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Global Trade Analysis Project

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Modelling the economic impact of the China Belt and Road Initiative on East Africa

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Abstract

The purpose of this study is to evaluate the effect of People's Republic of China's Belt and Road initiative strategy on trade and welfare in Eastern Africa.

In 2013, Chinese President Xi Jinping announced a proposal for a "Silk Road Economic Belt" and a "21st Century Maritime Silk Road", formally known as Belt and Road Initiative (BRI). The BRI routes will run through countries in Asia, Europe, and Africa. In East Africa, the countries along the BRI include Djibouti, Ethiopia, Kenya, Rwanda, Uganda and Tanzania. One of the BRI projects in East Africa, the standard gauge railway is already under construction. It will connect the ports of Mombasa and Dar-es-salaam to Kenya, Uganda, Tanzania and Rwanda. The standard gauge railway is expected to reduce transport costs in the region, which has implications for trade and welfare.

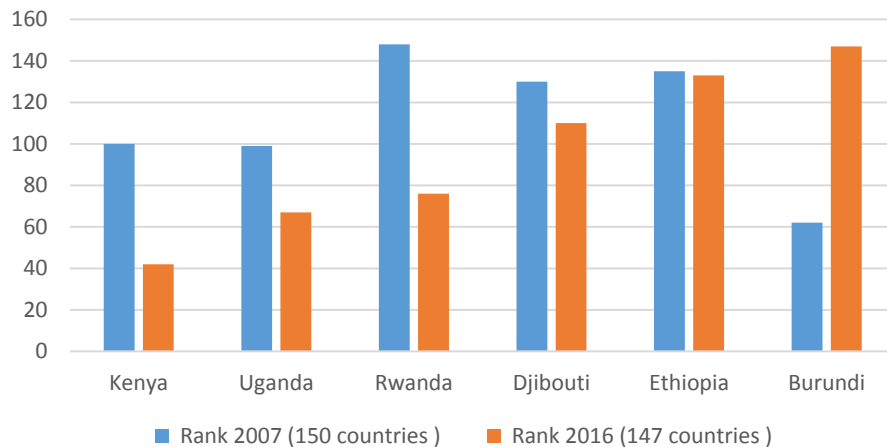
This study uses the Global Trade Analysis Project (GTAP) computable general equilibrium (CGE) model and the latest GTAP 10 database to analyse the effects of the establishment of the BRI. We conduct policy simulations to evaluate the potential impact of the BRI on trade and welfare in Eastern Africa. Under modest assumptions, the total exports of countries could increase by \$192 million and welfare by about \$1 billion. The BRI would result in a particularly pronounced increase in intra-regional trade.

Keywords: General equilibrium; Economic integration; China; Africa

JEL Classification: F15, I32, L91, O19

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Figure 2: Rank of the quality of trade and transport-related infrastructure



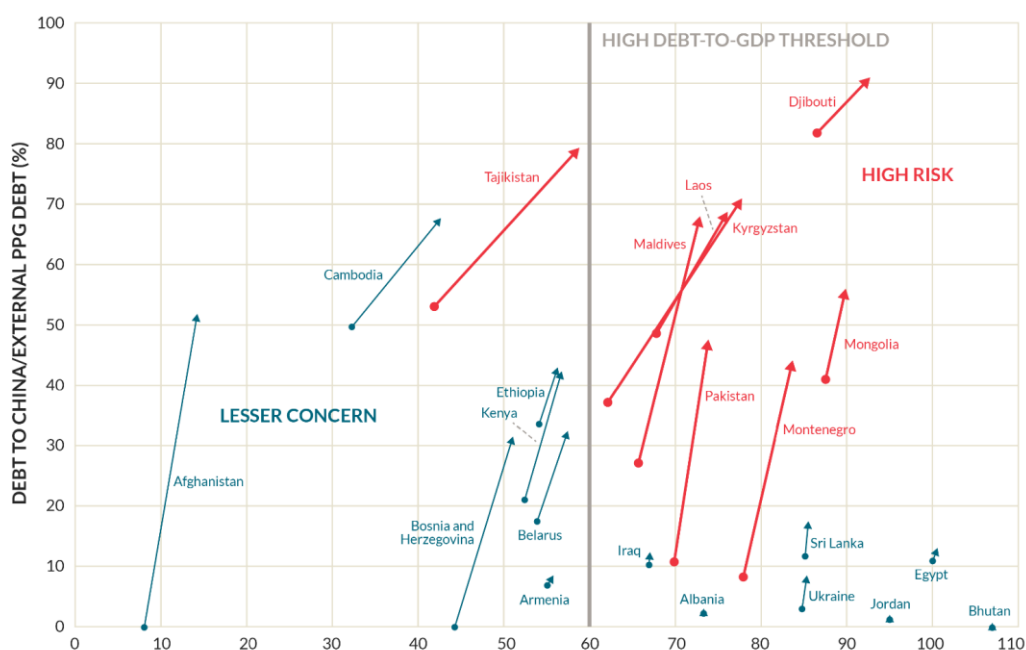
Source: World Bank (2018). Note: The higher the ranking, the lower the quality of infrastructure

