure of transparency, accountability and corruption is significant and with the correct sign. Improving these increases the volume of manufactured export products for all the three countries and the overall EAC region. In a modern world, e-commerce has taken centre stage as it improves communication and cuts down information costs reducing barriers to trade. Internet connectivity and telephone subscription in the estimation reveal that improving these increases chances of increasing the volume of exports of manufactured products.

For any country to industrialise and develop, the levels of energy consumption have to be high. When energy is scarce it imposes substantial constraints on the growth of the economy. Therefore the levels of energy infrastructure and subsequent consumption thereof is an economically meaningful way to explain why some countries have managed to industrialize while others have been less successful. The results suggest that increasing the per capita electric consumption increases the export of manufactured products for the EAC countries. This varies by country but is consistently significant with Kenya whose industrial base is the most advanced in the region likely to experience higher returns.

Whereas the population of the exporters is significant for all three EAC countries, that for importers is insignificant. Likewise, whereas the per capita income of exporters for all the three countries is significant with positive coefficients, the per capita income of importers is not significant.

The paper estimates the quantities of different infrastructure required by Uganda, Kenya and Tanzania to generate given quantities of manufactured exports as in the work of Portugal-Perez and Wilson (2012). Compared to previous studies, the results confirm that investments in both soft and hard infrastructure have high chances of increasing exports of manufactured products. The difference only occurs in the magnitudes of the changes, owing to the number and types of countries and the period involved, making heavy infrastructure investment is highly recommendable. The number of documents and days taken to export and the prevalence of corruption are typical non-tariff measures which form a significant source of trade restrictiveness especially for low-income countries as reflected in this paper and as argued by Hoekman and Nicita (2008). This argument is in agreement with Djankov *et al.* (2010) and Freund and Rocha (2011) who argue that exports are extremely vulnerable especially time sensitive products, such as perishable agricultural produce. Thus, improvements in on–the–border and behind-the border policies have the potential to generate higher returns in manufactured export performance as reported by Iwanow and Kirpatrick (2008). The role of institutions in mitigating the negative effects of public corruption as reported by Anderson and Marcoiller (2002) is underscored. Furthermore, the results are in agreement with Meon and Sekkat (2000) who ascertain that exports of manufactured products are positively affected by controlling corruption, the rule of law, government effectiveness and the lack of political violence. Finally, the paper confirms what Fink *et al* (2005) reported that improving communication is associated with increases in bilateral trade.

Table 9: Estimation results

Variable	Uganda	Kenya	Tanzania	EAC
Ln_ quality road infrastructure	4.772***	0.678***	11.12***	3.690***
	0.644	0.0624	6.366	*0.293*
Ln_ quality rail infrastructure	1.199***	0.592***	0.8037***	0.227***
	0.202	0.206	0.473	*0.0579*
Ln_ quality port infrastructure	0.13	0.540***	0.171***	0.424***
	0.069	0.272	0.9784	*0.0267*
Ln_ quality air infrastructure	0527***	0.559***	0.348***	0.690***
	0.789	0.172	1.736	*0.0389*
Ln_ electricity per capita	1.494***	3.461***	1.12***	0.228***
	0.532	0.159	0.0226	*0.00909*
Ln_ telephone	0.0649*	0.498***	0.419***	0.367***
	0.0253	0.017	0.195	*0.0229*
Ln_ internet connectivity	0.352***	0.143***	0.211***	0.193***
	0.0113	0.0089	0.159	*0.00926*
Ln_ public Transparency	0.792***	0.918***	3.44***	1.324***
	0.0527	2.028	0.229	*0.0698*
Ln_ population exporters	1.378***	4.550***	1.871***	2.830***
	0.172	0.143	1.474	*0.133*
Ln_ per capita exporters	0.841***	0.248***	0.155***	0.282***
	0.178	0.135	1.116	*0.0806*
Ln_ per capita importers	0.000	0.000	0.000	0.0011
	0.000	0.000	0.001	*0.0014*
Ln_ population importers	0.000	0.000	0.000	0.0009
	0.000	0.0001	0.001	*0.001*
Ln_ number of document s	-0.989***	-0.24.9***	-0.536***	-0.307***
	0.0231	0.576	0.372	0.0306
Ln_ time to export	-0.591***	-0.472***	-0.085	-0.631***
	0.0974	0.109	0.0667	*0.041*
Contiguity	0	0.0001	0.005	0.002
	0	0.004	0.007	*0.013*
Landlocked	0.000	0.000	0.000	0.000
	0.004	0.003	0.006	*0.008*
island	0.000	0.000	0.000	0.001
	0.004	0.002	0.005	*0.007*
Ln_ distance	0.000	0.000	0.000	0.002
	0.002	0.002	0.003	*0.005*
_cons	0	0	21.12***	-47.21***
	0	0	-17.99	*2.121*
r2				
r2_o	0.995	0.98	0.962	0.905
r2_b	0.976	0.976	0.976	0.976
r2_w	0.864	0.0256	0.668	0.864

