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African economic integration and its effects on climate change adaptation and hunger prevention

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Abstract

We study the effects of the African Continental Free Trade Area on climate change adaptation and mitigation. We also estimate the consequent effects on African economic prospects and food security. We apply a global CGE model that incorporates with several representative concentration pathways on its baseline.

Keywords: Climate Policy, Trade Policy, Economic Development, Food Security, Computable General Equilibrium Models

1 INTRODUCTION

The African Continental Free Trade Area (AfCFTA) launched at the beginning of 2021, making it the largest free trade area in the world by both members and population. The agreement will contribute to a further integration of the African economies, helping them better exploit their economic potential. An array of economic modelling studies has assessed the economic impacts of the agreement, and they indicate overall positive effects on economic activity, consumer welfare and increased trade between African nations (e.g. Mevel and Karingi, 2012, 2013; Jensen and Sandrey, 2015; World Bank, 2020; Fusacchia et al., 2021; Simola et al., 2021). Nevertheless, the environmental aspects of the agreement remain little studied, and greening of the agreement gains increasing policy interest (e.g. van der Ven and Signé, 2021).

Deepening integration notwithstanding, global warming poses increasingly alarming threats to economic development in Africa. Especially the mid-latitude nations, which Africa has many, are enduring a disproportionate share of the negative consequences of climate change such as droughts and extreme weather events. Climate change can significantly affect global trade patterns because climate conditions are a major determinant of regional production possibilities. This is especially true in Africa, where a relatively high share of value added comes from industries that climate directly affects such as agriculture and forestry. Furthermore, agriculture remains an important industry due to Africa's persistent food security challenges. For instance, a recent assessment by the FAO (2021) predicts that the African food security situation will deteriorate by 2030. Modelling studies have predicted both slower productivity growth and higher prices in agriculture due to global warming (Nelson et al., 2014), which makes the goal of hunger eradication harder to achieve.[1] The high

[1] Hasegawa et al. (2021) estimated that extreme climate events alone could increase the population facing hunger by 11-36% by 2050 worldwide.

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dependence on agricultural income and already high prevalence of hunger and malnutrition make climate change impacts particularly worrying in African countries.[2]

Studies have also shown that freer trade can help in adapting to climate change (e.g. Baldos and Hertel, 2015; Janssens et al 2020). Freer trade enables countries to access larger output and consumption bundles, which helps to mitigate the negative impacts of global warming. In more dynamic terms, freer trade gives countries a better access to foreign investments and new technologies that can help in both climate change mitigation and adaptation. On the other hand, higher income levels induced by freer trade mean increased consumption, which can generate more emissions and thus contribute to further warming of climate. Furthermore, as shown by Hasegawa et al. (2015), mitigation policies are costly and can locally even undermine food security because of negative income effects. The assessment of the net effects is a complicated task and requires using comprehensive modelling techniques.

In this study, we examine whether African countries can improve their climate resilience by engaging in freer trade. Effectively we compare a set of alternative climate change projections in hypothetical trade liberalization scenarios. The projections are based on general circulation model (GCM) predictions on agricultural yields in various representative concentration pathways (RCP). The predictions take into account the fossil fuel emission pathways and the CO_2 fertilization effect. We also examine various strategies of trade liberalizations and their comparative merits in various climate change scenarios. In addition to already agreed tariff reductions, we can identify tariff lines, which can be targeted for further reductions in order to help the adaptation to climate change.

For the analysis, we use the MAGNET model that is a recursive dynamic CGE model of the global economy (Woltjer et al., 2014). The model is based on the GTAP model and database, and it has a recursive dynamic structure for assessing long-term adjustment paths. MAGNET model has a host of modules that enables the evaluation of environmental impacts of various policy changes. In particular, we exploit the footprints module that estimates a variety of environmental footprints of economic activity. In addition, we exploit nutrition module that gives estimates of various nutritional outcomes, e.g. prevalence of hunger. Therefore, we can examine the mitigating effects of free trade on both climate change adaptation and food security.

Our study seeks to answer these questions:

1. How much can economic integration mitigate the harmful effects of climate change in Africa?
2. Do more ambitious trade liberalization targets on particular sectors yield additional adaptation gains?
3. How much the achieved adaptation can contribute to hunger prevention?

The study is structured as follows. Section 2 reviews the literature and section 3 describes the method used in the study. Section 4 outlays the main results while section 5 discusses them in more detail. Section 6 concludes.

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[2] Seekell et al. (2017) found that Africa, despite its high biophysical capacity, has low food system resilience on average due to low production diversity and susceptibility to trade shocks.

2 PREVIOUS STUDIES

The AfCFTA and preceding hypothetical African FTAs have been studied in several papers as *ex ante* evaluations. They indicate positive prospects for GDP and intra-African trade. For instance, an early study by Mevel and Karingi 2012 showed a moderate GDP increase and a significant boost for intra-African trade. A follow-up study (Mevel and Karingi, 2013) showed that agricultural production is likely to increase on average, but not uniformly across African countries. They also found that the non-tariff measure (NTM) reductions constitute a major part of total gains while tariff reduction have a marginal effect. Subsequent studies (e.g. Jensen and Sandrey, 2015; Vanzetti et al., 2018; Saygili et al., 2018; Bouët and Odjo, 2019; Abrego et al., 2019; African Development Bank, 2019; World Bank, 2020; Simola et al., 2021; Fusacchia et al, 2022) have confirmed the pattern. Fusacchia et al. (2022) added the global value chain perspective on the CGE approach, which allowed them to assess the resiliency of African food value chains. Their results indicate increased resiliency due to the AfCFTA albeit with substantial regional variation.

