

## Chapter 2

### **Economic Impact Analysis of Improved Maritime Connectivity between Asia and Africa: An Application of IDE-GSM**

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#### **Introduction**

Enhancing connectivity through quality infrastructure is a key growth pathway. In particular, improvements in logistics infrastructure are essential for economic and industrial development in African countries (Limao and Venables, 2001). Now hundreds of infrastructure development projects are in the pipeline or have been implemented in the region to address these issues.

Better connectivity within and between Asian and African countries contributes to trade expansion, productivity enhancement, and the upgrading of global supply chains, thereby enabling these countries to grab the attention of policymakers and international development banks. However, it is not an easy task to prioritize the relevant infrastructure projects and formulate an effective combination of soft and hard infrastructure for logistics. Because an improvement in a specific infrastructure in one country may change the regional logistic flows, the spillovers may affect other countries unintentionally.

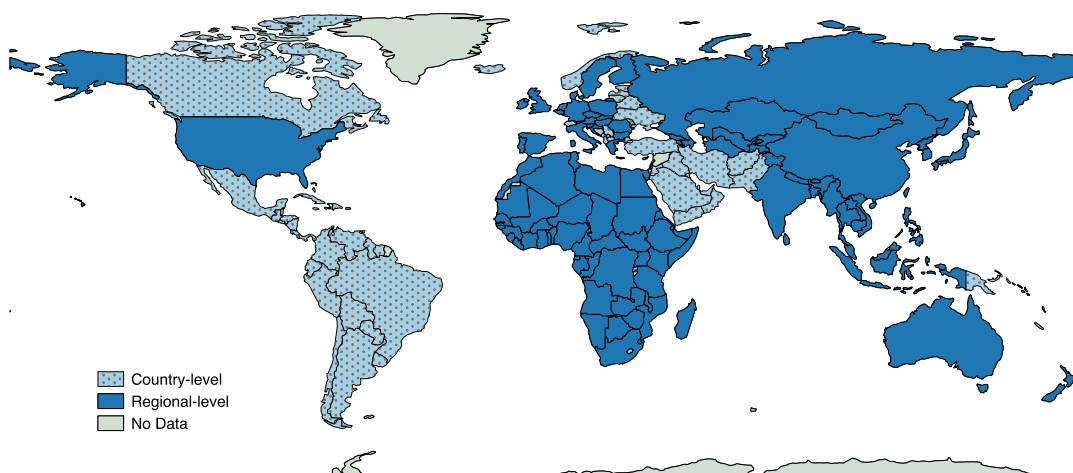
In this paper, we utilize the IDE-GSM (geographical simulation model), a computational general equilibrium model that is based on spatial economics (Kumagai et al. 2013), to analyze the economic impacts of various combinations of soft and hard infrastructure in the Asian and African regions. IDE-GSM has been under development since 2007 and has been utilized in formulating Comprehensive Asian Development Plan (CADP) /CADP 2.0 by ERIA, as well as in various regional development analyses.

#### **1. Compiling geo-economic data for Africa**

To run a simulation scenario using IDE-GSM, we need two types of datasets, namely, an economic dataset at the subnational level and a logistic network dataset. Figure 1 shows the geographical coverage of IDE-GSM as of January 2018. We constructed a geo-economic dataset for Africa by utilizing nighttime satellite imagery and land-use data by following the

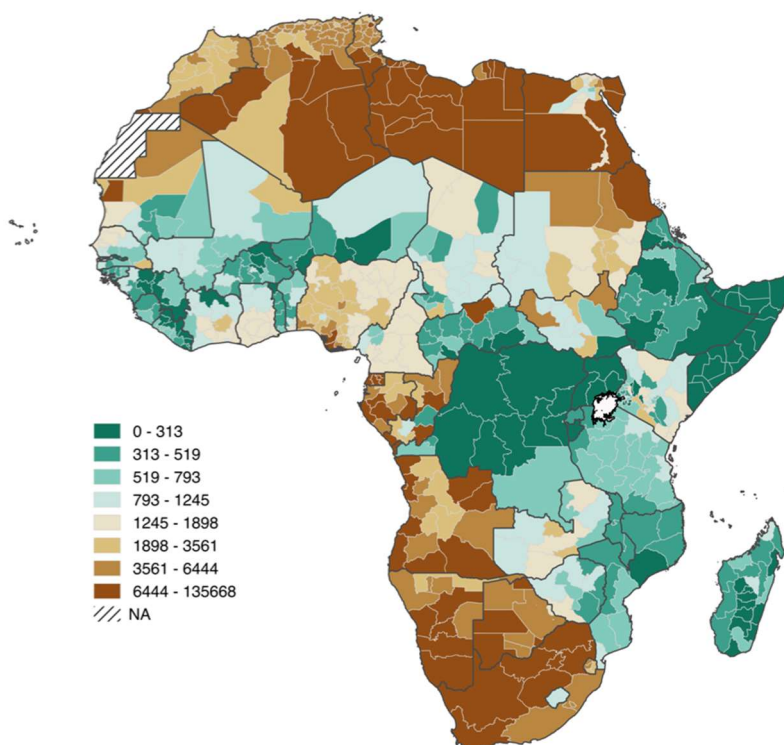
course charted by Keola and Kumagai (2016). We further improve the method of interpolating GDP in the mining sector by utilizing the number of mines of each mineral resource and the mineral export data for each country. Figures 2 and 3 show the 2010 GDP per capita and GDP density (GDP/km<sup>2</sup>) of African countries at the subnational level.