Standard errors in italics below coefficients

* $p<0.05$, ** $p<0.01$, *** $p<0.001$

Observations 4858

The continuous variables in the model were transformed into logarithms partly to enable estimation of elasticities. The elasticities are in turn used to estimate the percentage changes in exports of manufactured products resulting from given investment in infrastructure. The results are summarized in Table 10 to illustrate the likely change in the proportion of manufactured exports when the individual infrastructure category is increased by 10 percent.

The largest gain in manufactured exports is likely to be realized through investment in the stock of road infrastructure, electricity and public transparency for the individual EAC countries analysed. A 10 percent increase in road infrastructure investment is likely to increase manufactured exports by 48 percent for Uganda, 7 percent for Kenya and 111 percent for Tanzania. This can be explained by existing infrastructure gaps that are higher among the EAC Member states. When contrasted with railway infrastructure, results suggest that a 10 percent increase in its investment is likely to lead to an average between 6 to 10 percent increase in exports of manufactured products for the three countries. This is explained by the fact that most of the region is interlinked by road networks and not necessarily railway lines, although the latter is extremely important as well. Electricity remains an important category of infrastructure with a 10 percent increase in investment likely to lead to a 15 percent increase in exports of manufactured products in Uganda, 35 percent in Kenya and 12 percent in Tanzania.

Investment in air transport will bear significant gains in manufactured exports of about 7 percent. Increasing transparency and accountability and reducing corruption (Soft infrastructure) by 10 percent leads to an increase in manufactured exports by 8 percent in Uganda, 9 percent in Kenya and a massive 34 percent in Tanzania. Improving trade facilitation by reducing the number of documents and days in the exportation process generates large gains in increasing exports of manufactured goods. A 10 percent reduction in the number of documents increases exports of manufactured goods by 10 percent in Uganda, 3 percent in Kenya and 5 percent in Tanzania. Uganda being land locked makes the most gains. Similarly reducing the number of days to export by 10 percent leads to 6 percent increase in exports of manufactured products in Uganda, 5 percent in Kenya and 1 percent in Tanzania.

Table 10: Estimates of a ten % increase in the respective infrastructure on manufacturing exports

Infrastructure variable	Uganda	Kenya	Tanzania	EAC
Quality road infrastructure	47.7	6.8	111.2	36.9
Quality rail infrastructure	12.0	5.9	8.0	2.3
Quality port infrastructure	0.0	5.4	1.7	4.2
Quality of air infrastructure	5.3	5.6	3.5	6.9
Electricity per capita	14.9	34.6	11.2	2.3
Telephone	0.7	5.0	4.2	3.7
Internet connectivity	3.5	1.4	2.1	1.9
Public Transparency	7.9	9.2	34.4	13.2
Time to export (days)	-5.9	-4.7	-0.9	-6.3
The number of documents to export	-9.9	-2.5	-5.4	-3.1

6. CONCLUSIONS AND POLICY IMPLICATIONS

The paper estimates the impact of improving economic infrastructure in the EAC region on exports of manufactured products. The analysis specifically departs from the general analysis in the literature by looking beyond the impact of infrastructure (trade facilitation) on exports in general, and delving into exports of manufactured goods. The results suggest that improving economic infrastructure quality generates huge gains in terms of exports of manufactured products from the EAC Member States. Specifically, hard physical infrastructure has more potential to generate a greater impact on manufactured exports compared to soft infrastructure. It is evident for soft infrastructure that; transparency and accountability; internet connectivity and telephone subscription improve the efficiency and business environment which supports exports of manufactured products. Illustrative estimates demonstrate that improvements in infrastructure and border and transport efficiency reduce the number of days and documents needed to export, hence leading to more exports of manufactured goods.