The empirical link between temperature changes and economic outcomes is robust for developing countries. Newell et al. (2021) studied an array of econometric models and found that temperature increases by 2100 generate 1-3% losses in GDP levels, but no statistically significant effects on GDP growth rates. The effect was strongest on poor countries GDP and agricultural output, but not significant for rich countries nor non-agricultural sectors. Studies with various impact assessment models (IAMs) yield similar results (e.g. Rose et al., 2017). Abidoye and Odusola (2015) studied specifically African countries and they found that 1° temperature increase causes a 0.67% reduction in GDP growth. The study also finds that the largest economies of the continent, Nigeria and South Africa, mitigate the effects, which indicates a potential of economic integration for mitigating the climate effects in Africa.

Earlier studies have confirmed the strong connection of African economies and agricultural sectors to climate variables. For instance, Barrios et al. (2010) find that insufficient rainfall explains 15-40% of the GDP gap between Africa and rest of the developing world. Schlenker and Lobell (2010) predict that by mid-century the main stable crop yields decrease by 8-22% due to temperature increases. However, Hasegawa et al. (2016) find that the coarse grains consumed in Africa do not have large negative yield effects due to increased temperatures, which helps to mitigate climate related increase in undernourishment in Africa.

3 METHOD

We employ a global recursively dynamic CGE model because it is well suited for *ex ante* analysis of a policy that affects the whole economy and is explicit on its sectoral changes. The recursive dynamics add realism in the analysis as it integrates baseline projections with explicit trade policy schedules. The model we use is the Modular Applied GeNeral Equilibrium Tool (MAGNET) (Woltjer et al. 2014), based on the GTAP model version 7 (Corong et al., 2017) and database version 10 (Aguiar et al. 2019). MAGNET has several modules that extend the basic GTAP setting, including recursive dynamics. The present analysis uses modules that endogenize the demand for natural resources, and land use between agriculture and forestry, and calculate several macroeconomic indicators of food security, and environmental footprint indicators.

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Due to a variety in African economies, we aimed for as much detail on regional and sectoral levels as feasible. The database includes 40 regions, of which 32 are African countries or composite regions, and 40 tradable commodities that coincide with the production sectors. It is detailed on agri-food industries, and there are 12 commodities in primary food production (agriculture and fisheries) and 9 commodities in processed foods (including animal feed). The detailed lists of regional and sectoral dimensions are included in the appendix.

The simulations run at five-year time steps over the 2020-2050 period to cover the implementation of the AfCFTA from the launch in 2020 to the envisioned full implementation in 2035, and a reasonable medium-term climate effects after the full implementation. Due to the long time-horizon in AfCFTA's implementation, the macroeconomic closure rule allows production structures and trade patterns to adjust according to changes in trade policies. The closure rule assumes that investments are allocated to regions according to the rates of return until the expected rates of return converge. Investments for each region are therefore determined endogenously, whereas the savings are fixed by the regional savings-to-income ratio. Trade balance accommodates the difference between savings and investment so that the regional current account balances.

The model baseline builds upon the well-established global Shared Socioeconomic Pathways (SSP) of which we employ SSP2 (Fricko et al. 2017), the middle-of-the-road projection. In addition to the baseline of the SSP2, we run the alternative SSPs (SSP1, SSP3, SSP4 and SSP5) in order to estimate the AfCFTA's effects in a wider array of future pathways. The baseline includes the following exogenous components: population and GDP growth by region (according to SSPs), factor demand by region and by endowment category (skilled and unskilled labour, capital, and natural resources) and productivity of land by region and by agricultural sector. The trajectory of capital use follows directly from the GDP projection, so that the capital has the same growth rate as the GDP. The overall labour supply follows the population growth, and the proportions between skilled and unskilled labour are derived from educational projections in the Wittgenstein Centre's data on global educational attainment (Goujon et al. 2016). Land productivity projections are based on the yield projections of the Integrated Model to Assess the Global Environment (IMAGE) model. They are applied on land according to agricultural sector and they vary by crop and region.

The baseline starts from the most recent GTAP base year 2014. To base our analysis on data as recent as possible, the baseline is modified as follows:

- adjust the database to the most recent tariff and NTMs data using the Altertax procedure suggested by Malcolm (1998);
- update the database to year 2020 as a historic simulation with the latest IMF's World Economic Outlook (IMF 2021) data for the observed population and GDP growths.

The initial tariff rates are calculated from the MAcMap (International Trade Centre, 2020) data at HS6 level. The NTMs on trade in goods come from World Bank (2019) data based on methodologies described in Kee et al. (2009), and Kee and Nicita (2016) and NTMs on trade in services has been taken from Jafari and Tarr (2017). Tariffs and NTMs are applied bilaterally, and they are aggregated from the HS6 level to the model's commodity level.

The policy scenarios consider tariff cuts separately and in combination with NTMs reductions. At the moment of writing the modalities of the tariff cuts were already known, but the actual offers were neither completed for all countries nor published (Lunenborg 2019). Therefore, we assume that

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countries choose their tariff cuts so that the remaining tariffs maximize the remaining tariff revenues.[3]

4 Results

5 Discussion

6 Conclusion

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[3] The preceding study (Simola et al., 2021) assessed several alternative strategies for tariff reductions. We apply here only the tariff revenue maximization in order to keep the amount of simulations manageable, and maintain clarity in communication of the results. In addition, the differences between different strategies were small at the macro level. We also report only results that combine tariff cuts and NTM reductions.

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