Figure 1: Geographical Coverage of IDE-GSM (as of August 2017)



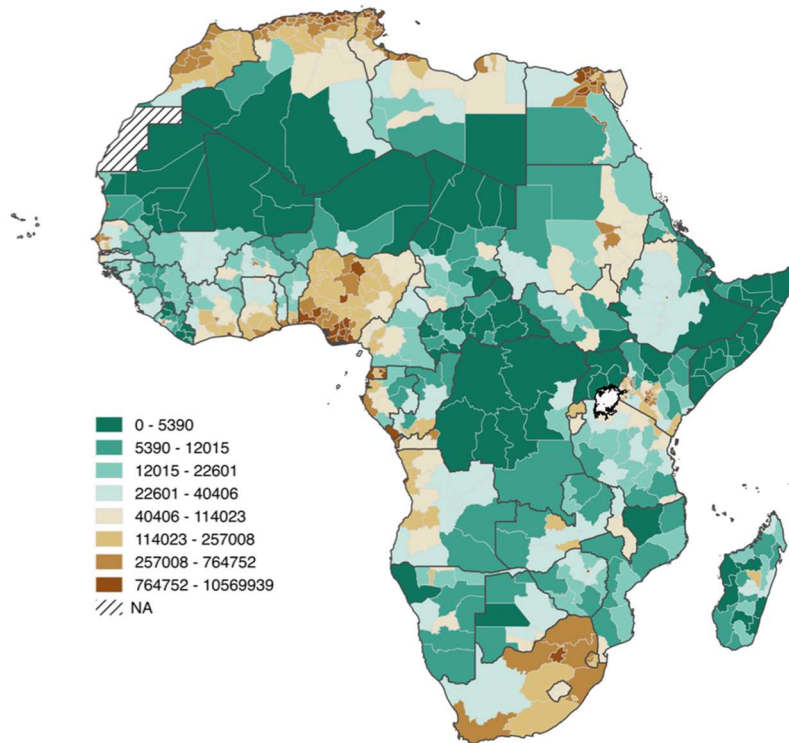
Source: Authors.

Figure 2: GDP per capita in 2010



Source: Authors.

Figure 3: GDP Density in 2010



Source: Authors.

## 2. Maritime Connectivity between Asia and Africa

Among various kinds of infrastructure, we concentrate the analysis on the trade and transport facilitation measures (TTFMs). The enabling of maritime transportation between Asia and Africa is one of the most important areas needing improvement in order to boost connectivity between the two regions, and the land transport networks in Africa also acquire the same importance, considering that some African countries are landlocked.

Software infrastructure improvement is also important. Inefficiencies in handling goods at ports and airports easily lead to the loss of a few days; indeed, the inefficiency of customs clearance at the border is a critical issue that must be resolved to facilitate trade. Improving the general business environment is also important in order to enable efficient trade and investment as repeatedly addressed in the *Doing Business* project sponsored by the World Bank.

We briefly overview the maritime networks from/to East African Countries (EACs) and India in terms of vessel movements. By adding up the directional movements of vessels, we calculate the total number of vessels moving between countries (see Table 1). Top three countries of destination are as follows; for Kenya, Tanzania, South Africa, and UAE; for Tanzania, Kenya, Mozambique, and UAE; for Mozambique, South Africa, India and Tanzania; for South Africa, Singapore, India and Mozambique.

With respect to the number of vessel movements and the number of destinations, South Africa is prominent and has proven to be an international hub. Clearly, the average vessel size is large and long-haul vessels are more popular. A closer examination of the top three countries reveals a nested hierarchy of countries. Mozambique is strongly linked to South Africa. Tanzania is linked to Kenya, not South Africa (which is ranked 5<sup>th</sup>). However, Kenya enjoys a nexus with Tanzania and South Africa. These connections suggest that Mozambique is the spoke of South Africa and that Kenya functions as a regional hub under South Africa, serving Tanzania and other neighboring countries.

With respect to India, it can be observed that its coastline is long, it stands between Asia and Africa, and it has many ports and connections to other countries. From Table 2, ranked at the top is Singapore, which is followed by Sri Lanka, the UAE, Malaysia, and Saudi Arabia, in that order. In terms of vessel movements, a close connection with countries in Southeast Asia, the Middle East, and Africa is revealed.