Therefore, the paper provides policymakers with empirical information about the effectiveness of possible interventions in trade facilitating infrastructure that would enhance the growth in manufactured exports within the EAC region.

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Table A1: Manufactured exports (% of merchandise exports)

Country	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Thailand	74.5	75.1	75.4	76.3	76.8	76.0	76.8	73.9	74.6	75.3	72.0	73.8	74.9	76.3
Vietnam	45.4	49.6	52.8	52.4	50.2	51.5	54.8	55.2	60.1	64.7	65.0	69.4	74.7	-
Tanzania	16.6	14.9	15.7	16.6	14.0	18.5	23.1	31.0	24.6	24.1	25.1	25.2	28.5	
Burundi	0.8	1.9	6.4	5.1	6.2	1.3	31.3	18.1	20.6	5.9	12.7	12.9	19.8	24.2
Rwanda	2.7	23.8	4.3	3.8	3.4	3.3	4.5	6.7	16.6	7.6	10.5	10.2	9.5	12.3
Kenya	23.3	24.0	24.2	25.7	31.9	35.7	37.3	36.5	36.6	34.7	-	-	36.9	
Uganda	5.5	5.5	11.7	11.0	11.5	21.3	22.1	27.4	25.6	22.8	31.5	34.2	25.7	
Comoros	3.7	2.6	2.3	3.0	12.9	13.4	6.3	29.4	27.1		-	-	-	-
DRC	-	-	-	-	-	-	21	23	25	18	18	17	18	18
Egypt	32.7	35.4	31.0	30.5	23.6	21.2	18.8	36.5	43.8	43.4	45.1	45.5	48.7	51.5
Ethiopia	13.4	14.3	11.4	3.8	4.6	5.4	13.8	9.0	8.7	8.9	10.4	8.8	8.6	-
Malawi	10.2	11.8	11.5	15.4	16.3	12.9	10.5	10.0	8.5	9.0	9.0	-	7.5	-
Mauritius	74.2	72.6	73.6	68.1	57.3	64.1	61.9	57.3	64.2	60.2	64.5	61.7	58.7	62.5
Swaziland	48.5	76.4	75.5	51.0	71.5	63.9	69.8	-	-	-	-	-	-	-
Zambia	14.3	14.4	15.3	9.8	8.8	5.8	7.3	6.7	8.4	6.3	10.0	11.7	15.9	11.7
Zimbabwe	14.6	38.4	-	-	38.1	24.0	50.3	40.2	34.3	36.4	23.1	10.4	17.4	27.0

Data Source: WDI

Table A2: Manufacturing, value added (% of GDP)

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Thailand	28.0	28.7	29.8	29.6	29.8	30.3	30.7	30.7	29.6	31.1	29.2	28.2	27.7	27.7
Vietnam	18.2	18.9	18.8	18.7	18.8	19.4	19.4	18.6	18.3	18.0	18.0	17.4	17.5	17.5
Tanzania	9.0	8.9	8.9	8.7	7.8	8.0	7.5	7.5	7.4	7.4	8.1	8.0	6.9	6.1
Burundi	11.6	11.7	12.0	12.4	12.9	11.3	12.1	10.5	10.6	10.1	9.7	9.1	9.5	9.7
Rwanda	6.9	7.5	6.8	6.9	5.6	5.3	4.8	4.9	5.3	5.4	5.3	5.3	5.2	4.8
Kenya	11.0	11.1	10.9	11.2	11.8	14.3	14.5	13.6	13.4	12.6	13.1	12.3	11.9	11.1
Uganda	7.5	7.8	7.5	6.7	7.5	7.5	7.6	7.8	10.0	9.2	11.0	11.7	10.8	10.0
Comoros	4.2	4.2	4.2	4.2	4.1	4.0	4.1	3.8	5.0	5.4	5.7	6.2	7.0	7.4
DRC	20.3	21.8	18.9	18.4	20.0	19.8	20.7	23.4	25.1	17.9	17.6	17.4	17.6	17.8
Egypt	19.1	19.8	18.5	18.3	17.8	17.0	16.1	16.3	16.6	16.9	16.5	15.8	15.6	16.4
Ethiopia	6.2	6.2	6.2	5.9	5.3	5.0	4.9	4.4	4.1	4.3	4.0	3.7	4.0	4.3
Malawi	11.5	10.6	11.7	10.1	9.3	10.7	11.3	12.3	12.0	11.8	11.8	11.1	11.4	11.4
Mauritius	23.3	22.4	21.7	21.0	19.8	18.6	18.3	18.4	17.8	17.0	16.9	16.7	17.0	16.5
Swaziland	39.7	39.2	39.9	39.6	38.9	41.4	41.7	42.2	42.3	45.7	38.9	38.2	37.7	37.4
Zambia	10.3	10.8	11.3	11.2	10.9	10.3	9.5	9.2	9.3	8.4	8.1	8.3	8.2	-
Zimbabwe	14.6	13.3	13.6	15.1	16.4	16.9	16.4	16.7	15.5	13.9	14.0	13.6	12.8	11.9

