# Economywide Impacts of Expansion of Maritime Infrastructure in Senegal

Amarendra Sahoo[*], Victor Vostinaru Nechifor[*], Emanuele Ferrari[*], Damit Serge Didier Amany[**]

**Abstract**

Senegal's port enjoys its strategical location to form Trans-Saharan trade rout boasting as one of the best infrastructure in the region. Country's trade industry largely depends on its port. Over 70% of country's mineral and forest production are exported, while around 15% of its agricultural products enters the export market. About 50% of the Senegal's demand for agricultural products, including rice, come from the imports. Petroleum products and petrochemicals dominate the country's import industry. However, the port capacity is increasingly facing pressures due to its infrastructural constraints, which could create iceberg types of trade costs, and also adversely affect the efficiencies of exports and imports. The infrastructural investment can potentially raise the port capacity and hence will increase the efficiencies of trade transactions, and will raise the preference for traded goods. A recursive dynamic computable general equilibrium model is used to evaluate potential outcome of increased preferences and efficiencies of exports and imports on the economic performances and wellbeing of the country. The model imitates the structure of the Senegal economy in the year 2017 and projected the business usual baseline to 2022. The simulated scenarios are contrasted against the baseline. It is expected that increase in trade, in general, would support increased food security and growth of the economy. However, the impacts of increase in efficiencies and preferences of exports and imports would bring a change in the structure of the domestic activities differently.

**Key words**: Recursive dynamic CGE model, Senegal, Maritime Infrastructure, Maritime Trade efficiencies, iceberg cost, Economic Performances and Wellbeing

[*] Joint Research Centre, European Commission, Seville, Spain
[**] BOAD, West African Development Bank, Togo

# 1. Introduction

Senegal enjoys one of the most successful economy in Economic Community of West African States (ECOWAS) with over 6% of GDP between 2014 and 2019. Thanks to the Priority Action Plan of Phase I Plan for an Emerging Senegal (French acronym PSE) 2014-2018, Government of Senegal initiated the structural transformation of its macroeconomic framework refocusing its priority on infrastructure, mainly transports, energy and agriculture sectors. During 2016–2018 Senegal recorded the highest contribution of investment to real GDP growth, at 5.6 percentage points, because of strong private investment (West Africa Economic Outlook, 2021). Although the new development plan had prompted an increase in the factor productivity of the economy, the performance of the transformation has been still slow. According to the World Economic Forum's Global Competitiveness Report (2019) in terms of infrastructure quality, Senegal with a score of 4.1 out of 7, is behind Rwanda (4.8) or Namibia (5.3) (World Economic Forum, 2019). The vision of Phase II PSE 2019-2024 envisages economic emergence of Senegal by 2035 with the support from increasing private sector driven investment projects in infrastructure. The African Development Bank Group's Country Strategy Paper for Senegal (2021-2025) has also identified infrastructure including transport network as one of the priority sectors in the economy to strengthen competitiveness and regional integration (AfDEV, 2021).

Senegal's trade industry predominantly relies on its port, which enjoys its strategical location to form Trans-Saharan trade rout. The Port of Dakar is the first major port-of-call from Europe and serves as a transhipment centre for landlocked nations in West Africa. It holds almost 90% of the Senegal's trade (USDA, 2019). The port has been the most important for the regional and international trading for petroleum products, besides exports of fish, cotton and mineral products like phosphates and Ilmenite. The annual trade volume of imports and exports handled by the port was estimated to be 9066424 and 2803133 tonne, respectively in 2012. Total volume of imports has increased by about 77% in 2020 over 2016 and volume of exports by 19% over this period. Hydrocarbons accounts around 19% in total import volume in 2020. Rice is the major food crop with about share of 9% in the total import volume. On the other hand, volume of exports from the port has increased by about 40% in 2015 over 2012. Although the total volume of exports from the port has increased in 2020 compared to 2012, there has been declining growth rate -21% in 2020 over 2016. Major export products like Phosphate and Imenite together constitutes around 23% and fish products 10% of shares in total volume of exports from the port (see Table A1).