The low infrastructure rankings for countries in East Africa highlight the need for improved infrastructure and the BRI represents an opportunity for countries to develop the quality of infrastructure. As we will report in Section 3, governments are clearly cognisant of these needs, and have sharply been increasing the share of their budgets dedicated to addressing the infrastructure deficit.

However, there are also concerns in some quarters that the BRI could lead to debt distress for some countries in the region. According to Hurley et al. (2018) countries like Djibouti are at high risk of debt distress because of the BRI (Figure 3). In the case of Kenya, it is certainly the case that there has been a sharp rise in outstanding debt over recent years, and infrastructure projects have clearly been a major contributor to that rise. Growth in stock of bilateral debt since 2012 has mainly been driven by a rise in stock of debt from the People’s Republic of China, now accounting for more than half of the total bilateral (KNBS, 2018:Table 6.1).² In Ethiopia, too, the IMF has raised alarm bells about the sharp rise of debt, and the country has now been deemed at ‘high risk of debt distress’ by the IMF (2018:11). Ultimately, however, the value of the infrastructure projects should be valued on the social cost-benefit that they contribute to the regional economies, and on that issue it is still too early to tell. Similarly, the sustainability of BRI infrastructure projects will partially depend on the productivity of the BRI projects. It is therefore vital to quantify the economic impact of the BRI. The purpose of this study is to quantify the impact of the BRI projects on East Africa's trade and welfare.

² Imports to Kenya from China have also continued to grow over the last five years making the country the leading source of Kenya’s imports in 2016. But pointedly, the major commodities imported from China included; wind-powered generators, rails and signalling systems – clearly imports associated with investment in power and transport infrastructure (KNBS, 2018: 139). High levels of capital goods imports in Ethiopia and Uganda linked to infrastructure projects have similarly recently been linked to sustained high current account deficits (IMF, 2018:5).

Figure 3: Immediate marginal impact of BRI lending



Source: Hurley et al. (2018); Note X-axis is Debt/GDP ratio (%)

The rest of this paper is organised as follows; section 2 discusses the empirical literature on the impact of infrastructure on trade and development. Section 3 provides an overview of the infrastructure investment in East Africa, and the extent to which China has been involved in those infrastructure projects. Section 4 describes the model and data specification. In section 5 we present the results of the GTAP model, and section 6 provides the conclusion.

2. Literature Review

The empirical literature on infrastructure and development in Africa has mainly focused on the impact of infrastructure on aggregate growth, firm output and the impact of infrastructure on trade. Despite a large body of theoretical work on the relationship between infrastructure and growth, empirical analyses in Africa have not yet offered a resounding consensus. Researchers agree that the relationship is heterogeneous and heavily dependent on the countries, infrastructure types, and periods under study (AfDB, 2018: Box 3.1.).³ Measurement of the economic impact of infrastructure development is also hindered by the inherent endogeneity of the relationship between economic growth and development, on the one hand, and infrastructure provision on the other.

Taking a broad definition of infrastructure development (i.e. including telecommunications, energy and transport infrastructure), simulations reported by Foster and Cecilia Briceño-Garmendia (2010:2) suggest that if all African countries were to catch up with Mauritius (the regional leader in infrastructure) per capita growth in the region could increase by 2.2 percentage points.

³ One study, Wolde-Rufael (2006), focussing on energy, even finds a negative relationship between infrastructure provision and growth in a number of African countries (Congo, Democratic Republic of Congo, Kenya, South Africa, and Sudan).

