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Trade Liberalization with BRICS: A CGE Model of Egypt

Kareem Ashraf
kareemashraf@aucegypt.edu

THE AMERICAN UNIVERSITY IN CAIRO
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Kareem Ashraf Mohamed Ahmed

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Kareem Ashraf

900130261

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Abstract:

This paper presents an ex-ante impact assessment of a hypothetical FTA between Egypt and the BRICS from an Egyptian economy-wide and sectorial perspectives, with a granular look into manufacturing. The chosen methodology is a static SAM-based Computable General Equilibrium model calibrated to Egypt's 2018-2019 Social Accounting Matrix (SAM). With respect to existing literature, the paper uniquely stands in considering an Egypt-BRICS FTA with a granular assessment of manufacturing subsectors and in running a simulation of Egypt's trade liberalization with the wider BRICS alliance, including the accession of Saudi Arabia, UAE, Ethiopia, and Iran, which joined the bloc along with Egypt in January 2024. Beside the wider BRICS simulation, the model is used to run a simulation with core BRICS members. Magnified upon considering the wider bloc, results predict an increase in real consumption across all household income quantiles with the poor generally reaping more of the welfare gains, defined as the increase in household real consumption. Real GDP expands while inflation is imported on the back of local currency depreciation, implying a positive exchange rate pass-through. On a sectorial level, sectors reliant

on local intermediate inputs suffer as they don't benefit from decreased import prices while still facing foreign competition. On the other hand, sectors with initially competitive export prices thrive on the back of a cheaper local currency.

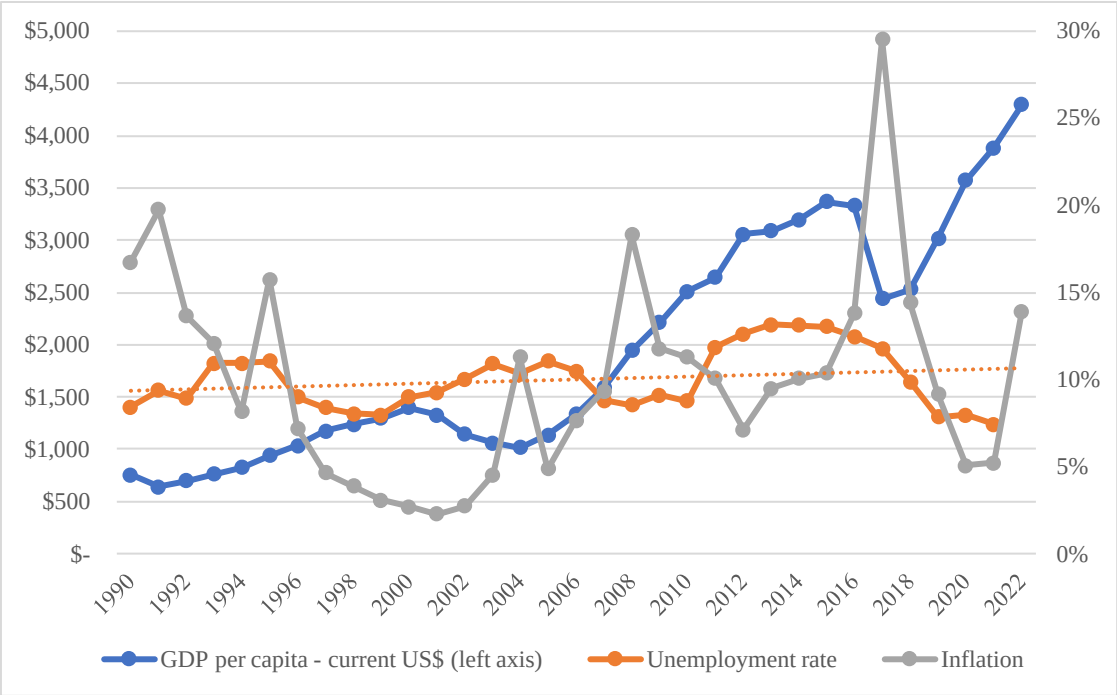
i) Introduction

Free Trade Agreements (FTAs) are mostly associated with benefits that emanate from the elimination of trade barriers such as import tariffs or quotas. In many cases, free trade is seen to unlock welfare gains, which is sometimes defined as an increase in household real consumption, otherwise precluded by the existence of barriers. This stems from access to a greater variety of commodities with different qualities that might outstand its locally produced counterpart, both in terms of specification and price, which can boost consumer surplus and generally enhances market efficiency. A study by Hübler et al. (2017) shows that not only can removing trade barriers enhance welfare, as other literature stand, but it can also be associated with productivity gains that substantially reduce incentives to impose strategic barriers. Productivity gains are usually rooted to cross boarder technology transfers and incentives to increased innovation by local producers to catch up with foreign competition. Other literature highlights the potential risks and challenges that might arise from free trade such as increased competition, volatility due to increased assimilation to international markets, loss of employment, and trade diversion, an inefficiency where generally trade diverts from more efficient to less efficient exporters only on the back of an FTA that creates a price differential in favor of the less efficient ones. Such outcome uncertainty of free trade makes the body of literature on ex-ante and ex-post impact assessment of FTAs quite sizable.

This paper attempts to add to this body of literature by presenting an ex-ante impact assessment of a hypothetical FTA between Egypt and members of the BRICS alliance after Egypt's official accession to the bloc in January 2024, a topic that lacks academic coverage as Egypt's official application to join the block came in June 2023. It uniquely stands in two aspects. First, it considers an Egypt-BRICS FTA while granularly assessing manufacturing subsectors, which is not currently covered in existing literature. Second, it considers a simulation of Egypt's trade liberalization with the wider BRICS alliance, including the accession of Saudi Arabia, UAE, Ethiopia, and Iran, which joined the bloc along with Egypt in January 2024.

The BRICS is an influential economic bloc known for its substantial global presence and market power, denoting a significant force in international trade and finance. On the other hand, Egypt is the 3rd most populous country in Africa after Nigeria and Ethiopia, with a population exceeding 110 million, making up 7.7% of the continent's population and more than 20% of that of the Middle East and North Africa according to the World Bank's latest published data in 2022. Growing at 6.6% in 2022, the Egypt's GDP is mostly composed of output from the services sector followed by industrial and agricultural output, respectively. As per World Bank Data, the Egyptian economy relies heavily on remittances as a main source of foreign currency as well as on foreign currency revenue from the Suez Canal. Additionally, and as seen in the below chart, the country's GDP per capita witnessed periods of exponential growth since 1990, showing relative resilience with respect to major global events and economic turbulence such as the 2020 Covid-19 Pandemic. On the other hand, income per capita seems to be mostly interrupted by local inflationary pressures resulting from shortages in foreign currency and steep devaluation of the Egyptian Pound (EGP), as was the case in the early 2000s, during the US 2008 financial crisis, in 2010s during the Arab Spring, in 2016 following economic hardships and lack of investor confidence after Egypt's

second revolution in 2013. Most recently a foreign exchange crunch took place following Russia's invasion of Ukraine in early 2022, for which inflation started to pick up as seen below with income/GDP per capita still lagging behind. On another note, and during the same period, unemployment hovered around 10% as seen from the orange, dotted trend line, while plummeted during the last two decades on the back of the US 2008 financial crisis and more recently due to the 2020 Covid-19 where it is still picking up pace.



Macroeconomic Indicators – Egypt Source: World Bank Data

Egypt's decision to join the BRICS suggests a shifting paradigm in its foreign policy and economic priorities. Joining BRICS could serve as a catalyst for Egypt's economic growth, initiating a range of social, political, and economic transformations. A significant cross-border economic engagement for Egypt is the Agadir Agreement of 2004 among Egypt, Jordan, Tunisia, and Morocco, which is seen as a building block towards the formation of the European Union-Mediterranean Free Trade Area, combining members of the EU with Egypt, Turkey, Morocco,

Algeria, Tunisia, Jordan, Lebanon, Israel, and the Palestinian National Authority, most of which are members of the Arab League and Arab Maghreb Union with Turkey already maintaining a Customs Union with the EU (see Galal and Hoekman 1997 for an assessment of initial Euro-Med agreements). Conversely and among this group of countries, Egypt's distinct accession to the BRICS alliance marks a shift in Egypt's economic reliance and attention to the 'global South' vs. the EU and the global West.

By examining various aspects of this membership, one can gain valuable numerical insights into the potential benefits and challenges that Egypt might encounter. Focusing on the potential next steps in one aspect of this partnership, this research examines the potential economic benefits and challenges that Egypt may face by liberalizing trade with this dynamic economic bloc. More importantly, challenges may include possible competition from other member countries, market volatility, and required policy adjustments. More generally, the paper focuses on analyzing the impact of one way through which Egypt might integrate into the BRICS on key economic indicators, such as GDP growth, balance of trade, and income distribution.

Using a SAM-based Computable General Equilibrium (CGE) approach in GAMS, this paper investigates and analyzes the potential impact of an Egypt-BRICS free trade agreement on Egypt as the country is set to officially join the alliance in January 2024. The study aims to provide insights into the probable economic consequences that Egypt may experience in a hypothetical scenario of discriminately removing tariff barriers with the alliance economies. Given that Egypt is to join the bloc along with Saudi Arabia, UAE, Iran, and Ethiopia, the study, as mentioned earlier, separately assesses the economic impact of free trade with the core alliance, which includes

Brazil, Russia, India, China, and South Africa as well as with the wider bloc given the new membership expansion.

Given that the body of literature on assessing the impact of economic cooperation between Egypt and the BRICS alliance is minimal, the study holds immense significance for several stakeholders, including policymakers, economists, academics, and investors. By shedding light on the potential impact of an Egypt-BRICS 'Free Trade Agreement' on the Egyptian economy with a detailed focus on manufacturing, this paper can inform strategic decision-making, support policy reforms, attract foreign investment, and contribute to the sustainable development of Egypt's economy.

In the remainder of this paper, section ii will focus on reviewing recently published papers in academic journals that have assessed the impact of trade agreements and economic blocs on member countries, using Computable General Equilibrium models. This includes literature that delves into the sector-specific repercussions of economic integration, focusing on industries such as manufacturing, agriculture, energy, and services. Section iii will delve into the methodology used in this study, CGE models. Discussion will revolve around critical examination of the method and then shift to the specific model used in this paper. Section iv will present the data used in this paper and how it relates to the model under discussion. Section v will present the results of trade liberalization simulations, including the simulated economy-wide and sector-specific impact. Section vi concludes.

ii) Literature review

Using computable general equilibrium models, existing literature on bilateral or regional trade agreements is mostly focused on the assessment of welfare implications, and the impact on the trade balance, trade volume, and trade diversion and creation. Studies also assess the impact of free trade on output, inequality, government revenue, employment, and factor wages. This section will proceed by reviewing such literature most relevant to the subject research, i.e., ones that use CGE models in their analysis, by first looking into bilateral agreements then moving into regional agreements before narrowing it down to the case of Egypt by reviewing literature that assess the impact of the country's trade liberalization using CGE models.