Source: WDI

Table A3: The estimation methods used by different authors

Authors	Models used
Anderson and Marcouiller (2002)	Used a structural model of import demand, to estimate the reduction of trade as a result of corruption.
Calí and te Velde's (2010):	The authors use an export demand model to show how some types of Aid for trade may influence exports.
Djankov et al (2010)	They estimate difference gravity equations using data collected on the days it takes to move standard cargo from the factory gate to the ship in 98 countries;
Fink *et al.* (2005)	Applied a gravity model to estimate the effect of the communication costs on bilateral trade.
Francois and Manchin (2013)	Used a gravity model by matching bilateral trade and tariff data and controlled for tariff preferences, levels of development, and standard distance measures etc.
Freund and Rocha (2011)	Used a modified gravity equation that controls for importer fixed effects and exporter remoteness. They used World Bank data from the 'Doing Business' survey covering 146 countries.
Hoekman and Nicita (2008)	The gravity equation is estimated using Poisson pseudo maximum likelihood (PPML); with a dataset that covers 104 importers and 115 exporters.
Iwanow and Kirkpatrick (2008)	Using a panel dataset for 124 developed and developing countries, the authors estimate an augmented standard gravity model with trade facilitation, regulatory quality, and infrastructure indicators.
Levchenko (2007)	First, the paper applies a simple model of international trade in which institutional differences are modelled within the framework of incomplete contracts. Second, the paper empirically tests whether institutions act as a source of trade.
Limão and Venables (2001)	The authors employ a gravity model incorporating the same geographical and infrastructure measures that are used in estimating trade costs.
Maur (2008)	The author looks at both the efficiency and implementation and investigates avenues through which efficiency gains can be made.
Méon and Sekkat (2006).	The authors use a panel of 60 countries in a two-stage approach.
Milner *et al.* (2008)	The paper is qualitative and uses an analytical framework constructed around 5 key issues arising from TF reforms.
Neufeld (2014)	The paper compares regional and multilateral initiatives, looking at areas of convergence and divergence, and highlighting where potential gaps exist. It analyses negotiating positions in the respective frameworks and discusses both the benefits and limitations of the resulting Trade Facilitation provisions.
Portugal-Perez and Wilson (2012)	Using a two-stage sampling model, Portugal-Perez and Wilson (2012) used factor analysis to construct four aggregate indicators of a country's trading environment. They then applied a standard gravity model to simulate the impact of these indicators on trade facilitation and export growth.
Soloaga *et al.* (2006)	They estimate a gravity mode using four indicators of trade facilitation: port efficiency, customs environment, regulatory environment, and e-commerce use by business (as a proxy for service sector infrastructure).
Wilson *et al.* (2004)	Analysis is done with a gravity model that uses a panel of disaggregated manufactured goods for 75 countries in global trade, and takes into consideration four important categories of trade facilitation: Port efficiency, customs environment, regulatory environment, and service sector infrastructure. Potential gains from trade facilitation reforms are predicted by using the estimated parameters.

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