Estache et al., (2005) used an augmented Solow model to study the effect of infrastructure on GDP per capita. They found that telecoms, electricity and roads had a significant positive effect on long-run growth in Africa. Boopen (2006) analysed a panel set of 33 African countries for the period 1980-2002. Results from the analysis highlighted the importance of transport capital as an element of development. Transport was confirmed to have a positive significant effect on economic growth.

Mold (2012) reviews the extent to which during the current infrastructure 'boom' African countries have managed to avoid the pitfalls of the previous infrastructure boom in the 1970s, and to develop sustainable infrastructure investment strategies that will prove catalytic for economic development. He argues that because of the prevailing low levels of infrastructure development, public investment in infrastructure could drastically increase the productivity of private capital. Kumo (2012) conducted Granger causality tests between economic growth, economic infrastructure investment, and employment in South Africa for the period 1960-2009 using a bivariate vector auto regression model. The results indicated that there was a strong causality between economic infrastructure investment and GDP growth that ran in both directions. This implied that economic infrastructure investment drove the long-term economic growth in South Africa while improved growth led to more public infrastructure investments.

Kodongo and Ojah (2016) use two indexes measuring the access and quality of various infrastructure types, in addition to gross fixed capital formation to control for public spending. Their results, drawn from 45 African countries, show that neither the stock/access nor the quality of infrastructure drives economic growth in a low basic infrastructure endowment— but that the spending on infrastructure and the increments (gains) in access do.

Regarding the effect of infrastructure on firm level output, Eifert et al., (2008) analysed the cost of doing business in Africa using data from the World Bank Enterprise Surveys. They found that that indirect costs (related to infrastructure and services) accounted for a relatively high share of firms' costs in poor African countries and posed a competitive burden on African firms. Escribano et al. (2010) carried out an empirical assessment of the impact of infrastructure quality on the total factor productivity (TFP) of African manufacturing firms. The results showed significant heterogeneity in the effects of infrastructure on African countries. Poor-quality electricity affected mainly poor countries, and likewise losses from transport interruptions affected mainly slower-growing countries. There was also some heterogeneity among countries in the infrastructure determinants of the allocative efficiency of African firms.

Tidiane et al. (2011) studied firm productive performances in five Middle East and North African (MENA) economies and eight manufacturing industries. They found that regarding labour productivity, enterprises in MENA performed poorly in contrast to the average for middle-income countries. Average low performances of MENA countries were linked to deficiencies in the investment climate that handicapped manufacturing competitiveness. Differences in the quality of various infrastructures, the experience and level of education of the labour force, the cost and access to financing, and several dimensions of business-government relations explained firm performance discrepancies. Moyo (2012) analysed the effect of infrastructure on African firms using firm-level manufacturing data from 10 African countries. The results showed that inadequate infrastructure in the form of customs, transport, electricity and water had a negative significant effect on export intensity and participation.

Looking at the effect of infrastructure on trade Portugal-Perez and Wilson, (2012) estimated the impact of aggregate indicators of “soft” and “hard” infrastructure on the export performance of developing countries using the gravity model. Their estimates showed that trade facilitation reforms, physical infrastructure and regulatory reforms do improve the export performance of developing countries. They also find statistical evidence on the complementarity between hard infrastructure and soft infrastructure.

Iwanow & Kirkpatrick (2009) used a panel dataset for 124 developed and developing countries, available for the period 2003–04, to assess the impact of trade facilitation and infrastructure on manufacturing export performance with particular reference to Africa. They estimated a standard gravity model augmented with trade facilitation, regulatory quality, and infrastructure indicators. Their results showed that trade facilitation reforms, business regulation quality and infrastructure variables had a positive significant on export performance in Africa. Akpan (2014) employed the gravity model of trade to examine the impact of improving the quality of regional road infrastructure in the ECOWAS sub-region, from its current level to the level of roads in South Africa, on intra-regional trade. The study augmented the traditional gravity model to include variables for language, common border and road quality. The results showed that such improvement led to a 5 per cent increase in intra-regional trade.

3. The Scale of Chinese Investment in Infrastructure in Eastern Africa – An Overview

This section discusses the available evidence regarding infrastructure spending in Eastern Africa, and the contribution that China is making to investment spending. Gross fixed capital formation (GFCF) as a percentage of GDP, which includes land improvements and the construction of infrastructure by both the private and public sector, is indicative of infrastructure spend of countries. East Africa’s average GFCF spend relative to GDP has consistently been over 20% since 2005, and has been in excess of 25 percent of GDP since 2010 indicating the importance of infrastructure in the region. Ethiopia stands out for its consistent GFCF spend and has one of the highest GFCF ratios globally. In the last decade, on average, Ethiopia has spent the equivalent of 32.8% of its GDP on infrastructure (Deloitte, 2016).