Wei, Zhenhua, and Adam (2019) analyzed the economic impact of the FTA signed by the US and Korea through the lens of a CGE model. Findings show that the reduction of bilateral tariffs on imports elevated welfare in the US by $368.1 million (Wei et al. 2019) with the Terms of Trade (ToT) effect representing at least 87% of the welfare gains arising from reduced import tariffs. Sectoral gross output was also impacted by the US-Korea FTA, where US firms gaining greater access to Korean markets expected to register major profit and sales revenue boosts (Wei et al. 2019), an access granted by a significant tariff reduction by Korea as part of the signed agreement.

Analysis by Cho et al. (2014) of an FTA between Australia and India predicted that trade liberalization with India would result in a huge increase in Australia's overall imports compared to exports; imports were projected to increase by approximately 3.2% per annum. while exports were to grow by 1.61% p.a. The study stipulates that increased trade between both countries would facilitate production in Australia, increasing total domestic production by 0.3% (Cho et al. 2014).

Further, they demonstrated that the FTA would result in an improved ToT for Australia and an appreciation of the Australian dollar. With regard to policy and welfare analysis, free trade with India would increase consumer welfare and government welfare in Australia by 0.31% and 0.74%, respectively, which can be linked to an increase in household disposable income and a fall in the price level (Cho et al. 2014).

Another study assessing the impact of an FTA between India and the US shows that US exports to India grew from $6 billion in 2000 to $32 billion in 2011, while US imports from India during the same period increased from $13 billion to $54 billion (Fukase et al. 2016). Sectoral analysis demonstrated that, over the same period, US agricultural exports to India increased from $0.119 billion to $0.585 billion, services exports increased from $2.58 billion to $11.108 billion, manufacturing exports increased from $3.221 billion to $18.752 billion, mining exports increased from $0.043 billion to $1.141 billion, and processed agriculture exports increased from $0.097 billion to $0.144 billion. On the other hand, US imports of agricultural goods from India increased from $0.548 billion to $0.972 billion, services imports increased from $1.901 billion to $16.921 billion, manufacturing imports increased from $9.941 billion to $33.747 billion, mining imports from $0.027 billion to $0.050 billion, and processed agricultural imports increased from $0.596 billion to $2.277 billion over the same period, respectively (Fukase et al. 2016).

Analysis of a potential FTA between Vietnam and the EU shows a variation in household consumption due to the elimination of industrial tariffs (Le 2019). The study shows that domestic producers are pushed to reduce prices to survive the new competition from imported goods. The reduction of tariffs also results in an increase in factors of production for the service and agricultural sectors in Vietnam (Le 2019). Manufacturers import modern machines, equipment,

and materials from the EU due to the elimination of tariffs for purposes of enhancing their production capacity, leading to faster growth of business and more employment. The increase in Vietnamese Exports to the EU is considered negligible. (Le 2019). The FTA was also predicted to increase Vietnamese imports from the EU, resulting in a trade deficit. Further, Vietnamese tariff-related government income is estimated to decrease by 90.6% due to tariff elimination. In comparison, income tax revenue would increase by 9.13%, and production tax would rise by 3.34% due to increased production and household consumption (Le 2019).

Despite most trade agreements in Asia being bilateral, the continent has witnessed a rise in Regional Trade Agreements (RTAs) involving three or more countries, with examples including the Transpacific Partnership (TPP), the Comprehensive and Progressive Trans-Pacific Partnership (CPTPP), and the Regional Comprehensive Economic Partnership (RCEP). Petri et al. (2019) estimated the impact of such RTAs on Australia's economy by considering the case of CTPPP and RCEP, where they found that the balance of trade does not change significantly over the long term as imports and exports increase nearly at the same rate. Considering that Australia has a comparative advantage in primary sectors such as mining and agriculture and a highly skilled labor force, sectoral analysis show that trade agreements with Asian countries result in higher net exports of services and primary goods and higher net imports of manufactured goods (Petri et al. 2019).

Regionally, a study to estimate the impact of a tripartite FTA involving the Common Market for Eastern and Southern Africa (COMESA), the East African Community (EAC), and the Southern African Development Community (SADC) predicted that gains from full implementation of such arrangement would be substantial due to a collective trade expansion of . $8.5 billion and a major improvement in manufacturing and processed foods (Mold et al. 2016). The study

stipulated that government revenue foregone would be small considering that the countries within COMESA, SADC, and EAC are already facing low average tariffs to deeper integration (Mold et al. 2016). In another study that assessed the economic implications of the African Continental FTA using a CGE model, Maliszewska et al. (2020) show that the FTA would contribute to a structural transformation of employment in Africa, lifting 30 million from extreme poverty. Other potential benefits of the said FTA include the growth of regional output by $211 billion by 2035 (Maliszewska et al. 2020). The impact of the same agreement on Morocco was analyzed by Raouf et al. (2021), which shows that there would be a diversion of trade in favor of the continent and to the detriment of Morocco's trading partners outside Africa, especially in agriculture and mining.

Using a CGE model, Correa et al. (2014) analyzed the possible impact of Preferential Trade Agreements (PTAs) between Brazil and India, China, and South Africa, all members of the BRICS alliance. In one simulation, tariffs on Chinese non-industrial imports were totally eliminated while those on Chinese industrial imports were reduced by 50%, tariffs on Indian non-industrial and industrial imports were reduced by 50%, and all tariffs on all imports from South Africa were removed. The study's simulation results show that Brazil's exports grew by 12%, 87%, and 60% for PTAs with China, India, and South Africa, respectively, while imports increased by 36%, 10%, and 71%, respectively (Correa et al. 2014).

Additionally, a study by Cabrera et al. 2020 showcase the impact of the EU-Mercosur Trade Agreement on Brazil to be improvement in private consumption, GDP, return on capital, wages, and an expansion in aggregate imports and exports. Another study by Rahman et al. (2020) on a trade alliance between India, Australia, Japan, and the US reveals positive economic gains, which tend to increase when South and Southeast Asia join the Indo-Pacific bloc.

While the importance of trade liberalization is emphasized due to the potential of increasing economic welfare in developed and developing countries, a study by Bakeer et al. (2019) reveals that the elimination of tariffs may pose risks for developing countries such as Egypt. The study used a CGE model to analyze the impact of the Egyptian-European Union Association Agreement that targeted tariff rates of Egypt's manufacturing and agricultural sectors. Simulation results show that trade liberalization leads to a decline in the welfare due to a decline in GDP, emanating from lower tariff rates and a decline in aggregate exports caused by Egypt's incapability to compete internationally due to lack of high-quality goods. Tariff reduction caused a decline in domestic output, import prices, domestic sales, aggregate exports, and welfare, while lead to an increase in export prices and inflation (Bakeer et al. 2019). An assessment of an FTA between the US and the UK after Brexit using a CGE model shows that the UK's GDP would increase by $0.202 billion while the US would lose $0.142 billion, resulting in employment losses (Ferry et al. 2021). On another note, the US was predicted to incur employment losses in the auto manufacturing sector due to NAFTA despite Mexico reporting gains in auto production and employment (Ferry et al. 2021). Further, the US was expected to report losses in sales revenue or gross output in 34 out of 57 sectors in its FTA with South Korea as was reported by Wei et al. (2019).

An analysis of the expected impact of an economic partnership agreement between the European Union and African, Caribbean, and Pacific (ACP) countries shows negative net effects on output for the latter (Tröster et al. 10). For example, the Economic Community of West African States (ECOWAS) bloc, East African Community, and SADC report losses of 0.61%, 0.42%, and 0.2% respectively of their GDP (Tröster et al. 2020). Individual countries within these blocs are significantly affected due to their reliance on trade with the EU, fragile sectoral structures, and

level of tariff protection. While the imports from the EU to SADC, the EAC, and ECOWAS rise by 2.2%, 6%, and 8%, respectively, exports from the economic partnership agreement regions remain almost unchanged (Tröster et al. 2020). Further, the economic partnership with the EU results in trade diversion, affecting the intraregional trade. The combined consequence is the decline of the export performance of the African countries involved (Tröster et al. 2020). The diversion effect of FTA was also revealed in a study focusing on the impact of Pakistan's bilateral FTAs with Malaysia and China on Pakistan's existing trading partners. Pakistan's FTA with China was particularly detrimental to Pakistan's trading partners, such as Thailand and Korea, which reported decreases in imports and exports (Zada et al. 2017).

As mentioned earlier, literature on assessing the impact of an Egypt-BRICS FTA on Egypt is minimal. One study that assesses the impact of Egypt's accession to the BRICS bloc using a static computable general equilibrium and with a focus on Egypt's agricultural sectors shows that there will be vital implications in trade output and overall welfare (Ahmed et al. 2020). In one of the scenario simulations presented involving tariff reductions, Egypt reports a 0.06% growth in GDP, $10 million growth in the trade balance, $0.03 million improvement in terms of trade (ToT), a $44 million loss in welfare, 0.05% decline in investment, and a 0.03% growth in consumption. Most of Egypt's trade with existing trade partners, such as the US, diverts to the bloc (Ahmed et al. 2020). Egypt is also reported to achieve increased output levels for sugar crops, wheat, textile and clothing, fiber crops, cereal grain, and light manufacturing. Another scenario that factors reductions in non-tariff barriers results in a 0.25% growth in GDP, $160 million drop in the trade balance, , a $611 million boost in welfare, 0.28% increase in investment, and a 0.43% growth in consumption. To the same conclusion, Zaki shows that general trade liberalization involving a 100 percent reduction in tariff with all trade partners would result in a slight improvement in real GDP

by 0.7% and national welfare due to a decline in domestic prices of imported commodities (Zaki 2021).