Although Senegal's infrastructure is one of the best in the West Africa, with the increased pressure on capacity, the port infrastructure faces several challenges that might have resulted in several associated cost escalations and negative impacts on the efficiency. USDA (2019) in its Senegal Exporter Guide Annual 2018 has identified some of the challenges: freight rates and transit times can be higher or longer for shipments originating from the USA; lack of modern cold chain operations, including reliable electricity, for perishable food products creates challenges for transportation outside Dakar; Senegal port fees are higher than neighbouring African countries. The country intends to tackle these challenges through stimulating new investment on expanding Dakar port with greater infrastructure capacity. With the expansion of the port infrastructure, there will be growth to the higher trade capacity leading to higher economic growth. Higher benefit is expected to accrue to the agriculture sector including fish, cotton and horticulture, which are important for the domestic as well export markets. Lower transfer, transaction and logistic costs will reflect on the affordable imported staple foods and products that enter as inputs to the domestic activities. There is more likely to be product diversification due to the lower iceberg costs across the board, which could result in different spill-over effects on the domestic economic activities. Increase in imports of

agricultural and food products can help increase the country's food security. At the same time the structure of domestic agricultural and non-agricultural activities may change prompted by the export competitiveness of some commodities.

Given the significant interlinkages between trade, production, consumption and transaction costs, expansion of port infrastructure is expected to have economy-wide effects through linkages with other sectors and prices. A recursive dynamic CGE model incorporating transfer costs and non-tariff barrier type of iceberg costs linked to the existing port infrastructure is applied to evaluate the impacts of cost reduction and increasing trade capacity due to the expansion of maritime infrastructure on the future growth, wellbeing and food security of the country.

The rest of the paper is organized into four sections. Section 2 outlines the database and the model. Section 3 and Section 4 discuss the scenarios and results, respectively. Section 5 concludes the paper.

## 2. Data and Model

The benchmark database describing the Senegal economy is based on 2014 Social Accounting Matrix (SAM). The Senegal CGE model represents the structure of the economy with 14 regions contributing to the production activities, and factors of production differentiating regional skilled and unskilled labour. Other factors of production are irrigated and non-irrigated land, agricultural and non-agricultural capital and livestock. There are rural urban households for 14 regions, who contribute to the factor endowment and demand system. The model has 66 commodities, of which there are nine subsistence food crops and 17 marketable agricultural commodities.

The study uses a recursive dynamic CGE model that solves sequentially for each period based on economic behaviour and assumptions that link growth of one period to the next till the year 2022. The model closely follows the single country Dynamic Equilibrium Model for Economic development Resources and Agriculture (DEMETRA) model (McDonald et al, 2016). The marginal farmers behave in a semi-subsistence of home production and consumption (HPHC) products assuming a single production activity for each marginal farmer type in a region. The surplus outputs above the HPHC of the marginal farmers enter as the marketable products. The basic features includes flexible CES nested production function with the presence of home production and home consumption' separating marketable and subsistence production activities, flexible CES-LES household demand system and regional based factor market segmentation. Household migration and movement of labour across the skill levels are considered in the model. The model considers multi-product activities using various technological assumptions. Household consumption commodities include 'leisure' consumed by each representative household group, introducing a labour-leisure trade off in the model. The pattern of factor ownership by each household group changes by the interplay of factor mobility and household migration, together with employment changes and the labour-leisure trade-offs.

Following the standard small country assumption, the country is a price taker for imports and cannot affect world prices. The model allows the relaxation of the small country assumption for exported commodities that do not face perfectly elastic demand on the world market. Exported and imported goods are differentiated from the domestically produced goods; domestic production can be exported through an elasticity of transformation and foreign goods can substitute the domestic produce by an elasticity of substitution. The balance of payment constraint incorporates fixed

foreign savings valued in foreign currency. The exchange rate of domestic currency is determined by the market in the model.