Table 1. Vessel movements with EACs

Rank	Kenya	freq.	avg. dwt	Tanzania	freq.	avg. dwt
1	Tanzania	375	37202	Kenya	375	37202
2	South Africa	227	44323	Mozambique	218	36334
3	United Arab Emirates	198	42767	United Arab Emirates	132	51839
4	Sri Lanka	176	39636	Sri Lanka	101	32268
5	India	165	59033	South Africa	94	48357
6	Oman	136	41186	Oman	82	38728
7	Mozambique	118	40301	India	56	59472
8	Singapore	113	47542	Seychelles	43	29736
9	Saudi Arabia	53	69848	Thailand	32	38958
10	Malaysia	51	35504	Maldives	28	34692
11	Somali Republic	50	30021	Singapore	23	43425
12	Indonesia	24	46059	Saudi Arabia	18	75407
13	Russia	21	51242	Pakistan	16	27971
14	Pakistan	20	41096	Malaysia	16	34123
15	Djibouti	12	37943	Djibouti	14	41672

Rank		freq.	avg. dwt		freq.	avg. dwt
1	South Africa	752	44454	South Africa	1527	91487
2	India	241	59084	Singapore	1402	86519
3	Tanzania	218	36334	India	752	44454
4	Singapore	156	48705	Mozambique	527	75537
5	Kenya	118	40301	Brazil	362	70387
6	Madagascar	111	34402	Mauritius	320	66126
7	Mauritius	70	37138	Malaysia	301	88162
8	United Arab Emirates	55	54320	Nigeria	278	32958
9	Sri Lanka	46	31947	Namibia	249	90766
10	Saudi Arabia	39	57565	Canary Islands	235	71810
11	Malaysia	31	31835	Angola	227	44323
12	Australia	30	57936	Kenya	213	45482
13	Canary Islands	24	35010	U.S.A.	175	48660
14	Oman	19	55503	Argentina	169	68805
15	Pakistan	16	49462	Spain	168	57844
				United Arab Emirates		

Source: LLID'S Global VOYAGES 2015

Table 2. Vessel movements with India

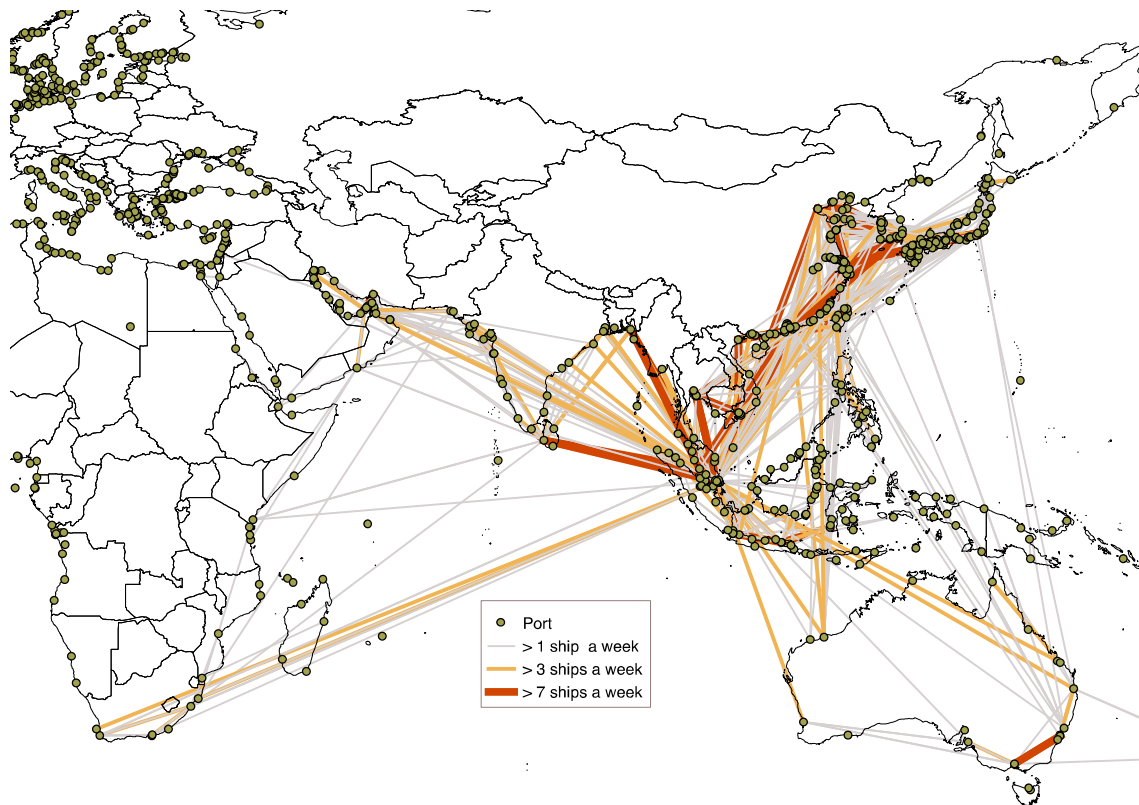
	India	freq.	avg. dwt
1	Singapore	6809	54075
2	Sri Lanka	3354	32021
3	United Arab Emirates	2879	59569
4	Malaysia	1946	38532
5	Saudi Arabia	1657	103078
6	Pakistan	1575	53306
7	Indonesia	1406	31282
8	South Africa	1402	86519
9	Iran	879	47641
10	Brazil	800	97890
11	Oman	710	60323
12	Qatar	494	56898
13	Kuwait	394	100750
14	Iraq	379	195320
15	Bangladesh	341	26784