As seen, most literature pinpoint that, in most cases, opening up national borders and markets with partner countries facilitates and expands trade with those partners. And sometimes such policy expands their combined pie of output on the back of, not just trade, but other explicit and implicit synergies that might result in productivity gains, which might still come with other associated considerable costs. With the same token, this paper intends to contribute to this body of literature by presenting an ex-ante case of the economic implications expected from an Egypt-BRICS FTA from an Egyptian economy-wide and sectorial perspective, with a granular look into manufacturing.

iii) Methodology

The computable general equilibrium modeling approach is the most preferred methodology in the analysis of FTAs as partial equilibrium fail to factor standard direct or the general equilibrium impact of interactions between price and quantities of the various markets in the economy (Wei et al. 2019). The standard static CGE model is pegged on constructs of a competitive and free market environment, stimulates price adjustment mechanisms, predicts, and simulates the effects of economic policies (Xu 2021). Given that liberalization of trade in the form of free trade may result in the creation and diversion of trade that affects trade flows, it is necessary to understand the economy-wide implications of trade flows. As such, the best instrument to study the wide effects of FTAs is the CGE model due to its capability to simultaneously study the economy-wide impacts of policy change (Zada et al. 2017).

CGE models factor multiple market relationships of consumers and producers in terms of their response to external shocks, regulations, and price signals and within the limits of natural resources, labor, and capital available (Wei et al. 2019). The CGE model portrays the economy as a set of interconnected supply chains, hence their application in the analysis of tax and international trade policy. The advantages of CGE models emanate from being detailed in diverse sectors, fully accounting of all parameters governing the flows of primary production factors and intermediate goods, incorporation of constraints, nonlinearities, consideration of actions of markets and prices, consideration of independencies, and behavioral content (Wei et al. 2019). The use of a model associated with a high level of sectoral disaggregation is preferable in the analysis of FTAs. CGE models provide a clear relationship between the macroeconomy and the microeconomic structure; hence, these models are adept at depicting the interconnections among many markets and industrial sectors. The model can also be applied in the evaluation of indirect and direct impacts of a public policy change on diverse economic variables such as economic welfare, income, employment, and output (Wei et al. 2019).

General equilibrium models provide policymakers with the ability to gain an overview of the macroeconomic impact resulting from diverse shocks in the economy, such as Brexit (Latorre et al. 2020). While partial equilibrium models may provide detailed information in some cases, they suffer from the lack of an overall perspective that is necessary for policy decision-making. General equilibrium models also factor in the knock-on, feedback, and indirect interaction effects originating from diverse forces in the market (Latorre et al. 2020). CGE models factor detailed aspects of the economy such as bilateral trade, demand and supply across factor markets and products, and other macroeconomic aggregates. The model depends on microeconomic

optimization, national account identities, and an improved input-output framework (Latorre et al. 2020).

CGE models capture the microeconomic behaviors such as maximization of utility by consumers and profit maximization by firms (Latorre et al. 2020). The maximization of profit depends on production functions that include inter-sectoral input-output relationships of domestic and imported intermediates and production factors such as capital, land, and labor. Such relationships are depicted mathematically using a huge system of nonlinear equations. Shocks, such as larger tariffs, result in changes in the equilibrium of these nonlinear equations (Latorre et al. 2020).

CGE models are also useful modeling tools for developing countries that mainly suffer from several statistical issues like inconsistent long-term series, unreliable sources, or lack of data (Zaki 2021). CGE models do not require a lot of data, considering that they use only the Social Accounting Matrices (SAM) (Zaki 2021). However, one drawback of SAMs is that it is difficult to change a sector that has been categorized as informal. This means that it may become difficult to explore intra-industry changes in the share of informal to formal employment, ignoring informal workers in all sectors of the economy (Randrianarisoa et al. 2021).

While CGE models are distinguished by the increased application of information related to the structure of the economy instead of time series data, the use of equations founded on the microeconomic fundamentals, and the high level of disaggregation, they are criticized for the use of restrictive assumptions such as price and wage flexibility and full employment (Dzialo et al. 2017). Critics claim that CGE models exaggerate welfare benefits emanating from free trade (Nilsson 2018). For example, when trade costs are decreased, the model's mechanics ensure an

increase in the output of competitive sectors of the economy in relation to the baseline. In contrast, the less competitive sectors usually report reduced output (Nilsson 2018). Critics contend that this can only happen when labor moves from contracting towards expanding sectors associated with increase in wages. This process is pegged on the assumption that there will be no friction. However, such an assumption can be expected to hold within sectors and not across sectors. Labor market frictions such as temporary wage replacement payments and training are some of the fiscal implications required in the adjustment process. However, they are not factored in the macroeconomic welfare analysis (Nilsson 2018).

There are also claims that CGE models may underestimate the impact of trade liberalization. This can be explained by the failure of CGE models to factor productivity gains induced by competition as highlighted in Hübler et al. (2017). Also, most CGE models fail to account for the impact of trade liberalization on foreign investment (Nilsson 2018). This is an important demerit as the presence of foreign direct investment is by itself an enabler for technology and knowledge advancements in recipient economies (Nilsson 2018).

The model used on this paper is based on Lofgren et al. (2002) for its standard nature and suitability for developing countries as Egypt. The subject model is built and ran on GAMS with a structural adjustment to incorporate the inclusion of BRICS besides the rest of the world (ROW). Due to the model's size, this adjustment along with other parts of the model can be seen in the appendix where the model is entirely presented with definitions for its domains, variables, parameters, and equations. In line with the SAM structure, the CGE model used in this study is divided into four equation blocks: the price block, the production and trade block, the institutions block, and the system constraints block.

The production and trade block models the production technology nest for each activity. At the bottom of the nest, intermediate inputs and factors of production are aggregated separately into aggregate intermediate inputs, using a Leontif specification, and aggregate value added, using a constant elasticity of substitution (CES) function, respectively. Both aggregate outputs are then considered as inputs into a Leontif function to determine the activity level at the top of the nest. Commodities that are produced by multiple activities are simultaneously determined and allocated to the various producing activities using collective profit maximization, which is not incidental to the current model.

More important to this study, the production and trade block includes behavioral equations and FOC that factor in producers' choice of the optimal exports-domestic-sales combination based on revenue maximization. This is done using a CES specification. The same is applied to factor in consumers choice of the optimal import-domestic-output based on cost minimization. To account for BRICS as a destination on the producer side, behavioral equations and FOC were added to the standard model for producers deciding on the destination with the higher yield. Same is applied for consumers deciding on the country of origin of the underlying commodity. Producers are assumed to direct exports to the destination with the higher yield, whether BRICS or ROW, simultaneously as they choose the optimal bundle of exports and domestic sales. On the consumer side, demanders are assumed to choose imports from the countries of origin with the lowest cost, whether BRICS or ROW, simultaneously as they choose the optimal bundle of imports and domestic output. Commodities with either imports or domestic sales, but not both, or either exports or domestic sales, but not both, do not go through this process and are determined with a simple linear system, as is controlled by equations' domains.

The institutions block include income and spending of factors, domestic non-government institutions, and government. It also includes intra-institutional transfers, linear expenditure system for household demand, making up the FOC for household utility maximization, investment, and government demand.

System constraints block include identities that has to be satisfied by the whole system but not necessarily by specific agents. It includes equilibrium conditions in factor markets, markets for goods and services, the current account balance, the government budget balance, and the national and foreign savings and investment balance. The model assumes perfect competition.

iv) Data

The CGE model applied in this paper is SAM-based. That is, it relies primarily and feeds on Egypt's latest Social Accounting Matrix (SAM) constructed by Serag et al. (2021) in the "2019 Nexus Social Accounting Matrix for Egypt". The dataset was constructed in collaboration with the Central Agency for Public Mobilization and Statistics (CAPMAS), the official statistical agency of the Government of Egypt (GoE), for the fiscal year 2018-2019.

The SAM presented in the Nexus is a standard SAM. It separates Activities from commodities to treat the commodity accounts as markets through which payments flow in from demanders such as households, enterprises, intermediate demand from producers, government, and non-domestic importers of domestic output. From these markets, payments also flow out to producers of final goods, trade-services providers (transaction costs), indirect/ad-valorem taxes to government, and non-domestic exporters to domestic markets. Although such optionality is not utilized in the subject SAM, the segregation of commodities and accounts also serves to avail room for a single

commodity to be produced by multiple activities and for a single activity to produce multiple commodities (Löfgren et al. 2002).

In this paper, all sectors have been suppressed to a single account for each category except for manufacturing, which was kept at 30 subsectors as this study stands to take a more granular look into the impact of free trade on manufacturing.

The subject SAM is also significantly disaggregated with respect to factors of production accounts, with 8 accounts for labor, segregating urban labor from rural labor and further segregating each into 4 levels of education. Education strata include ‘uneducated’, ‘primary’, ‘secondary’, and ‘tertiary’. One account is allocated for ‘Land’ and 4 for ‘Capital’, originally disaggregated into crops, livestock, mining, and non-primary capital but aggregated into one account in this study.

The SAM includes 3 domestic institutions, one for government and 2 for non-government institutions being enterprises and households. Enterprises are allocated one account while households are segregated into urban and rural households, with each disaggregated into four categories by income level, classified by quantiles of each population.

Other accounts include direct and indirect taxes, with the former applied on factors and domestic non-government institutions and the later on an ad-valorem basis on commodities in the form of sales taxes and tariffs on imports. One account represents transaction costs, which takes in payments from all sectors requiring trade-services such as moving commodities from domestic producers to domestic buyers, from exporters to the national boarders, and from national borders to importers. As mentioned earlier, this account makes payments into the markets for commodities

used for those services. In the subject SAM, sectors providing such trade-services are transport, wholesale and retail trade, and warehousing. The transaction cost account was disaggregated on a per-commodity pro-rata basis with respect to the sum of imports, exports, and domestic sales of domestic output.

Two investment-related accounts are also included in the subject SAM, Saving-Investment (S-I) and Change in Stock, with the former pertaining to investment in long-term-use physical capital while the latter belonging to investment in working capital i.e., inventory. The S-I account captures investment by sector of origin; that is, it captures payments made to sectors whose commodities are used to build physical capital, regardless of the destination sector of such physical capital. In other words, it captures demand for commodities used for investment. The S-I account receives funding directly from domestic and non-domestic institutions while the Change in Stock account receives funding indirectly through the S-I account.