Trade and transport margins between factory and dock gate and the consumer are levied on domestic consumption, which are added to the domestic price in addition to the indirect taxes as it is passed on to the consumers as higher consumer price. The freight on board (FOB) export price paid by the foreign importers in the export market includes the trade margin that differentiates the FOB export price from the price received by the producer that produces export goods. The composite price paid by consumers is the weighted sum of domestic and import prices. Similar to the domestic price, the price paid for imported commodities in local currency includes import duties, domestic indirect taxes and transport margin. Trade and transport margins on exportable exports are split into port, air and other transport margins.

For the recursive dynamic, the capital in each sector is updated every year with capital depreciation and investments from the previous period. Capital can be divided into fixed and mobile. Once fixed capital is located within an activity, it can exit that activity by economic and/or accelerated depreciation. On the other hand, the mobile capital enter the pool and can are allocated across activities in the current period in response to the return to capital depending on the level of existing stock. The business as usual (BAU) scenario closely mimics the long run expected growth of the economy, which typically includes forecast of several macro aggregates, e.g. growth in baseline growth in GDP, investment, savings, population and world prices.

## 3. Scenarios

According to the Africa Development Bank (2021), Senegal exports about 77% of its exports to the outside Africa. This indicates the importance of maritime transports for the country. Even though Senegal boasts of having excellent seaport services in the West Africa Region, the efficiency index of seaport services has been only 50% (Singapore tops with 91%), while the boarder clearance index for trade is only 29% compared to 44% for Côte d'Ivoire and 78% for Germany (Global Competitiveness Report, 2019). Trade openness in terms prevalence of non-tariff barriers stands around 45% compared to only 26% in Singapore. Thanks to the private sector involvements in the port service activities, the handling costs of at the Port of Dakar have substantially fallen World Bank (2011). However, compared to the global standard, the costs of importing to Senegal (per container) is still 1.6 times the costs of importing to OECD country. Although, in terms of the average dwell time for container, Dakar Port excels among the African competitors, general-cargo vessel stay/turnaround time (60) still remains higher than neighbouring ports (2.2 for Côte d'Ivoire, 40.8 for Nigeria, and 48 for Ghana and Benin) (Torres et al, 2011). The average general-cargo-handling charge (ship to gate) has been $15 per tonne in Dakar compared to $8-$10 in Nigeria, Benin and Togo.

Senegal maritime activity still can improve to achieve best practices. Investing in maritime infrastructure would help facilitate trade by reducing transaction and several handling costs. Iceberg costs can simply be modelled as non-tariff measures (NTM) in terms of loss of imports and exports due to the trade transaction costs at the border, e.g. freight and time costs, storage and distributional costs, and several associated non-tariff policy distortion. Unlike the tariff equivalent NTMs, where NTMs linked to the additional taxes or tariffs, the price distortions between domestic and foreign goods due to the iceberg costs do not generate economic rents. Iceberg cots are implemented in the global CGE model as change in efficiency by shifting the import augmenting

technical change in the CES Armington function for imports (Hertel et al, 2001; Fox et al., 2003; Francois et al, 2005, Fugazza and Maur, 2008). The indirect non-tariff costs in these studies are the costs due to hindrances in trade facilitation and implemented as ad valorem equivalent technical non-tariff barriers. In our knowledge, very few studies address to port transports in CGE framework. Haddad et al. (2011) have applied a spatial CGE model to transport network system to evaluate impact of increase in port efficiency in Brazil. In our scenarios, we consider all the dead-weight losses in exports and imports due to the prevalence of several transaction and distributional costs resulted from maritime infrastructural constraints. We will consider increase in efficiencies in both export CET and import CES Armington function.

Hummels and Schaur (2013), Hummels et al. (2007) and Walmsley and Minor (2015) have discussed willingness to pay for a reduction in time to tradethat can be converted into ad valorem price. This could be Reduction in time to trade will increase the importers willingness to pay more for the same amount. Walmsley and Minor (2015) have applied this willingness to pay as rise in the marginal utility for the OECD countries. This is implemented as increasing the distributional parameter in the trade equation where the ratio of prices equal the ratio of marginal utility. Authors have relaxed the assumption that the distribution parameters are fixed, although they still ensure the adding up constraint. The impact of this new distribution parameter on demand is very similar to the impact of a change in relative prices, but with the opposite sign.