According to figures provided by Deloitte, Kenya is the regional powerhouse in terms of the number of projects, with 11 large-scale projects, 25.6% of the total, closely followed by Ethiopia and Uganda, each with 9 projects, and then Tanzania with 8 projects. In value terms, transport and energy projects have accounted for around 80 percent of all the projects in the region over the period 2013-2016.

There is, however, also some evidence that infrastructure investments in the region have peaked. Following John Magufuli’s election as Tanzania’s president in October 2015, the country has begun implementing austerity measures in an effort to reduce the widening budget deficit. This has included the rationalising of ambitious capital projects and cutting state spending. The suspension of the Bagamoyo Port Project (worth US\$11bn) saw a significant decrease in the value of ongoing projects in

East Africa.⁴ Other countries in the region are also being urged to adopt a more cautious approach to infrastructure development by the International Financial Institutions, though judging by recent announcements of budgets going forward for 2018/19, governments are reluctant to heed those warnings, and continue to give a high priority to infrastructure spending.⁵

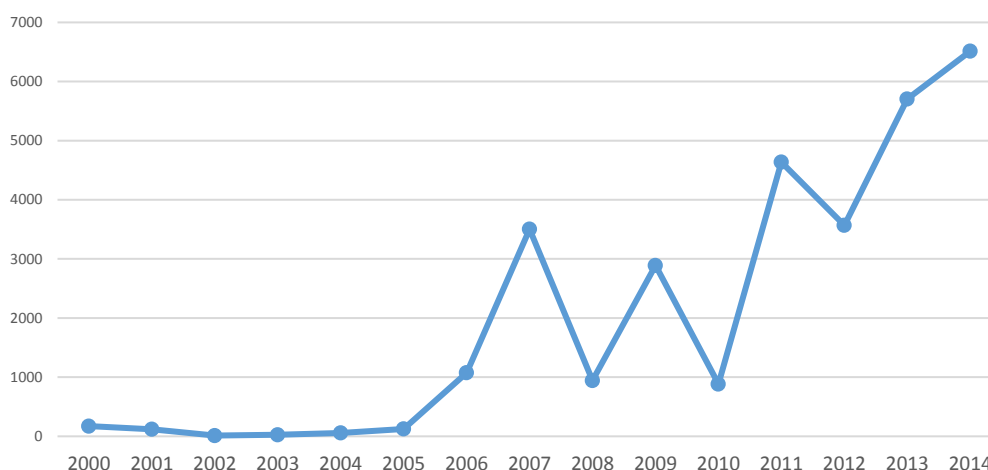
Table 1: East African Infrastructure Projects

	2013	2014	2015	2016
Number of projects	93	51	61	43
Value (US\$bn)	67.7	60.7	57.5	27.4

Source: Deloitte (2017).

And what of the Chinese contribution to these projects? Albeit on partial data, Figure 4 shows the massive increase in infrastructure provision through Chinese projects since the early 2000s.⁶ Total infrastructure spending linked to Chinese projects reached 6 billion USD in 2014, with a very sharp rise since 2010. This went from negligible levels reported in the early 2000s. Clearly, although we do not have figures going beyond 2014 for the region, there has been a step-change in the degree of Chinese engagement in the region, and it has been driven principally by increases in financial support to infrastructure development (Figure 5).

Figure 4: Total Chinese Infrastructure Aid per Year to East Africa (millions USD, current prices)