Finally, the subject SAM includes a 'Rest of the World' (ROW) account representing an aggregate of non-domestic institutions, being countries in the rest of the world. This account has been disaggregated into two accounts, ROW and BRICS, to serve the purpose of this paper. Disaggregation was based on the trade volume between Egypt and the BRICS as a share of Egypt's total trade volume. The data was sourced from the United Nations Comtrade database, which aggregates detailed global annual and monthly trade statistics by product and trading partner. Notice that to study the impact of trade liberalization both with the core BRICS and with the wider alliance to account for new members, the disaggregation of the ROW account had to be done twice. Once to segregate the share of 'core' BRICS members of these transactions with Egypt from that of the rest of the world, and another time to segregate the share of the 'wider' BRICS members of

these transactions with Egypt. This means that the model is calibrated twice, once when considering trade liberalization with the core BRICS and another when considering trade liberalization with the wider BRICS. Both calibrations use identical SAMs with the exception of the distributional shares of Egypt's transactions with the last two accounts of ROW and BRICS, but not their sum, which always has to reflect Egypt's total transaction with all other countries however disaggregated. Collected for the year 2019 to match the subject SAM, the data show that the share of the core BRICS alliance of Egypt's trade volume was 22.05%, while that of the wider alliance after accounting for new members stood at 32.12%.

Social Accounting Matrices captures an economy's circular flow. It captures payments from activities/producers to factors, which in turn make payments to domestic (such as households) and non-domestic institutions. These institutions in turn make payments through markets to activities, with the government being paid taxes along the way while savings finding its way into the capital markets. Through capital markets, the investments flow also finds its way to activities through markets of commodities. The underlying theory that governs such flows is captured by the Computable General Equilibrium model, which, as mentioned, is calibrated using the SAM data to regenerate it. After the model is successfully calibrated, it is used as a lab to experiment several scenarios by tweaking parameters or exogenous variables to generate a new SAM or a tweaked version of the initial circular flow presented by the SAM, one that represent the economy under the conditions set forth.

v) Simulation Analysis

This paper analyses two simulation runs using the CGE model described in the previous section. In this section, results of both simulations will be presented and discussed first at the macro

level then at the sectoral level with a more granular look into manufacturing. The two simulations are identical as tariffs applied on BRICS imports are completely eliminated under both. The only distinction is the definition of BRICS, which in one represents only core members of the alliance being Brazil, Russia, India, China, and South Africa and in the other considers new members as well, including Saudi Arabia, UAE, Iran, and Ethiopia. In this section, changes are measured as percent deviation from the base run.

Simulated Economy-wide Impact:

As expected, the impact on the Egyptian economy of trade liberalization is magnified when considering the wider alliance vs. only core members. Although with different magnitudes, the impact seems to fall in the same direction, affecting the same economic variables in both cases alike.

Tariff Elimination on Macro Variables	**Core BRICS**	**Wider BRICS**
Real Consumption - HHrQ1	0.05%	0.07%
Real Consumption - HHrQ2	0.05%	0.08%
Real Consumption - HHrQ3	0.05%	0.08%
Real Consumption - HHrQ4	0.05%	0.07%
Real Consumption - HHrQ5	0.04%	0.06%
Real Consumption - HHuQ1	0.04%	0.06%
Real Consumption - HHuQ2	0.04%	0.06%
Real Consumption - HHuQ3	0.04%	0.05%
Real Consumption - HHuQ4	0.03%	0.05%
Real Consumption - HHuQ5	0.02%	0.03%

In the model, the Egyptian population of households is divided into rural and urban, with each segregated into 5 quantiles. The household population is classified according to household income with Q1 capturing the 20% with the lowest income and Q5 capturing the 20% with the highest income. As seen in the above table, the positive welfare implications of free trade with the alliance, measured by real household consumption, are higher in rural population, HHr, in both simulations.

The average increase in real consumption for rural households is 0.05% upon eliminating tariffs with the core alliance vs. 0.03% for urban households, HHu. This is compared with a 0.07% increase in rural household consumption upon tariff elimination with the wider BRICS vs. 0.05% for urban households. Moreover, within rural households, the first quantile, HHrQ1, reaps more of the welfare gains than the fifth quantile, HHrQ5, under both scenarios. The same is even more pronounced in the urban population structure where, in the core simulation, urban households in the lowest income quantile, HHuQ1, report 2.37 times the welfare gains reported for urban households in the highest income quantile, HHuQ5. This sheds light not only on the geographical redistribution of welfare resulting from free trade with the alliance but also on the within urban/rural population welfare redistribution post import tariff elimination. That is, in general, the poor tend to gain more than the rich as a result of trade liberalization under BRICS. The general increase in real consumption is due to lower composite prices on the back tariff elimination with the alliance countries. On the other hand, the asymmetric gains among household quantiles are mainly rooted in variations in SAM-calibrated parameters of subsistence levels and commodity budget shares in rural vs. urban households and within rural and urban household quantiles.

Tariff Elimination on Macro Variables	**Core BRICS**	**Wider BRICS**
Real GDP	0.06%	0.09%
Nominal GDP	0.15%	0.21%
Exchange Rate	0.21%	0.30%
Trade Balance	-1.24%	-1.80%
Government Deficit	2.24%	3.25%

Nominal GDP, at factor cost, increases by 0.15% and 0.21% in the core and wider BRICS simulations, respectively, while the percentage change in real GDP is reported at 0.06% and 0.09%, respectively, implying an increase in the general price level of 0.09% in the core alliance

simulation and 0.12% in the wider alliance simulation, which, paradoxically, is an indirect impact of tariff removal.

Expectedly, the most direct impact of tariff elimination with the BRICS alliance is an increase in total imports, which will be discussed in the next section upon taking a granular look into simulated sectoral impact. The increase in imports is paralleled with a higher demand on foreign currency, leading to a local currency depreciation. As seen in the above table, the exchange rate, presented in units of local currency per unit of foreign currency, jumps by 0.21% in the core BRICS simulation vs. 0.30% in the wider alliance case, reflecting a depreciation in local currency with respect to foreign currency. This is the main reason behind inflation, implying a positive exchange rate pass-through, the elasticity of import prices in local currency with respect to the exchange rate.

With the same token, the increase in the value of exports coming on the back of a cheaper local currency is outweighed by the increase in the value of imports, pressuring the trade balance in the deficit direction. The trade deficit, or the negative trade surplus, widens by 1.24% in the core BRICS simulation, compared to 1.80% in the wider bloc scenario. Finally, the elimination of tariffs pressures the government budget by decreasing its revenue, widening the government deficit size. The simulated government deficit expands by 2.24% from the base run in the core BRICS scenario, compared to a 3.25% expansion upon eliminating tariffs with the wider alliance.

Simulated Sectoral Impact:

In this part of section viii, the simulated sectoral impact is discussed. Two tables are presented below; the first includes percentage changes from the base run upon simulating tariff

elimination with the core alliance and the second includes the difference between the simulation for the wider alliance and the core alliance. In other words, and for each cell, adding the second table to the first makes up the percentage change for the wider alliance simulation. The tables are identical in structure with rows representing the same economic variables and columns representing the various sectors considered in the model. Economic variables include, for BRICS and ROW and for each sector: import quantity, export quantity, and trade balance. Variables also include, for each sector, domestic output, being the aggregation of domestic sales and total exports, total exports share of domestic output, domestic supply, being the aggregation of domestic sales and total imports, and total imports share of domestic supply.

As seen in the first table, and on the back of an import price differential in favor of the bloc, imports divert from the rest of the world to BRICS in all sectors with few exceptions, where total sectoral imports still increase. Another exception is services, where imports from BRICS and ROW drop by 0.12% in the core BRICS vs. 0.17% in the wider BRICS simulation as the impact of foreign currency depreciation on the import price of BRICS and ROW outweighs the impact of tariff elimination, for which the rate was virtually zero in the base run. In the core BRICS tariff elimination simulation, agricultural imports from core BRICS increases by 0.52%, mining by 0.02%, and manufacturing sectors by an average of 5.28%, with imports of processed fruits and vegetables increasing by 7.67%, refined sugar by 4.85%, other food by a sizable 44.67%, processed tobacco by 12.86%, textiles by 7.63%, clothing by 15.59%, leather & footwear by 17.74%, non-metal minerals by 4.22%, and vehicle and transport equipment by 11.51%. Those sectors witness a softer increase in imports in the wider BRICS simulation, where the percentage changes in imports were lower by an average of 0.28ppts. The softer increase in BRICS-related imports in the wider alliance simulation is linked to the higher pressure on the exchange rate from

liberalizing a greater trade volume, which exerts a further upward pressure on import prices and relatively cancels a greater part of the impact of tariff elimination. While imports with the wider bloc still increase, it inches up at a lower rate.

On the back of a cheaper local currency, exports increase across all sectors with the exception of other grain milling, machinery and equipment, and vehicle and transport equipment where exports drop by 0.02%, 0.10%, and 0.82%, respectively, in the core alliance simulation, and by 0.04%, 0.14%, and 1.21%, respectively, in the wider alliance simulation, noting that these are among the sectors that witness drop in total domestic output. In the core BRICS tariff elimination simulation, agricultural exports to core BRICS and ROW both increase by 0.16%, mining by 0.21%, and manufacturing sectors by an average of 0.23%, with exports of processed fruits and vegetables increasing by 0.30%, refined sugar by 0.23%, other food by a mild 0.02%, processed tobacco by 0.40%, textiles by 0.43%, clothing by 2.01%, leather & footwear by 0.17%, and non-metal minerals by 0.19%. Those sectors witnessed more pronounced increases in the wider BRICS simulation, where the percentage changes were higher by an average of 0.24ppts. As the increase in sectorial imports outweighs that of sectorial exports in most sectors and subsectors, the trade balance with core BRICS and non-BRICS partners deteriorates in most sectors, leading to the drop in the overall balance highlighted in the simulated economy-wide impact sub-section.

The removal of tariff barriers has left some sectors exposed to foreign competition, which, on the back of a higher domestic-import price ratio due to tariff elimination, resulted in imports making up a larger share of such sectors domestic supply, with some exceptions in mining, rice milling, petroleum products, and services. Exceptions exist due to an insignificant downward deviation in the domestic-import price ratio. In these sectors, the share of imports in domestic supply fell by

0.05%, 0.04%, 0.05%, and 0.08%, respectively, with these shares falling further an average of 0.02% upon liberalizing trade with the wider alliance. On the other hand, sectors prone to foreign competition witnesses a significant increase in the domestic-import price ratio, following by an increase in imports share of domestic supply. Specifically, an increase in the share of imports of domestic supply by 1.43% is seen in processed fruits and vegetables, 0.91% in refined sugar, 7.58% in other food, 2.38% in processed tobacco, 0.71% in textiles, 2.53% in clothing, 2.77% in leather and footwear, 0.81% in non-metal minerals, 0.54% in vehicle and transport equipment, and 0.60% in other manufacturing. The wider alliance simulation's increase in the import share of domestic supply of non-resilient sectors surpassed that of the core alliance by 0.66ppts for processed fruits and vegetables, 0.42ppts for refined sugar, 3.71ppts for other food, 1.11ppts for processed tobacco, 0.33ppts for textiles, 1.18ppts for clothing, 1.30ppts for leather and footwear, 0.37ppts for non-metal minerals, 0.25ppts for vehicle and transport equipment, and 0.28ppts for other manufacturing.