In our scenarios, we consider all the dead-weight losses in exports and imports due to the prevalence of several transaction and distributional costs resulted from maritime infrastructural constraints. We argue that increase in the port capacity would increase both export supply and import demand by reducing the waiting time and embedded dead-weight losses. Following Walmsley and Minor (2015) approach, the distributional parameters of imports in import demand and exports in export supply functions can be raised. This is equivalent to raising the marginal utility of import and export goods.

Following scenarios are developed for our analysis.

- **Baseline scenario**: The model is calibrated to the year 2017 mimicking the structure of the Senegal economy for that year. The model is then projected to the year 2022 to create baseline growth path.
- **Increase in exports and imports preferences**: Export supply is raised by 20% relative to the supply for domestic demand, and Import demand is raised by 20% relative to domestic demand
- **Increase in export and import efficiencies**: 20% increase in both export and import efficiencies.

# 4. Results

## 4.1 Increase in Preferences for Exports and Imports through

### 4.2 Increased Export and Import Efficiencies

## 5. Conclusion

**References**

AfDEV (2021). Senegal Country Strategic Paper 2021-2025. West Africa Regional Development and Business delivery Office, Country Economic Department (ECCE), African Development Bank Group, Sierra Leon.

Africa Development Bank (2021). West Africa Economic Outlook 2021, Debt Dynamics: The Path to Post-Covid Rcovery. African Development Bank Group, Côte d'Ivoire. www.afdb.org.

McDonald, S., Thierfelder, K. and Ariagie, E. (2016). A Static Applied General Equilibrium Model: Technical Documentation. SRAGE_DEV Version 2. www.cgemod.org.uk.

Fox A., J. F. Francois and P. Londono-Kent (2003). Measuring border costs and their impact on trade flows: The United States-Mexican trucking case. Unpublished manuscript. https://www.gtap.agecon.purdue.edu/resources/download/1492.pdf.

Francois, J. F., H. van Meijl and F. van Tongeren (2005). Trade liberalization in the Doha development round. *Economic Policy*, 20 (42), 349–391.

Fugazza, M. and J. C. Maur (2008). Non-Tariff Barriers in Computable General Equilibrium Modelling. Policy Issues in Ineternational Trade and Commodities Study Series. United Nations. New York and Geneva.

Haddad, E.A., Hewings, G.H.D., Perobelli, F.S. and dos Santos, R.A.C. (2010). Regional effects of port infrastructure: A spatial CGE application to Brazil. *International Regional Science Review*, 33(3) 239-263, SAGE Publications.

Hertel T. W., T. L. Walmsley and K. Itakura (2001). Dynamic effects of the 'new age' free trade agreement between Japan and Singapore. Journal of Economic Integration, 16 (4), 446–484.

Hummels, D., P. Minor, M. Reismann, and E. Endean, (2007). Calculating tariff equivalents for time in trade. N. A. Inc. Arlington, VA, Report for the United States Agency for International Development (USAID).

Hummels, D. and G. Schaur (2013). Time as a trade barrier. *American Economic Review* 103: 1-27.

Terrie Walmsley and Peter Minor (2015). Willingness to pay in CGE model: Estimating the benefits of improved customs efficiencies within the WTO Trade Facilitation Agreement. WORKING PAPER—002 REV-2, ImpactECON Economic Consulting, Colorado, USA.

Torres, C., Briceño-Garmendia, C.M. and Dominguez, C. (2011). Senegal's Infrastructure: A Continental Perspective. Africa Infrastructure Country Diagnostic Development, Country report, The International Bank for Reconstruction and Development / The World Bank, Washington, DC.

USDA (2019). Senegal Exporter Guide Annual 2018. USDA Foreign Agricultural Service, Global Agricultural Information Network, Prepared by Jasmine Osinski and Fana Sylla, Dakar, Senegal.

World Bank (2011). Doing Business 2011: Making a Difference for Entrepreneurs. Washington, DC: World Bank.

World Economic Forum (2019). The Global Competitiveness Report 2019. Ed: Klaus Schwab, Geneva, Switzerland.

**Annexure**