Source: LLID'S Global VOYAGES 2015

Figure 4 shows the frequency of vessel movement between Asia, Africa, and Oceania in 2015. Thicker lines show a more frequent maritime network. Obviously, the maritime networks between Asia and Africa are less developed when compared with the networks within East Asia, particularly from the east coast of India to Japan. One exception is the maritime network between Singapore and South Africa. There are some frequent shipping lines between Singapore and three ports in South Africa, namely, Durban, Saldanha Bay, and Richards Bay.

For countries on the east coast of Africa, other than South Africa, only two ports have frequent networking with Asia. One is Dar es Salaam, which has a frequent network with Port Salalah, Oman. The other is Mombasa, which has frequent networks with Colombo, Sri Lanka, and Singapore.

Figure 4. Frequency of Vessels between Asia, Africa, and Oceania in 2015



Source: LLID'S Global VOYAGES 2015

### 3. Economic Impacts of Improved Maritime Connectivity

We conducted some simulation analyses to generate a rough idea of the economic impacts from representative TTFMs within East Africa and between East Africa and Southeast Asia. We conducted a simulation analysis for the following four scenarios. In all scenarios, the TTFMs were supposed to have been completed in 2025.

Scenario 1: Ring Corridor in the EACs

- Upgrading the ring road that connects Mombasa, Nairobi, Kampala, Kigali, and Dares Salaam, as well as the road between Kigali and Bujumbura.
- Reducing time and monetary costs at the related national borders by one-half.

Scenario 2: Connecting to Mumbai/Colombo

- In addition to Scenario 1, we add the maritime links between Mombasa/Dar es Salaam and Mumbai/Colombo/Singapore. This means that the connectivity between the said ports is upgraded such that they service the trunk routes for global shipping lines.
- Reducing handling time at the ports from twice the standard costs and time to one-half of the standard costs and time.

Scenario 3: Connecting to Mumbai/Colombo and developing SEZs in Mombasa, Dar es Salaam, and Nairobi.

Scenario 4: Connecting to Mumbai/Colombo, developing SEZs in Mombasa, Dar es Salaam, and Nairobi, and implementing the Mekong–India Economic Corridor (MIEC).

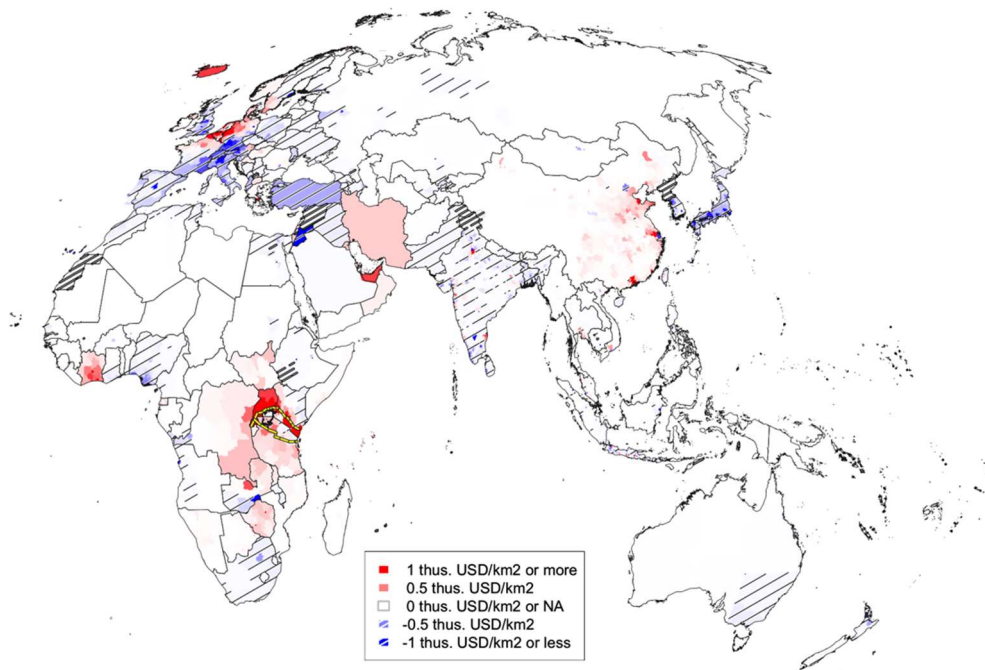
Figure 5 provides a geographical representation of economic impacts according to Scenario 1 against the baseline scenario without TTFM developments. The economic impacts are depicted in USD/km<sup>2</sup> or “impact density” to standardize the differences in the size of each administrative division. The red areas show the regions that have benefited from the positive impacts of development, while the blue areas show those that have borne the negative impacts. The gray areas are the countries or regions on which data are not available or countries where only country-level data is available.