Moreover, domestic output fell mostly in sectors in which intermediate inputs are sourced locally. Those sectors do not much benefit from reduced import prices while still potentially face foreign competition. Domestic output fell in services (0.01%), meat processing (0.06%), other grain milling (0.17%), other food (0.12%), cotton yarn (0.05%), textiles (0.05%), leather and footwear (0.17%), wood products (0.18%), machinery and equipment related subsectors (average 0.77%), and other manufacturing subsectors (0.19%). This is exacerbated by an average of 0.13ppts in the wider BRICS simulation as foreign competition expands. As the model assumes frictionless factor mobility with full employment as mentioned earlier, labor employment fall in these sectors. Such labor is reallocated to the remaining manufacturing sectors as well as to agricultural and mining.

Tariff Elimanation - Core BRICS	**agri**	**mining**	**services**	**meat processing**	**seafood processing**	**dairy**	**fruit/veget. Processing**	**fats & oils**	**maize milling**	**Sorghum & millet milling**	**rice milling**	**Wheat & barely milling**	**Other grain milling**	**sugar refining**	**other food**	**animal feed**	**beverage**	**tobacco processing**
Imports - BRICS	0.52%	0.02%	-0.12%	1.71%	0.74%	0.53%	7.67%	1.07%	1.23%		0.02%	0.71%	0.45%	4.85%	44.67%	0.75%	1.58%	12.86%
Imports - ROW	-0.03%	-0.02%	-0.12%	-0.14%	-0.12%	0.00%	-0.19%	-0.04%	0.01%		0.02%	0.00%	-0.23%	-0.02%	-0.19%	-0.03%	-0.05%	-0.10%
Exports - BRICS	0.16%	0.21%	0.14%	0.15%	0.23%	0.23%	0.30%	0.31%	0.21%		0.22%	0.25%	-0.02%	0.23%	0.02%	0.16%	0.18%	0.40%
Exports - ROW	0.16%	0.21%	0.14%	0.15%	0.23%	0.23%	0.30%	0.31%	0.21%		0.22%	0.25%	-0.02%	0.23%	0.02%	0.16%	0.18%	0.40%
Trade Balance - BRICS	-0.11%	1.90%	2.19%	-0.41%	-0.15%	-0.23%	1.03%	-0.25%	-0.46%		0.22%	0.49%	-0.20%	-2.03%	-34.04%	-0.09%	-0.72%	-4.96%
Trade Balance - ROW	0.08%	1.85%	2.19%	0.05%	0.07%	0.00%	0.63%	0.08%	0.06%		0.22%	0.48%	-0.04%	-0.01%	-0.62%	0.13%	-0.03%	-0.20%
Domestic Output	0.03%	0.07%	-0.01%	-0.06%	-0.00%	0.07%	0.06%	0.08%	0.07%	0.07%	0.08%	0.11%	-0.17%	0.06%	-0.12%	0.02%	0.02%	0.06%
Exports/Domestic Output	0.13%	0.13%	0.15%	0.21%	0.23%	0.16%	0.25%	0.23%	0.14%		0.14%	0.14%	0.15%	0.17%	0.14%	0.14%	0.16%	0.34%
Domestic Supply	0.03%	0.04%	-0.04%	0.10%	0.04%	0.07%	0.05%	0.10%	0.07%	0.07%	0.06%	0.08%	-0.12%	0.12%	0.40%	0.03%	0.03%	0.21%
Imports/Domestic Supply	0.06%	-0.05%	-0.08%	0.17%	0.03%	0.05%	1.43%	0.10%	0.21%		-0.04%	0.08%	0.04%	0.91%	7.58%	0.12%	0.27%	2.38%

Tariff Elimanation - Core BRICS	**cotton yarn**	**textiles**	**clothing**	**Leather & footwear**	**wood products**	**paper & publishing**	**petroleum products**	**fertilizers & herbicides**	**other chemicals**	**non-metal minerals**	**metal & metal products**	**machinery & equip.**	**electrical equipment**	**vehicle & transport equip.**	**other manufac.**
Imports - BRICS		7.63%	15.59%	17.74%	1.37%	1.42%	0.01%	0.69%	0.76%	4.22%	1.16%	2.36%	1.08%	11.51%	3.39%
Imports - ROW		-0.60%	-0.24%	-0.36%	-0.30%	-0.10%	-0.03%	-0.07%	-0.06%	-0.16%	-0.37%	-0.56%	-0.58%	-2.98%	-0.38%
Exports - BRICS		0.43%	2.01%	0.17%	0.07%	0.47%	0.20%	0.30%	0.27%	0.19%	0.01%	-0.10%	0.27%	-0.82%	0.13%
Exports - ROW		0.43%	2.01%	0.17%	0.07%	0.47%	0.20%	0.30%	0.27%	0.19%	0.01%	-0.10%	0.27%	-0.82%	0.13%
Trade Balance - BRICS		-4.60%	9.07%	-6.81%	-0.53%	-0.72%	-0.46%	0.62%	-0.38%	1.87%	-0.78%	-1.10%	-1.24%	-6.19%	-5.25%
Trade Balance - ROW		-1.17%	4.91%	-0.47%	-0.10%	-0.17%	-0.42%	0.59%	-0.05%	0.79%	-0.28%	-0.37%	-0.68%	-2.81%	-1.68%
Domestic Output	-0.05%	-0.05%	0.55%	-0.17%	-0.18%	0.12%	0.06%	0.12%	0.07%	-0.03%	-0.23%	-0.42%	-0.07%	-2.37%	-0.19%
Exports/Domestic Output		0.48%	1.45%	0.34%	0.25%	0.34%	0.15%	0.18%	0.20%	0.23%	0.23%	0.32%	0.34%	1.59%	0.32%
Domestic Supply	-0.05%	0.43%	0.47%	0.52%	-0.03%	0.12%	0.03%	0.04%	0.06%	-0.02%	-0.19%	-0.19%	-0.25%	-0.54%	-0.16%
Imports/Domestic Supply		0.71%	2.53%	2.77%	0.10%	0.12%	-0.05%	0.05%	0.06%	0.81%	0.15%	0.27%	0.03%	0.54%	0.60%

Tariff Elimanation - Scenario Delta: Wider minus Core BRICS	**agri**	**mining**	**services**	**meat processing**	**seafood processing**	**dairy**	**fruit/veget. Processing**	**fats & oils**	**maize milling**	**Sorghum & millet milling**	**rice milling**	**Wheat & barely milling**	**Other grain milling**	**sugar refining**	**other food**	**animal feed**	**beverage**	**tobacco processing**
Imports - BRICS	-0.01%	-0.01%	-0.05%	-0.06%	-0.06%	0.00%	-0.09%	-0.02%	0.01%		0.01%	0.00%	-0.10%	-0.01%	-0.12%	-0.01%	-0.02%	-0.05%
Imports - ROW	-0.01%	-0.01%	-0.05%	-0.06%	-0.06%	0.00%	-0.09%	-0.02%	0.01%		0.01%	0.00%	-0.10%	-0.01%	-0.09%	-0.01%	-0.02%	-0.05%
Exports - BRICS	0.07%	0.09%	0.06%	0.06%	0.10%	0.10%	0.14%	0.14%	0.10%		0.10%	0.11%	-0.01%	0.10%	0.01%	0.07%	0.08%	0.18%
Exports - ROW	0.07%	0.09%	0.06%	0.06%	0.10%	0.10%	0.14%	0.14%	0.10%		0.10%	0.11%	-0.01%	0.10%	0.01%	0.07%	0.08%	0.18%
Trade Balance - BRICS	0.04%	0.82%	0.98%	0.02%	0.03%	0.00%	0.28%	0.04%	0.03%		0.10%	0.22%	-0.02%	-0.01%	-0.28%	0.06%	-0.01%	-0.09%
Trade Balance - ROW	0.04%	0.82%	0.98%	0.02%	0.03%	0.00%	0.28%	0.04%	0.03%		0.10%	0.22%	-0.02%	-0.00%	-0.28%	0.06%	-0.01%	-0.09%
Domestic Output	0.01%	0.03%	-0.01%	-0.03%	-0.00%	0.03%	0.03%	0.04%	0.03%	0.03%	0.04%	0.05%	-0.08%	0.03%	-0.05%	0.01%	0.01%	0.03%
Exports/Domestic Output	0.06%	0.06%	0.07%	0.09%	0.10%	0.07%	0.11%	0.10%	0.06%		0.06%	0.06%	0.07%	0.08%	0.06%	0.06%	0.07%	0.16%
Domestic Supply	0.01%	0.02%	-0.02%	0.05%	0.02%	0.03%	0.02%	0.04%	0.03%	0.03%	0.03%	0.04%	-0.05%	0.06%	0.18%	0.01%	0.02%	0.09%
Imports/Domestic Supply	0.03%	-0.02%	-0.03%	0.08%	0.01%	0.02%	0.66%	0.05%	0.09%		-0.02%	0.04%	0.02%	0.42%	3.71%	0.05%	0.13%	1.11%