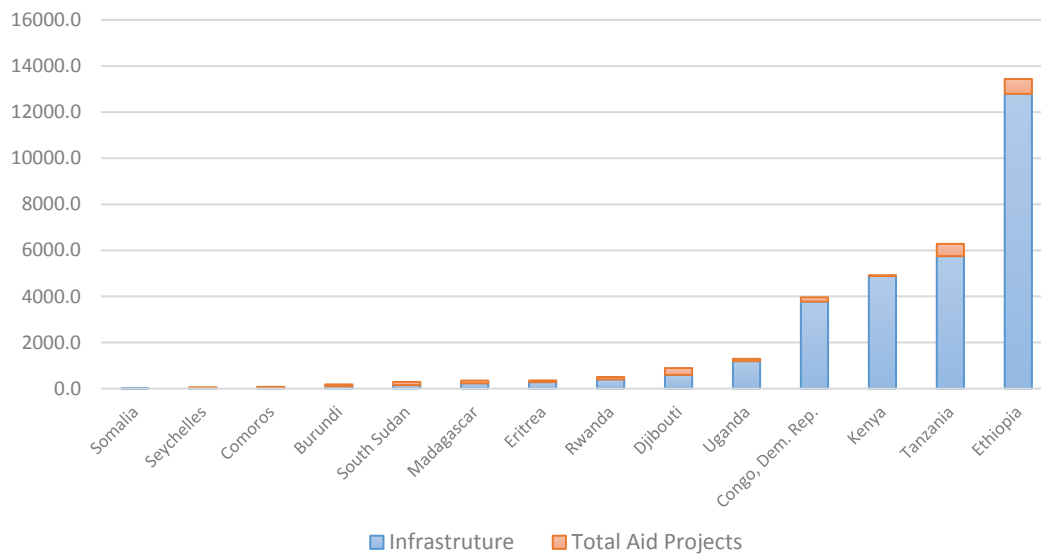
Source: China Aiddata

⁴ Bagamoyo would have become the largest port in East Africa, but the new government instead choose to focus more intensely on the previously delayed ports of Dar es Salaam and Mtwara. The Bagamoyo Project included a new port, supporting rail and road networks and an industrial park. It is not yet known if or when construction at Bagamoyo will resume.

⁵ Cite in footnote articles from the East African on the budgetary commitments.

⁶ This trend mirrors the sharp increase of trading relations with Eastern Africa. For example, in the early 2000s, Chinese trade represented just 2 or 3 percent of all imports into Eastern Africa.

**Figure 5: Chinese Support to East Africa, 2000-2014, by country
(millions USD, current prices)**



Source: China Aiddata

It is hard to exaggerate the suspicions that this Chinese involvement in Africa awakens on the part of many Western observers. Typical of this kind of complaints is a recent article in *The Financial Times* which claimed that while China brings crucial investments and skills for construction infrastructure in Africa, ‘with exceptions, they have done so using equipment and labour imported from home, without transferring skills to local communities’.⁷ Some commenters are less measured in their criticisms. One highly distinguished Canadian scholar recently described how China was ‘raping’ the region.⁸

From East Africa, the perspective is different. Chinese involvement in the region is not without its controversies,⁹ but on the whole Chinese engagement has made a very visible impact on prospects for development, particularly in the area of infrastructure provision. China’s activities in infrastructure are divided fairly evenly between transport and energy, especially railroads and hydropower (Brautigam and Hwang, 2016). Table 2 highlights some of the major projects being undertaken in the region, and the associated financial commitments. It is doubtful whether, in the absence of Chinese engagement and financing, many of these projects would have got off the ground, particularly given the apparent reluctance of the IFIs to support further infrastructure development.

⁷ <https://www.ft.com/content/562692b0-898c-11e2-ad3f-00144feabdc0>

⁸ Personal communication with one of the authors.

⁹ Cite example.

Table 2: Top Chinese-financed projects in Infrastructure in 2015

Country	Financier	Millions USD	Purpose
Kenya	Eximbank	1,500	SGR phase II Nairobi to Malaba sub-phase 1, Nairobi to Naivasha section 120.4km
Uganda	Eximbank	1,445	Karuma hydropower project 600MW with transmission lines and substations
DRC	Eximbank	660	Busanga hydropower project-Sicomines
Djibouti	Eximbank & CCECC	596	Hasan Gouled Aptidon International Airport & Ahmed Dini Ahmed International Airport in Obock
Kenya	ICBC	900	Lamu coal power station, 1,050MW, between Karuma and Soyo

Source: Sais-Cari Economic Bulletin No.1, October 2017: "China-Africa research initiative"