The economic impacts of the ring road connecting the five EACs are limited to those EACs. Almost all the regions in the EACs seem to be benefiting from the development, except for the northern regions of Kenya, which are so far away from the ring road that they cannot benefit from it. This small negative impact emanates from the relocation of industry to regions near the upgraded ring roads. A sectorial analysis reveals that a majority of the

economic impacts come from the service sector. These results can be interpreted as the ring road benefits percolating mainly to service sectors involving trade and tourism and not much the manufacturing sector.

Nonetheless, small yet negative economic impacts are found in East Asian, Middle Eastern, and European countries. This phenomenon is a kind of “diversion” effect from the EACs having closer economic relationships among themselves, making other countries relatively disadvantaged when compared with them.

Figure 5: Economic Impacts under Scenario 1 (2030, against baseline, impact density)



Source: Estimated by IDE-GSM

Table 3 shows economic impacts by industry under Scenario 1 against the baseline scenario without TTFM developments. Economic impacts are shown as a percentage of GDP in 2030. Economic impacts are largest on Tanzania (1.5%), Uganda (1.2%), and Kenya (0.9%), in that order.

By industry, the economic impacts are large in some manufacturing sectors in Burundi and Rwanda, while the economic impacts are larger within service sectors in Tanzania, Uganda, and Kenya. The mining sectors in Rwanda and Uganda have also benefited from the ring road.



Figure 6 shows a geographical representation of economic impacts in Scenario 2 against the baseline scenario. Compared with Figure 5, larger positive impacts are observed in the EACs, as well as other sub-Saharan African countries, India, and Sri Lanka.

Table 3: Economic Impacts under Scenario 1 (2030, against baseline, impact density)

	Agriculture	Automotive	E&E	Textile	Food Proc.	Oth. Mfg.	Services	Mining	GDP
Kenya	0.0%	0.5%	0.2%	0.3%	0.4%	0.2%	1.2%	0.7%	0.9%
Uganda	0.0%	0.1%	0.3%	0.4%	0.7%	0.2%	1.5%	2.8%	1.2%
Burundi	0.0%	2.9%	0.7%	1.4%	2.0%	0.0%	0.0%	0.5%	0.0%
Rwanda	0.0%	2.3%	0.6%	3.1%	3.1%	0.2%	0.0%	4.3%	0.1%
Tanzania	0.0%	0.8%	0.5%	0.5%	0.9%	0.0%	2.2%	0.7%	1.5%
South Africa	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
India	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
ASEAN10	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
China	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Japan	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Korea	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Australia	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
EU	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
United States	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
World	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

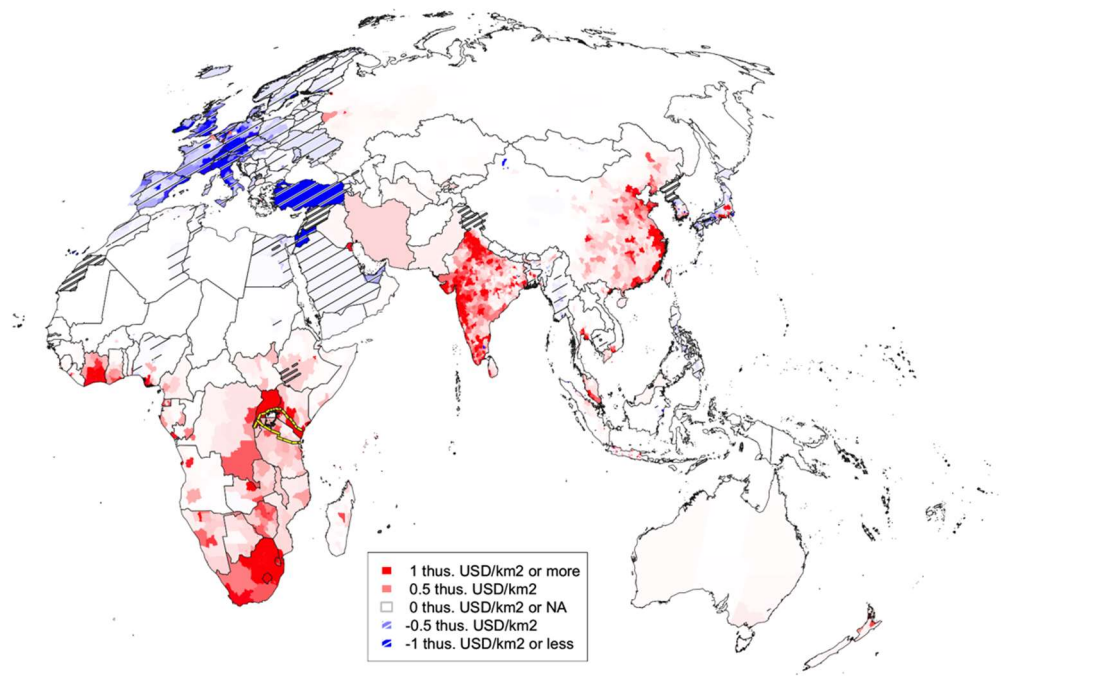
Source: Estimated by IDE-GSM

Table 4 shows economic impacts by industry under Scenario 2, and these are significantly larger for the EACs when compared with Scenario 1. The economic sectors that benefited the most from the development were the textile, food processing, and automotive industries, in that order.