Tariff Elimanation - Scenario Delta: Wider minus Core BRICS	**cotton yarn**	**textiles**	**clothing**	**Leather & footwear**	**wood products**	**paper & publishing**	**petroleum products**	**fertilizers & herbicides**	**other chemicals**	**non-metal minerals**	**metal & metal products**	**machinery & equip.**	**electrical equipment**	**vehicle & transport equip.**	**other manufac.**
Imports - BRICS		-0.29%	-0.12%	-0.19%	-0.14%	-0.04%	-0.01%	-0.03%	-0.02%	-0.07%	-0.17%	-0.26%	-0.26%	-1.53%	-0.18%
Imports - ROW		-0.27%	-0.11%	-0.16%	-0.13%	-0.04%	-0.01%	-0.03%	-0.02%	-0.07%	-0.17%	-0.25%	-0.26%	-1.33%	-0.17%
Exports - BRICS		0.19%	0.93%	0.07%	0.03%	0.21%	0.09%	0.13%	0.12%	0.09%	0.00%	-0.05%	0.12%	-0.39%	0.06%
Exports - ROW		0.19%	0.93%	0.07%	0.03%	0.21%	0.09%	0.13%	0.12%	0.09%	0.00%	-0.05%	0.12%	-0.39%	0.06%
Trade Balance - BRICS		-0.53%	2.27%	-0.21%	-0.05%	-0.08%	-0.19%	0.26%	-0.02%	0.35%	-0.13%	-0.17%	-0.31%	-1.22%	-0.75%
Trade Balance - ROW		-0.53%	2.27%	-0.21%	-0.05%	-0.08%	-0.19%	0.26%	-0.02%	0.35%	-0.13%	-0.17%	-0.31%	-1.26%	-0.76%
Domestic Output	-0.02%	-0.02%	0.25%	-0.08%	-0.08%	0.06%	0.03%	0.05%	0.03%	-0.02%	-0.10%	-0.19%	-0.03%	-1.07%	-0.09%
Exports/Domestic Output		0.22%	0.67%	0.15%	0.11%	0.15%	0.06%	0.08%	0.09%	0.10%	0.11%	0.14%	0.16%	0.72%	0.15%
Domestic Supply	-0.02%	0.20%	0.22%	0.24%	-0.01%	0.05%	0.01%	0.02%	0.03%	-0.01%	-0.08%	-0.09%	-0.11%	-0.24%	-0.07%
Imports/Domestic Supply		0.33%	1.18%	1.30%	0.05%	0.05%	-0.02%	0.02%	0.03%	0.37%	0.07%	0.12%	0.02%	0.25%	0.28%

vi) Conclusion

In a nutshell, this paper aims to provide a flavor of the economic implications of an Egypt-BRICS FTA from an Egyptian angle both at the economy and sectorial levels. Results show that such agreement will have not only economic but social implications by impacting household income distribution between rural and urban areas and within rural and urban areas. That is, it is expected that the poor will generally reap more of such FTA's welfare gains and that such gains are magnified by expanding this FTA to the wider BRICS alliance to include new members. More broadly, the agreement tends to expand Egypt's real GDP while still importing inflation on the back of a local currency depreciation as it contributes to the expansion of the country's existing twin deficit, being trade and government balances. On a sectorial level, imports from agricultural, services, mining and manufacturing are expected to increase, with food, tobacco processing, and leather and footwear reporting the most impacted. Exports are also generally stimulated on the back of a depreciated local currency but represent an insignificant contribution to the change in total domestic output relative to that of imports on the change in domestic supply. Sectors in which foreign competition takes over as a share of domestic supply due to the FTA include processed fruits and vegetables, processed tobacco, clothing, and leather and footwear. On the other hand, total domestic output tends to shrink for sectors missing most benefits from reduced import prices through intermediate inputs on the back of the FTA while still facing foreign competition.

References

Ahmed, Y. N., Fatma Hefnawy, and V. Shaker. "Egypt's Engagement with the BRICS: Alternative Development Cooperation Initiative." *Journal of Agricultural Economics and Social Sciences* 11.11 (2020): 825-832.

Bakeer, Mayar, and Hebatallah Ghoneim. "Impact of Tariff and Protectionism on Egypt: Overviewing the Egyptian-European Union Association Agreement." IME Conf. 2nd International Conference on Research in Management and Economics. No. 12-14. 2019.

Bakeer, Mayar, and Hebatallah Ghoneim. "To Protect or Not to Protect-Tariffs in Small Countries: Evidence From Egypt." The Journal of Applied Business and Economics 23.7 (2021): 47-56.

Burfisher, Mary E. *Introduction to computable general equilibrium models*. Cambridge University Press, 2021.

Cho, Sang-Wook, and Gordon Yoon. "Sectoral analysis of an Australia–India free trade agreement." *Journal of the Asia Pacific Economy* 19.2 (2014): 205-229.

Correa, Luiz Felipe de Seixas; Thorstensen, Vera Helena; Ferraz, Lucas Pedreira do Couto; Jatkar, Archana; Mukumba, Chenai; Baihua, Gong; Hairong, Luo; Draper, Peter; Dube, Memory. "5th BRICS Trade and Economic Research Network (TERN) meeting: the impact of mega agreements on BRICS." *Center for Global Trade and Investment* (2014).

Dzialo, Joanna, Bogna Gawronska-Nowak, and Ziemowit Stanczyk. "What do we really know about the Transatlantic Trade and Investment Partnership: facts versus myths? Trying to

Understand Social Expectations." *International Journal of Business and Economic Sciences Applied Research* (IJBESAR) 11.1 (2017): 52-60.

El Maaly, Saad Chiekh Ahmed, and Saad Chiekh. "What the Analysis of 136 Studies from 1960 to 2020 Tells Us About Comparative Regionalism Studies." *Economic Issues* 27.Part 2 (2022).

Ferry, Jeff, Badri Narayanan Gopalakrishnan, and Amanda Mayoral. "The Economic Impact of Tariff Eliminations in a US-UK Free Trade Agreement: A CGE Model with Worker Displacement." Available at SSRN 3894566 (2021).

Fukase, Emiko, and Will Martin. "The economic potential of an India-US free trade agreement." *Journal of Economic Integration* (2016): 774-816.

Galal, Ahmed, and Bernard Hoekman. "Regional partners in global markets: Limits and possibilities of the Euro-Med Agreements." *CEPR/ECES* (1997)

Gonzalez Cabrera, Carlos Javier, María C. Latorre, and Gabriela Ortiz Valverde. "A Computable General Equilibrium Model (CGE) assessment of the short and long-run impact on Brazil of the European Union–Mercosur Trade Agreement." *GTAP Annual Conference on Global Economic Analysis* (2020).

Hübler, Michael, and Frank Pothen. "Trade-induced productivity gains reduce incentives to impose strategic tariffs." *Economic Modelling* 61 (2017): 420-431.

Latorre, Maria C.; Olekseyuk, Zoryana; Yonezawa, Hidemichi; Robinson, Sherman. "Making sense of Brexit losses: An in-depth review of macroeconomic studies." *Economic Modelling* 89 (2020): 72-87.

Phat, Le Trung Ngoc; Hanh, Nguyen Kim. "Impact of removing industrial tariffs under the European–Vietn a"m free trade agreement." *Journal of Economics and Development* (2019).

Löfgren, Hans. "*A stylized CGE model for Egypt in GAMS*." No. 3. Working Paper: *The American University in Cairo*, 1993.

Löfgren, Hans, Rebecca Lee Harris, and Sherman Robinson. "A standard computable general equilibrium (CGE) model in GAMS". Vol. 5. *Intl Food Policy Res Inst*, 2002.

Maliszewska, Maryla, et al. "African Continental Free Trade Area: Economic and Distributional Effects." *GTAP Annual Conference on Global Economic Analysis* (2020).

Mold, Andrew, and Rodgers Mukwaya. "Modelling the economic impact of the tripartite free trade area: Its implications for the economic geography of Southern, Eastern and Northern Africa." *Journal of African Trade* 3.1-2 (2016): 57-84.

Nilsson, Lars. "Reflections on the economic modeling of free trade agreements." *Journal of Global Economic Analysis 3.1* (2018): 156-186.

Petri, Peter A., and Michael G. Plummer. "Mega-Regional Agreements and Their Impact on Australia." *Australian Economic Review 52*.4 (2019): 468-475.

Rahman, Mohammad Masudur, Chanwahn Kim, and Prabir De. "Indo-Pacific cooperation: what do trade simulations indicate?." *Journal of Economic Structures* 9 (2020): 1-17.

Randrianarisoa, Hanjatiana Nirina. "The Impact of Trade Liberalization on Informality: Evidence from Egypt and Kenya." *Trinity College Digital Repository* (2021).

Raouf, Radouane, Hajar Dahane, and Nabil El Baouchari. "Impact of AfCFTA implementation on the Moroccan economy: A CGE modeling assessment." *GTAP Annual Conference on Global Economic Analysis* (2021).

Serag, Eman, et al. “A 2019 Nexus Social Accounting Matrix for Egypt”. Vol. 35. *Intl Food Policy Res Inst*, 2021.

Tröster, Bernhard, et al. "Delivering on promises? The expected impacts and implementation challenges of the Economic Partnership Agreements between the European Union and Africa." *JCMS: Journal of Common Market Studies* 58.2 (2020): 365-383.

Wei, Dan, Zhenhua Chen, and Adam Rose. "Estimating economic impacts of the US-South Korea free trade agreement." *Economic Systems Research 31*.3 (2019): 305-323.

Xu, Luyuan. "A quantitative relationship analysis of industry shifts and trade restructuring in ASEAN based on multiregional computable general equilibrium models." *Complexity* 2021 (2021): 1-12.

Zada, Naseeb, and Khalid Khan. "General Equilibrium Analysis of Pakistan's Free Trade Agreements 'A Global CGE Approach'." Proceedings of the Pakistan Society of Development Economists (PSDE), *33rd Annual General Meeting and Conference, Islamabad, Pakistan*. 2017.

Zaki, Chahir. "Trade facilitation and corruption: a CGE model of Egypt." *The Journal of North African Studies* 18.1 (2013): 70-111.

Zaki, City Eldeep1 Chahir. "The Unfinished Business of Stabilization Programses: A CGE Model of Egypt." *EMNES*, 2021.