4. Model and data specification

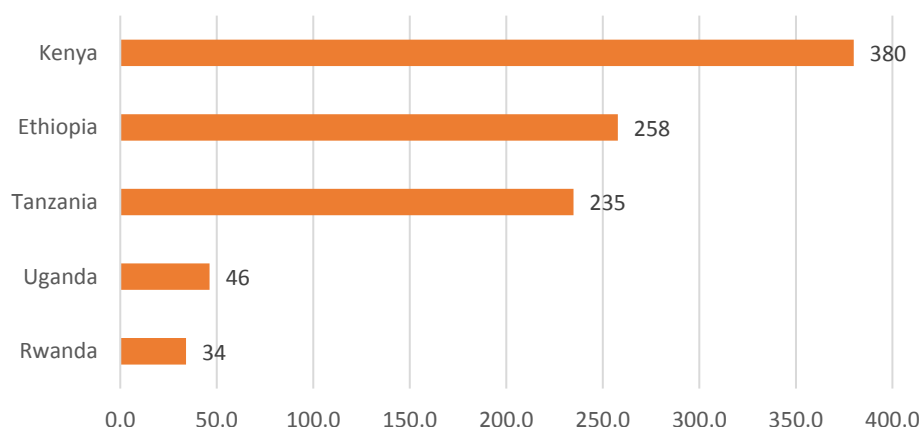
This study uses the Global Trade Analysis Project (GTAP) computable general equilibrium (CGE) model and the new GTAP 10 database to analyse the effects of the China Belt and Road Initiative (BRI) on welfare and trade in Eastern Africa. We assume that the BRI will result in a 10 percent decline in trade margin costs on both exports and imports. Within the parameters estimated in other studies, this represents a quite conservative modelling assumption.¹⁰ We model the reduction in trade margin costs for imports as a 10% increase in productivity in trade margin services (atd) for imports and likewise model a reduction in trade margin costs for exports as a 10% increase in productivity in trade margin services (ats) for exports. The shock is applied to countries in Eastern Africa that are part of the China BRI and these include Ethiopia, Kenya, Rwanda, Tanzania and Uganda. The model closure uses the standard GTAP closure, but adjusted to allow for high levels of un- and under-employment prevalent in the region, by fixing wages for Ethiopia, Kenya, Rwanda, Tanzania and Uganda.

¹⁰ For instance, in a similar exercise, Villafuerte et al. (2016) assumed a 25 percent reduction in international road transport margin for all BRI regions/countries.

5. Results from GTAP Model

Simulation results from the GTAP model show net welfare gains of \$953 million (Table 1) to consumers in the five East African countries. However, as shown in Figure 4, the distribution of these gains will be heavily skewed with 40 percent of welfare gains going to consumers in Kenya, followed by Ethiopia (27 percent) and Tanzania (25 percent).

Figure 4: Welfare Gains (\$US, Millions)



Source: GTAP results

Table 3 shows the decomposition of welfare gains in the region. Endowment effects - which represent changes in the factors of production - constitute the largest share of welfare gains (35 percent). Technology effects (24 percent) and allocative efficiency effects (18 percent) represent the second and third largest shares of the welfare gains. Total net terms of trade also improved as a result of the increase in the prices of exports relative to prices of imported goods.

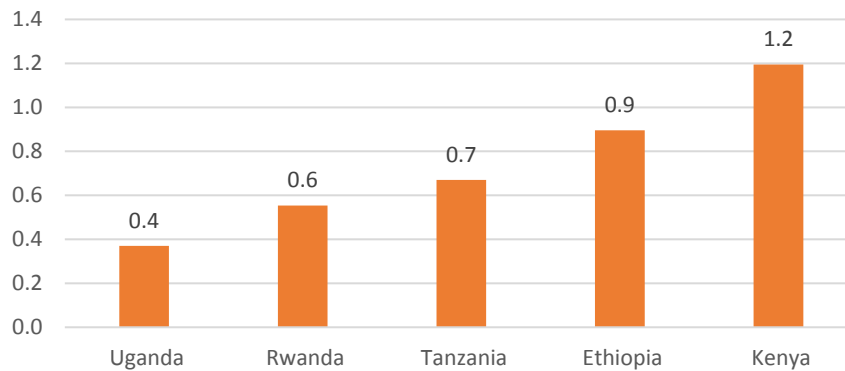
Table 3: Welfare Decomposition (\$US, Millions)

	Allocative Efficiency	Endowment effect	technology effects	Terms of trade effect	Investment savings	Total
Ethiopia	57.8	105.1	39.2	38.4	17.3	257.7
Kenya	45.6	124.1	89.6	55.1	65.6	380.0
Tanzania	55.1	85.2	65.0	23.7	5.8	234.8
Uganda	4.2	12.0	23.3	6.5	0.2	46.3
Rwanda	6.4	11.4	13.8	2.3	0.1	34.1
Total	169.1	337.8	230.9	126.0	89.0	952.8