Other than the manufacturing sectors in the EACs, those in South Africa have also benefited from development, and the automotive and textile industries in India have derived some positive effects from it as well. Some larger positive impacts on the manufacturing sector have likewise been observed in the EACs. Even the regions with negative impacts in Kenya under Scenario 1 benefit under Scenario 2.

Figure 7 and Table 5 show the economic impacts under Scenario 3 against the baseline scenario. Figure 7 is not very different from Figure 6, while the economic impacts are larger on countries that have SEZs. For Kenya, the economic impact almost trebles, rising from 1.8% to 4.5%, while for Tanzania, the impact is only slightly larger, rising from 2.1% to 2.3%.

Figure 6: Economic Impacts under Scenario 2 (2030, against baseline, impact density)



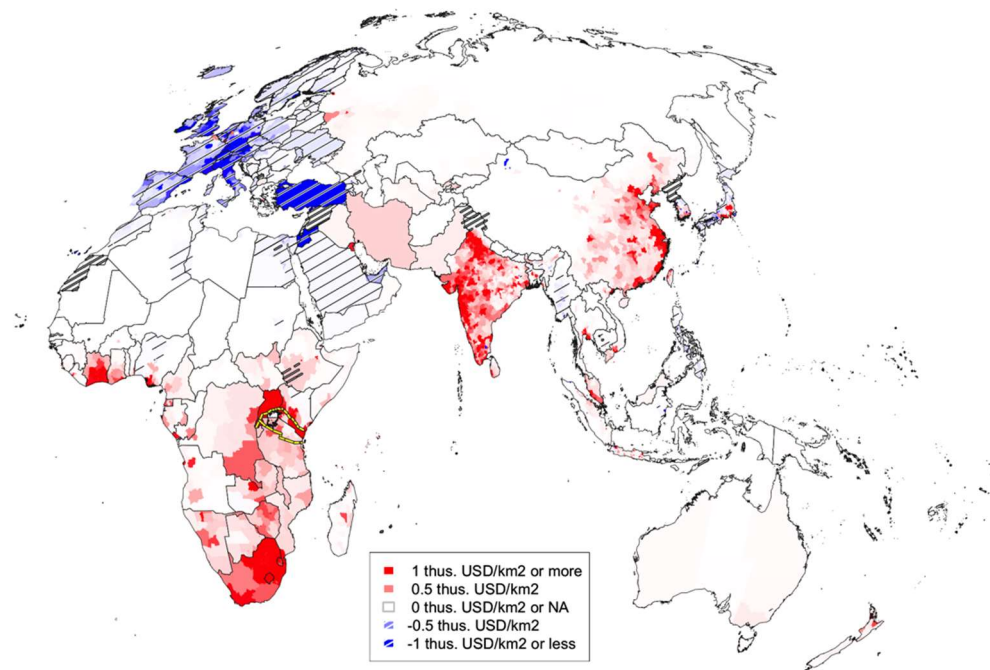
Source: Estimated by IDE-GSM

Table 4: Economic Impacts under Scenario 2 (2030, against baseline, impact density)

	Agriculture	Automotive	E&E	Textile	Food Proc.	Oth. Mfg.	Services	Mining	GDP
Kenya	0.0%	10.1%	0.7%	41.6%	19.6%	1.6%	1.0%	6.1%	1.8%
Uganda	-0.1%	3.5%	0.3%	37.8%	18.5%	1.0%	1.4%	6.4%	1.9%
Burundi	-0.1%	9.1%	0.9%	12.0%	12.4%	0.3%	-0.1%	0.3%	0.2%
Rwanda	0.0%	12.8%	0.6%	44.9%	14.8%	0.6%	0.0%	7.2%	0.5%
Tanzania	-0.1%	19.3%	0.8%	23.5%	23.9%	1.7%	2.1%	8.2%	2.1%
South Africa	0.0%	6.9%	0.1%	9.6%	8.0%	1.1%	-0.1%	0.5%	0.3%
India	0.0%	0.6%	0.0%	0.5%	0.2%	0.1%	0.0%	1.0%	0.1%
ASEAN10	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.0%
China	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.0%
Japan	0.0%	0.0%	0.0%	-0.1%	0.0%	0.0%	0.0%	0.1%	0.0%
Korea	0.0%	0.0%	0.0%	-0.1%	0.0%	0.0%	0.0%	0.0%	0.0%
Australia	0.0%	0.1%	0.0%	0.0%	0.2%	0.0%	0.0%	0.1%	0.0%
EU	0.0%	-0.1%	0.0%	-0.1%	-0.1%	0.0%	0.0%	0.0%	0.0%
United States	0.0%	0.0%	0.0%	-0.1%	0.0%	0.0%	0.0%	0.0%	0.0%
World	0.0%	0.1%	0.0%	0.1%	0.0%	0.0%	0.0%	0.1%	0.0%