APPENDIX: MODEL

SETS

$a \in A$	activities
$a \in ACES(\subset A)$	activities with a CES function at the top of the technology nest
$a \in ALEO(\subset A)$	activities with a Leontief function at the top of the technology nest
$c \in C$	commodities
$c \in CD(\subset C)$	commodities with domestic sales of domestic output
$c \in CDN(\subset C)$	commodities not in CD
$c \in CE(\subset C)$	exported commodities
$c \in CEN(\subset C)$	commodities not in CE
$c \in CM(\subset C)$	imported commodities
$c \in CMN(\subset C)$	commodities not in CM
$c \in CT(\subset C)$	transactions service commodities
$c \in CX(\subset C)$	commodities with domestic production
$f \in F$	factors
$i \in INS$	institutions (domestic, BRICS, and rest of the world)
$i \in INSD(\subset INS)$	domestic institutions
$i \in INSDNG(\subset INSD)$	domestic non-government institutions

$h \in H(\subset INSDNG)$ households

PARAMETERS

$cwts_c$ weight of commodity c in the CPI

$dwts_c$ weight of commodity c in the producer price index

$ica_{c\,a}$ quantity of c as intermediate input per unit of activity a

$icd_{c\,c'}$ quantity of c as trade input per unit of c' produced and sold domestically

$ice_{c\,c'}$ quantity of c as trade input per exported unit of c'

$icm_{c\,c'}$ quantity of c as trade input per imported unit of c'

$inta_a$ quantity of aggregate intermediate input per activity unit

iva_a quantity of value-added per activity unit

$\overline{mps}_i$ base savings rate for domestic institution i

$mps01_c$ 0-1 parameter with 1 for institutions with potentially flexed direct tax rates

$pweb_a$ export price (foreign currency) BRICS

$pwer_a$ export price (foreign currency) ROW

$pwmb_a$ import price (foreign currency) BRICS

$pwmr_a$ import price (foreign currency) ROW

$qdst_c$ quantity of stock change

$\overline{qg}_c$ base-year quantity of government demand

$\overline{qinv}_c$	base-year quantity of private investment demand
$\text{shif}_{i\,f}$	share for domestic institution i in income of factor f
$\text{shii}_{i\,i'}$	share of net income of i' to i
ta_a	tax rate for activity a
te_a	export tax rate
tf_f	direct tax rate for factor f
$\overline{tins}_i$	exogenous direct tax rate for domestic institution i
tins01_i	0-1 parameter with 1 for institutions with potentially flexed direct tax rates
tm_c	import tariff rate
tq_c	rate of sales tax
trnsfr_{if}	transfer from factor f to institution i
tva_a	rate of value-added tax for activity a
α_a^a	efficiency parameter in the CES activity function
α_a^{va}	efficiency parameter in the CES value-added function
α_a^{ac}	shift parameter for domestic commodity aggregation function
α_c^{qt}	Top Armington function shift parameter
α_c^{qb}	Bottom Armington function shift parameter

α_c^t	CET function shift parameter
β_{ach}^h	marginal share of consumption spending on home commodity c from a for h
β_{ch}^m	marginal share of consumption spending on marketed commodity c for h
δ_a^a	CES activity function share parameter
δ_{ac}^{ac}	share parameter for domestic commodity aggregation function
δ_c^{qt}	Top Armington function share parameter
δ_c^{qb}	Bottom Armington function share parameter
δ_c^{tt}	Top CET function share parameter
δ_c^{tb}	Bottom CET function share parameter
δ_{fa}^{va}	CES value-added function share parameter for factor f in activity a
γ_{ch}^m	subsistence consumption of marketed commodity c for household h
γ_{ach}^h	subsistence consumption of home commodity c from activity a for household h
θ_{ac}	yield of output c per unit of activity a
ρ_a^a	CES production function exponent
ρ_a^{va}	CES value-added function exponent
ρ_c^{ac}	domestic commodity aggregation function exponent
ρ_c^{qt}	Top Armington function exponent
ρ_c^{qb}	Bottom Armington function exponent

ρ_c^{tt} Top CET function exponent

ρ_c^{tb} Bottom CET function exponent

EXOGENOUS VARIABLES

$\overline{CPI}$ consumer price index

$\overline{DTINS}$ change in domestic institution tax share (= 0 for base; exogenous variable)

$\overline{FSAV}_{BRICS}$ foreign savings (FCU) – BRICS

$\overline{FSAV}_{ROW}$ foreign savings (FCU) – ROW

$\overline{GADJ}$ government consumption adjustment factor

$IADJ$ investment adjustment factor

$\overline{MPSADJ}$ savings rate scaling factor (= 0 for base)

$\overline{QFS}_f$ quantity supplied of factor

$\overline{TINSADJ}$ direct tax scaling factor (= 0 for base; exogenous variable)

$\overline{WFDIST}_{fa}$ wage distortion factor for factor f in activity a

ENDOGENOUS VARIABLES

$DMPS$ change in domestic institution savings rates (= 0 for base; exogenous variable)

DPI producer price index for domestically marketed output

EG government expenditures

EH_h consumption spending for household

EXR	exchange rate (LCU per unit of FCU)
$GOVSHR$	government consumption share in nominal absorption
$GSAV$	government savings
$INVSHR$	investment share in nominal absorption
MPS_i	marginal propensity to save for INSDNG (exogenous variable)
PA_a	activity price (unit gross revenue)
PDD_c	demand price for commodity produced and sold domestically
PDS_c	supply price for commodity produced and sold domestically
PE_c	export price (domestic currency)
PEB_c	export price (domestic currency) – BRICS
PER_c	export price (domestic currency) – ROW
PM_c	import price (domestic currency)
PMB_c	import price (domestic currency) – BRICS
PMR_c	import price (domestic currency) – ROW
$PINTA_c$	aggregate intermediate input price for activity a
PQ_c	composite commodity price
PVA_a	value-added price (factor income per unit of activity)
PX_c	aggregate producer price for commodity

$PXAC_{ac}$ producer price of commodity c for activity a

QA_a quantity (level) of activity

QD_c quantity sold domestically of domestic output

QE_c quantity of exports

QEB_c quantity of exports - BRICS

QER_c quantity of exports – ROW

QF_{fa} quantity demanded of factor f from activity a

QG_c government consumption demand for commodity

QH_{ch} quantity consumed of commodity c by household h

QHA_{ach} quantity of household home consumption of c from a for h

$QINTA_a$ quantity of aggregate intermediate input

$QINT_{ca}$ quantity of commodity c as intermediate input to activity a

$QINV_c$ quantity of investment demand for commodity

QM_c quantity of exports

QMB_c quantity of imports - BRICS

QMR_c quantity of imports – ROW

QQ_c quantity of goods supplied to domestic market (composite supply)

QT_c quantity of commodity demanded as trade input

QVA_c	quantity of (aggregate) value-added
QX_c	aggregated marketed quantity of domestic output of commodity
$QXAC_{ac}$	quantity of marketed output of commodity c from activity a
$TABS$	total nominal absorption
$TINS_i$	direct tax rate for institution i
$TRII_{ii'}$	transfers from institution i' to i
WF_f	average price of factor f
YF_f	income of factor f
YG	government revenue
YI_i	income of domestic nongovernment institution
YIF_{if}	income to domestic institution i from factor f

EQUATIONS

PRICE BLOCK:

BRICS import price:

(1) $$PMB_c = pwmb_c \cdot (1 + tmb) \cdot EXR + \sum_{c' \in CT} PQ_{c'} \cdot icm_{c'c} \qquad c \in CM$$

ROW import price:

(2) $$PMR_c = pwmr_c \cdot (1 + tmr) \cdot EXR + \sum_{c' \in CT} PQ_{c'} \cdot icm_{c'c} \qquad c \in CM$$

Average import price:

(3) $$PM_c \cdot QM_c = PMR_c \cdot QMR_c + PMB_c \cdot QMB_c \qquad c \in CM$$

BRICS export price:

(4) $$PEB_c = pweb_c \cdot (1 - teb) \cdot EXR + \sum_{c' \in CT} PQ_{c'} \cdot ice_{c'c} \qquad c \in CE$$

ROW export price:

(5) $$PER_c = pwer_c \cdot (1 - ter) \cdot EXR + \sum_{c' \in CT} PQ_{c'} \cdot ice_{c'c} \qquad c \in CE$$

Average export price:

(6) $$PE_c \cdot QE_c = PER_c \cdot QER_c + PEB_c \cdot QEB_c \qquad c \in CE$$

Demand price for domestic nontraded goods:

(7) $$PDD_c = PDS_c + \sum_{c' \in CT} PQ_{c'} \cdot icd_{c'c} \qquad c \in CD$$

Absorption:

(8) $$PQ_c \cdot (1 - tq_c) \cdot QQ_c = PDD_c \cdot QD_c + PM_c \cdot QM_c \qquad c \in (CD \cup CM)$$

Marketed output value:

(9) $$PX_c \cdot QX_c = PDS_c \cdot QD_c + PE_c \cdot QE_c \qquad c \in CX$$

Activity price:

(10) $$PA_a = \sum_{c \in C} PXAC_{ac} \cdot \theta_{ac} \qquad a \in A$$

Aggregate intermediate input price:

(11) $$PINTA_a = \sum_{c \in C} PQ_c \cdot ica_{ca} \qquad a \in A$$

Activity revenue and costs:

(12) $$PA_a \cdot (1 - ta_a) \cdot QA_a = PVA_a \cdot QVA_a + PINTA_a \cdot QINTA_a \qquad a \in A$$

Consumer price index:

(13) $$\overline{CPI} = \sum_{c \in C} PQ_c \cdot cwts_c$$

Consumer price index:

(14) $$DPI = \sum_{c \in C} PDS_c \cdot dwts_c$$

PRODUCTION AND TRADE BLOCK:

CES technology – Activity production function:

(15) $$QA_a = \alpha_a^a \cdot (\delta_a^a \cdot {QVA_a}^{-\rho_a^a} + (1 - \delta_a^a) \cdot {QINTA_a}^{-\rho_a^a})^{-\frac{1}{\rho_a^a}} \qquad a \in ACES$$

CES technology – Value added intermediate-input quantity ratio:

(16) $$\frac{QVA_a}{QINTA_a} = (\frac{PINTA_a}{PVA_a} \cdot \frac{\delta_a^a}{1-\delta_a^a})^{\frac{1}{1+\rho_a^a}} \qquad a \in ACES$$

Leontief technology – Demand for aggregate value-added:

(17) $$QVA_a = iva_a \cdot QA_a \qquad a \in A\text{LEO}$$

Leontief technology – Demand for aggregate intermediate-input:

(18) $$QINTA_a = inta_a \cdot QA_a \qquad a \in A\text{LEO}$$

Value-added and factor demands:

(19) $$QVA_a = \alpha_a^{va} \cdot \left(\sum_{f \in F} \delta_{fa}^{va} \cdot {QF_{fa}}^{-\rho_a^{va}}\right)^{-\frac{1}{\rho_a^{va}}} \qquad a \in A$$

Factor demand:

(20) $$WF_f \cdot \overline{WFDIST}_{fa} = PVA_a \cdot (1 - tva_a) \cdot QVA_a \cdot$$

$$\left(\sum_{f \in F'} \delta_{fa}^{va} \cdot {QF_{fa}}^{-\rho_a^{va}}\right)^{-1} \cdot \delta_{fa}^{va} \cdot {QF_{fa}}^{-\rho_a^{va}-1} \qquad a \in A$$

Disaggregated intermediate-input demand:

(21) $$QINT_{ca} = ica_{ca} \cdot QINTA_a \qquad a \in A$$

$$c \in C$$

Commodity production and allocation:

(22) $$QXAC_{ac} + \sum_{h \in H} QHA_{ach} = \theta_{ac} \cdot QA_a \qquad a \in A$$

$$a \in CX$$

Output aggregation function:

(23) $$QX_c = \alpha_c^{ac} \cdot \left(\sum_{a \in A} \delta_{ac}^{ac} \cdot {QXAC_{ac}}^{-\rho_c^{ac}}\right)^{-\frac{1}{\rho_c^{ac}-1}} \qquad c \in CX$$

First-order condition for output aggregation function:

(24) $$PXAC_{ac} = PX_c \cdot QX_c \cdot \left(\sum_{a \in A,} \delta_{ac}^{ac} \cdot QXAC_{ac}{}^{-\rho_c^{ac}}\right)^{-1} \cdot \delta_{ac}^{ac} \cdot QXAC_{ac}{}^{-\rho_c^{ac}-1} \qquad a \in AC$$

$$c \in CX$$

Output transformation function - Top:

(25) $$QX_c = \alpha_c^{tt} \cdot (\delta_c^{tt} \cdot QE_c{}^{\rho_c^{tt}} + (1 - \delta_c^{tt}) \cdot QD_c{}^{\rho_c^{tt}})^{\frac{1}{\rho_c^{tt}}} \qquad c \in (CE \cap CD)$$

Export-domestic supply ratio:

(26) $$\frac{QE_c}{QD_c} = (\frac{PE_c}{PDS_c} \cdot \frac{1-\delta_c^{tt}}{\delta_c^{tt}})^{\frac{1}{\rho_c^{tt}-1}} \qquad c \in (CE \cap CD)$$

Output transformation function - Bottom:

(27) $$QE_c = \alpha_c^{tb} \cdot (\delta_c^{tb} \cdot QER_c{}^{\rho_c^{tb}} + (1 - \delta_c^{tb}) \cdot QEB_c{}^{\rho_c^{tb}})^{\frac{1}{\rho_c^{tb}}} \qquad c \in CE$$

ROW-BRICS supply ratio:

(28) $$\frac{QER_c}{QEB_c} = (\frac{PER_c}{PEB_c} \cdot \frac{1-\delta_c^{tb}}{\delta_c^{tb}})^{\frac{1}{\rho_c^{tb}-1}} \qquad c \in CE$$

Output transformation for non-exported commodities:

(29) $$QX_c = QD_c + QE_c \qquad c \in (CD \cap CEN) \cup (CE \cup CDN)$$

Composite supply (Armington) function - Top:

(30) $$QQ_c = \alpha_c^{qt} \cdot (\delta_c^{qt} \cdot QM_c{}^{\rho_c^{qt}} + (1 - \delta_c^{qt}) \cdot QD_c{}^{\rho_c^{qt}})^{\frac{1}{\rho_c^{qt}}} \qquad c \in (CM \cap CD)$$

Import-domestic demand ratio:

(31) $$\frac{QM_c}{QD_c} = \left(\frac{PDD_c}{PM_c} \cdot \frac{\delta_c^{qt}}{1-\delta_c^{qt}}\right)^{\frac{1}{\rho_c^{qt}-1}} \qquad c \in (CM \cap CD)$$

Composite supply (Armington) function - Bottom:

(32) $$QM_c = \alpha_c^{qb} \cdot \left(\delta_c^{qb} \cdot QMR_c{}^{\rho_c^{qb}} + (1-\delta_c^{qb}) \cdot QMB_c{}^{\rho_c^{qb}}\right)^{\frac{1}{\rho_c^{qb}}} \qquad c \in CM$$

ROW-BRICS demand ratio:

(33) $$\frac{QMR_c}{QMB_c} = \left(\frac{PMB_c}{PMR_c} \cdot \frac{\delta_c^{qb}}{1-\delta_c^{qb}}\right)^{\frac{1}{\rho_c^{qb}-1}} \qquad c \in CM$$

Composite supply for non-imported outputs and non-produced imports:

(34) $$QQ_c = QD_c + QM_c \qquad c \in (CD \cap CMN) \cup (CM \cup CDN)$$

Demand for transaction services:

(35) $$QT_c = \sum_{c' \in C'} (icm_{cc'} \cdot QM_{c'} + ice_{cc'} \cdot QE_{c'} + icd_{cc'} \cdot QD_{c'}) \qquad c \in CT$$

INSTITUTIONS BLOCK:

Factor income:

(36) $$YF_f = \sum_{a \in A} WF_f \cdot \overline{WFDIST}_{fa} \cdot QF_{fa} \qquad f \in F$$

Institutional factor incomes:

(37) $$YIF_f = shif_{if} \cdot [(1-tf_f) \cdot YF_f - trnsfr_{row\,f} \cdot EXR] \qquad f \in F,\ i \in INSD$$

Income of domestic non-government institutions:

(38) $$YI_i = \sum_{f \in F} YIF_{if} + \sum_{i' \in INSDNG'} TRII_{ii'} + trnsfr_{i\ gov} \cdot \overline{CPI} + trnsfr_{i\ row} \cdot EXR \qquad i \in INSDNG$$

Intra-institutional transfers:

(39) $$TRII_{ii'} = shii_{ii'} \cdot (1 - MPS_{i'}) \cdot (1 - TINS_{i'}) \cdot YI_{i'} \qquad i \in INSDNG,\ i' \in INSDNG'$$

Household consumption expenditure:

(40) $$EH_h = (1 - \sum_{i \in INSDNG} shii_{ih}) \cdot (1 - MPS_h) \cdot (1 - TINS_h) \cdot YI_h \qquad h \in H$$

Household consumption demand for marketed commodities:

(41) $$PQ_c \cdot QH_{ch} = PQ_c \cdot \gamma_{ch}^m + \beta_{ch}^m (EH_h - \sum_{c' \in C} PQ_{c'} \cdot \gamma_{c'h}^m) \qquad h \in H,\ c \in C$$

Investment demand:

(42) $$QINV_c = IADJ \cdot \overline{qinv_c} \qquad c \in CINV$$

Government consumption demand:

(43) $$QG_c = \overline{GADJ} \cdot \overline{qg_c} \qquad c \in C$$

Government revenue:

(44) $$YG = \sum_{i \in INSDNG} TINS_i \cdot YI_i + \sum_{f \in F} tf_f \cdot YF_f + \sum_{a \in A} tva_a \cdot PVA_a \cdot QVA_a + \sum_{a \in A} ta_a \cdot PA_a \cdot QA_a + \sum_{c \in CM} tmb_c \cdot pmwb_c \cdot QMB_c \cdot EXR +$$

$$\sum_{c\in CM} tmr_c \cdot pmwr_c \cdot QMR_c \cdot EXR + \sum_{c\in CE} teb_c \cdot pewb_c \cdot QEB_c \cdot EXR +$$

$$\sum_{c\in CE} ter_c \cdot pewr_c \cdot QER_c \cdot EXR + \sum_{c\in C} tq_c \cdot PQ_c \cdot QQ_c +$$

$$\sum_{f\in F} YIF_{gov\,f} + trnsfr_{gov\,row} \cdot EXR$$

Government expenditure:

(45) $$EG_c = \sum_{c\in C} PQ_c \cdot QG_c + \sum_{i\in INSDNG} trnsfr_{i\,gov} \cdot \overline{CPI}$$

SYSTEM CONSTRAINS BLOCK:

Factor market:

(46) $$\sum_{a\in A} QF_{fa} = \overline{QFS}_f \qquad f \in F$$

Composite commodity markets:

(47) $$QQ_c = \sum_{a\in A} QINT_{ca} + \sum_{h\in H} QH_{ch} + QG_c + QINV_c + qdst_c + QT_c \qquad f \in F$$

Current account balance for ROW (in LCY):

(48) $$\sum_{c\in CM} pwmb_c \cdot QMB_c + \sum_{c\in CM} pwmr_c \cdot QMR_c + \sum_{f\in F} trnsfr_{BRICS\,f} +$$

$$\sum_{f\in F} trnsfr_{ROW\,f} = \sum_{c\in CE} pweb_c \cdot QEB_c + \sum_{c\in CE} pwer_c \cdot QER_c + \sum_{f\in F} trnsfr_{f\,BRICS} +$$

$$\sum_{f\in F} trnsfr_{f\,ROW} + \overline{FSAV}_{BRICS} + \overline{FSAV}_{ROW}$$

Government balance:

(49) $$YG = EG + GSAV$$

Direct institutional tax rates:

(50) $$TINS_i = \overline{tins}_i \cdot (1 + \overline{TINSADJ} \cdot tins01_i) + \overline{DTINS} \cdot tins01_i \qquad i \in INSDNG$$

Institutional savings rates:

(51) $$MPS_i = \overline{mps}_i \cdot (1 + \overline{MPSADJ} \cdot mps01_i) + \overline{DMPS} \cdot mps01_i \qquad i \in INSDNG$$

Saving-Investment balance:

(52) $$\sum_{i \in INSDNG} MPS_i \cdot (1 - TINS_i) \cdot YI_i + GSAV + EXR \cdot (\overline{FSAV}_{BRICS} + \overline{FSAV}_{ROW})$$

$$= \sum_{c \in C} PQ_c \cdot QINV_c + \sum_{c \in C} PQ_c \cdot qdst_c$$

Total absorption:

(53) $$TABS = \sum_{h \in H} \sum_{c \in C} PQ_c \cdot QH_{ch} + \sum_{a \in A} \sum_{c \in C} \sum_{h \in H} PXAC_{ac} \cdot QHA_{ach} +$$

$$\sum_{c \in C} PQ_c \cdot QG_c + \sum_{c \in C} PQ_c \cdot QINV_c + \sum_{c \in C} PQ_c \cdot qdst_c$$

Ratio of investment to absorption:

(54) $$INVSHR \cdot TABS = \sum_{c \in C} PQ_c \cdot QINV_c + \sum_{c \in C} PQ_c \cdot qdst_c$$

Ratio of government consumption to absorption:

(55) $$GOVSHR \cdot TABS = \sum_{c \in C} PQ_c \cdot QG_c$$

MODEL CLOSURE:

Factor Markets: *Fixed economy-wide labor supply,* $\overline{QFS}_f$*; flexible economy-wide wage,* WF_f.

Government: *Flexible government savings,* $GSAV$*; fixed direct tax rates,* $TINS_i$.

Rest of the World: *Fixed foreign savings,* $\overline{FSAV}_{BRICS} + \overline{FSAV}_{ROW}$*; flexible real exchange rate,* EXR.

Savings-Investment: *Flexible capital formation,* $QINV_c$*; fixed MPS for all non-government institutions,* MPS_i.