Source: GTAP results

Decreasing trade margins result in positive changes to GDP (Figure 5). Countries in the region would experience an increase in the value of GDP due to reduced trade margins. Kenya would experience the highest gains (1.2%) while Uganda would experience the lowest benefits (0.4%). While these GDP changes seem small, they are much higher than GDP figures for a similar study in Asia. Villafuerte et al. (2016) assumed a 25% reduction in international road transport margins for all BRI regions in Asia and found that GDP values increased between 0.19 percent and 0.01 percent. This supports the findings in previous econometric literature that the payoffs from infrastructure development produce higher marginal benefits in the context of low-income economies.

Figure 5: Change in value of GDP (%)



Source: GTAP results

The decrease in trade margins would result in changes in supply and demand in the region leading to changes in the values of industry output within the region. Table 4 below shows the distribution of changes in industry output. Average industry output would increase for meat and livestock (0.8 percent), grains (0.3 percent) and processed foods (0.3 percent). This would be due to increased exports and higher prices on the global market. In contrast, however, the average output for textiles, light manufacturing and heavy manufacturing would decrease by 0.6, 0.6 and 0.8 percent respectively due to increased import competition and reduced prices.

Table 4: Percentage Change in industry output by region

	Grains Crops	Meat Lstk	Extraction	Proc Food	Text Wapp	Light Mnfc	Heavy Mnfc
Ethiopia	0.5	1.5	0.1	0.3	-0.5	-0.5	-1.1
Kenya	0.4	0.4	0.3	0.3	-0.7	-0.8	-0.6
Tanzania	0.2	0.4	0.5	0.3	-0.5	-0.9	-1.0
Uganda	0.2	0.2	-0.2	0.2	-0.6	-0.3	0.0
Rwanda	0.2	1.7	0.1	0.2	-0.9	-0.5	-1.2
Average	0.3	0.8	0.2	0.3	-0.6	-0.6	-0.8

Source: GTAP results

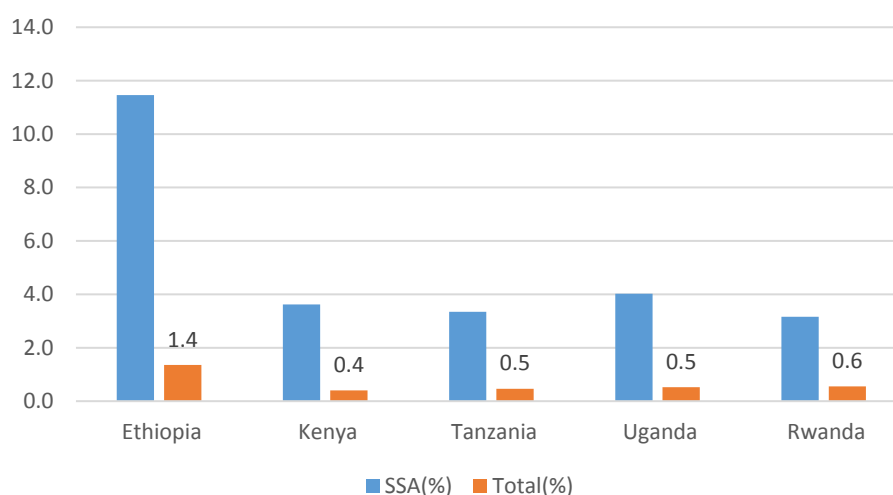
Table 5 shows the changes in the value of merchandise exports as a result of decreased trade margins. Intra-regional exports (sub-Saharan Africa) increased by \$ 278 million while exports to the rest of the world declined by \$ 87 million. As a result, total exports from the region increased by \$192 million. The change to intra-regional exports was skewed with Ethiopia increasing by 11.4 percent while the other countries increased by less than 5 percent (Figure 6).