Source: Estimated by IDE-GSM

Figure 7: Economic Impacts under Scenario 3 (2030, against baseline, impact density)



Source: Estimated by IDE-GSM

Table 5: Economic Impacts under Scenario 3 (2030, against baseline, impact density)

	Agriculture	Automotive	E&E	Textile	Food Proc.	Oth. Mfg.	Services	Mining	GDP
Kenya	-0.3%	16.6%	6.6%	48.6%	26.0%	8.6%	3.3%	6.0%	4.5%
Uganda	-0.1%	3.5%	0.3%	37.9%	18.7%	1.0%	1.4%	6.4%	1.9%
Burundi	-0.1%	9.2%	0.9%	12.0%	12.4%	0.3%	-0.1%	0.3%	0.2%
Rwanda	0.0%	13.1%	0.7%	44.9%	14.9%	0.6%	0.0%	7.2%	0.5%
Tanzania	-0.1%	20.0%	1.4%	24.1%	24.6%	2.4%	2.2%	8.2%	2.3%
South Africa	0.0%	6.9%	0.1%	9.6%	8.0%	1.1%	-0.1%	0.5%	0.3%
India	0.0%	0.6%	0.0%	0.5%	0.2%	0.1%	0.0%	1.0%	0.1%
ASEAN10	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.0%
China	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.0%
Japan	0.0%	0.0%	0.0%	-0.1%	0.0%	0.0%	0.0%	0.1%	0.0%
Korea	0.0%	0.0%	0.0%	-0.1%	0.0%	0.0%	0.0%	0.0%	0.0%
Australia	0.0%	0.1%	0.0%	0.0%	0.2%	0.0%	0.0%	0.1%	0.0%
EU	0.0%	-0.1%	0.0%	-0.1%	-0.1%	0.0%	0.0%	0.0%	0.0%
United States	0.0%	0.0%	0.0%	-0.1%	0.0%	0.0%	0.0%	0.0%	0.0%
World	0.0%	0.1%	0.0%	0.1%	0.1%	0.0%	0.0%	0.1%	0.0%

Source: Estimated by IDE-GSM

Table 6 shows the economic impacts under Scenario 3 on regions with SEZs, namely, Mombasa and Nairobi in Kenya and Dar Es Salaam in Tanzania. In this analysis, an SEZ implies a 10% increase in regional productivity. With SEZs, economic impacts are much larger.

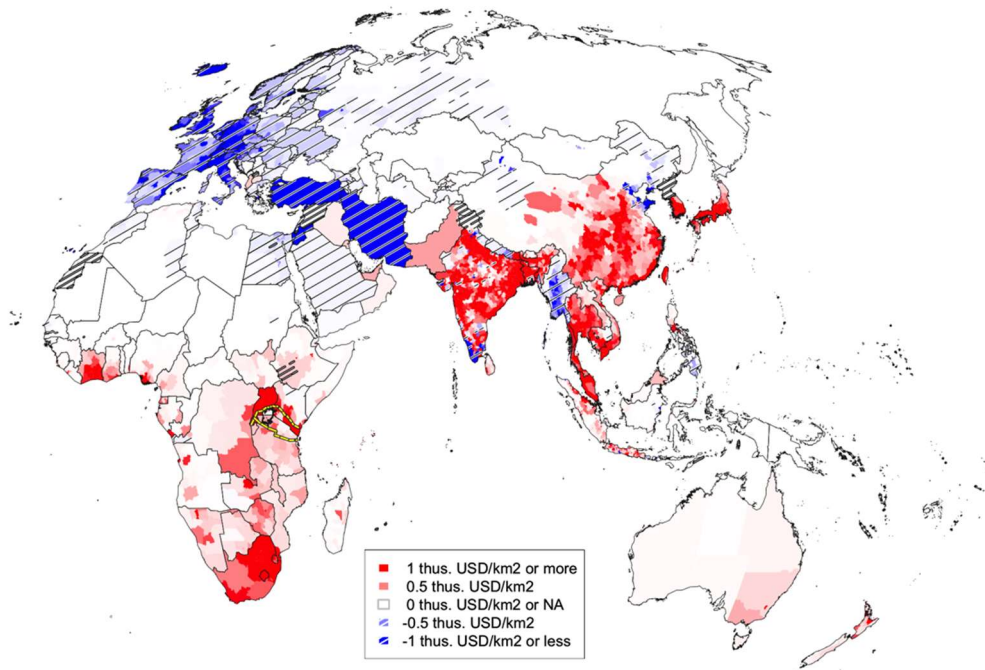
Table 6: Economic Impacts under Scenario 3 for Regions with SEZs (2030, against baseline, impact density)

	Agriculture	Automotive	E&E	Textile	Food Proc.	Oth. Mfg.	Services	Mining	GDP
Mombasa	0.1%	12.1%	1.6%	49.5%	23.5%	1.8%	4.1%	6.5%	4.5%
With SEZ	0.2%	42.5%	29.4%	83.9%	54.0%	29.6%	17.5%	7.2%	19.5%
Nairobi	-0.1%	10.0%	0.4%	41.0%	19.3%	1.5%	0.5%	6.2%	1.5%
With SEZ	-0.1%	39.5%	27.5%	72.9%	48.2%	28.9%	13.1%	6.8%	15.8%
Dar Es Salaam	0.0%	21.2%	0.5%	27.1%	27.6%	2.0%	2.8%	9.0%	2.6%
With SEZ	-0.8%	53.1%	26.8%	54.4%	57.1%	27.7%	14.0%	8.9%	15.2%

Source: Estimated by IDE-GSM

Figure 8 and Table 7 show the economic impacts under Scenario 4 against the baseline scenario. Most of the regions from East Asia to Africa would benefit from such comprehensive development.

Figure 8: Economic Impacts under Scenario 4 (2030, against baseline, impact density)



Source: Estimated by IDE-GSM

Table 7: Economic Impacts under Scenario 4 (2030, against baseline, impact density)

	Agriculture	Automotive	E&E	Textile	Food Proc.	Oth. Mfg.	Services	Mining	GDP
Kenya	-0.3%	16.5%	6.6%	48.0%	25.4%	8.6%	3.3%	6.0%	4.5%
Uganda	0.0%	3.6%	0.3%	37.4%	18.7%	1.0%	1.4%	6.3%	1.9%
Burundi	-0.1%	9.4%	0.9%	11.9%	12.5%	0.3%	0.0%	0.3%	0.2%
Rwanda	0.0%	13.2%	0.7%	45.2%	14.6%	0.6%	0.0%	7.2%	0.5%
Tanzania	-0.1%	19.9%	1.4%	23.8%	24.4%	2.4%	2.3%	8.2%	2.4%
South Africa	0.0%	6.9%	0.1%	9.1%	8.1%	1.0%	-0.1%	0.5%	0.3%
India	0.0%	3.0%	-0.1%	2.6%	2.1%	0.1%	-0.1%	1.3%	0.3%
ASEAN10	0.0%	1.6%	0.0%	1.8%	1.7%	0.1%	0.0%	0.2%	0.3%
China	0.0%	0.0%	0.0%	0.1%	0.1%	0.0%	0.0%	0.1%	0.0%
Japan	0.0%	0.1%	0.1%	0.3%	0.0%	0.0%	0.0%	0.1%	0.0%
Korea	0.0%	0.2%	0.0%	0.5%	0.2%	0.0%	0.0%	0.0%	0.0%
Australia	0.0%	0.4%	0.0%	0.4%	0.2%	0.0%	0.0%	0.1%	0.0%
EU	0.0%	-0.1%	0.0%	-0.2%	-0.2%	0.0%	0.0%	0.0%	0.0%
United States	0.0%	0.1%	0.0%	0.2%	-0.1%	0.0%	0.0%	0.1%	0.0%
World	0.0%	0.4%	0.0%	0.4%	0.3%	0.0%	0.0%	0.2%	0.0%

Source: Estimated by IDE-GSM

## Conclusion

In this paper, we conduct simulation analyses on the improvement of maritime connectivity between Asia and Africa. These simulation analyses lead to the following findings and policy implications. First, improvements in connectivity among the EACs seem to be beneficial for different sectors in each country; however, the size of the benefit is not large and is mainly limited to the five EACs. This means that it only improves inland connectivity among the EACs, which are not well-industrialized. It would not have contributed much to their economic development.

Yet, our simulation analysis reveal that connecting the EACs to East Asia by maritime transport mainly benefits the manufacturing sector in the EACs. We need to think of connecting the EACs to growing manufacturing hubs in Asia so as to assist with industrialization in the EACs. This can be a rationale for public policies aimed at expanding Asian maritime transport networks to the east coast of Africa.

Second, our simulation analysis revealed that if SEZs are developed in major ports or cities, the economic impacts of TTFMs multiply. We need to formulate a policy to invite FDI to these countries so as to unlock the potential of TTFMs, including the development of SEZs.

Third, the improvement in maritime connectivity between East Asia and Africa benefits Indian manufacturing sectors, particularly the automotive and textile industries. Considering that India and South Africa have a considerable stake in the automobile industry, connecting both countries through the EACs may contribute to the development of the automotive

industry in these countries. Considering its geographic proximity, India seems to be a suitable place with which to expand industrial networks for Africa, while ASEAN and the Northeast Asian countries would do well to expand the existing industrial networks first to India.

Overall, we can expect that improving connectivity between Africa and Asia via maritime transport, together with improving overland connectivity among African countries, will be beneficial to both Africa and Asia. Our simulation analyses show that improvements in the maritime networks between Asia and Africa provide essential support for the coming industrialization of African countries.

## **References**

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