Table 5: Change in Exports (Millions, USD)

	Total	Intra-regional (SSA)	Rest of world
Ethiopia	86.9	124.0	-37.4
Kenya	35.1	65.5	-30.5
Tanzania	33.7	45.4	-11.7
Uganda	27.3	35.8	-8.6
Rwanda	8.6	7.0	1.6
Total	191.6	277.7	-86.6

Source: GTAP results

Figure 6: Percentage change in Exports



Source: GTAP results

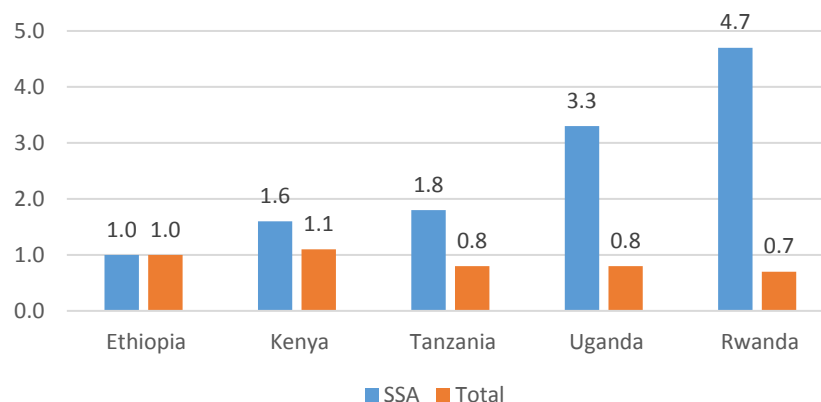
Table 6 shows the changes in the value of merchandise imports as a result of decreased trade margins. Intraregional imports (sub-Saharan Africa) increased by \$127 million while imports from the rest of the world increased by \$ 447 million. As a result, total imports to the region increased by \$574 million. Intraregional imports to Rwanda increased by 4.7 percent compared to 1 percent for Ethiopia (Figure 7).

Table 6: Change in Imports (Millions, USD)

	Intraregional (SSA)	Rest of world	Total
Ethiopia	5.1	125.8	130.9
Kenya	37.1	218.7	255.8
Tanzania	28.3	101.2	129.4
Uganda	30.4	12.1	42.5
Rwanda	26.0	-10.9	15.1
Total	126.8	446.9	573.8

Source: GTAP results

Figure 7: Percentage change in Imports



Source: GTAP results

6. Conclusions

This study confirms that the BRI initiative could have a very significant positive impact on East Africa. For instance, reducing the export and imports trade margins by 10 percent as a result of the BRI could result in increases the GDP growth in East Africa ranging from 0.4 to 1.2 percentage points. It could also contribute to an increase in regional welfare of nearly \$ 1 billion. The total exports of countries could also increase by \$192 million by boosting intra-regional trade- another important objective against the backdrop of the recently signed African Continental Free Trade Area (AfCFTA).

As is to be expected in this kind of analysis, however, the distribution of benefits arising from BRI is not equal, with some countries benefiting more than others. Indeed, the larger countries, Ethiopia, Kenya and Tanzania would gain substantially more from the BRI initiatives. It is, therefore, in their best interests to make sure that the regional initiatives to improve infrastructural provisions do not stall.

Particularly interesting is the fact that the simulations suggest that the BRI would actually provide more of an impetus to intra-African exports than to exports with the rest of the world (which actually fall under our modelling scenarios). In this sense, only it was not the original purpose of the BRI, it seems that the infrastructure would facilitate the completion of regional agendas to intensify intra-African trade, as reflected in the African Continental Free Trade Area (AfCFTA) that was signed by all but two of the countries (Burundi, Tanzania) in the group of countries studied here.

Also of note, however, is that it would not necessarily help resolve the chronic trade deficits that the region suffers from – the import supply response seems much more pronounced than exports. Transport infrastructure is a ‘two-way’ street, and there is no guarantee that a better provision of infrastructure will be conducive to a supply-side response on the part of regional goods manufactures. That would require other complementary policies to boost productivity.

Issuing a caveat is appropriate in the interpretation of these result. We were not able to include debt sustainability variables in our model and yet the credit risk ratings of these countries are diverse, with some countries closer to debt distress than others. Most recently the IMF managing director Christine Lagarde has urged China to prevent its “Belt and Road” infrastructure plan from driving up debt in the region (Bloomberg, 2018).

Yet it could be the case in Africa at least that Chinese responsibility for that increase in debt has already peaked. In the face of lower commodity prices, commitments to infrastructure development in Africa declined to \$62.5 billion in 2016, its lowest level in five years. That represented a \$16.4 billion fall compared with 2015, mainly due to a large reduction of \$14.5 billion of reported funding from China (AfDB, 2018:82). If this represents a turning point, and these continental-wide trends are generalisable, it could be that China is no longer the main driver of rising debts, and the culprits should be looked for elsewhere.

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