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Small Impact and New Questions

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The above-mentioned study was published on the DG Trade's website in March 2016 with the results submitted by the authors and is accessible under the following link: http://ec.europa.eu/trade/policy/policy-making/analysis/#_bilateral-regional. Differences in some of the results between the study and the present article are linked to hypotheses on public revenues in the computable general equilibrium model. In the present article, it is assumed that a new tax offsets the loss of customs revenue. The DG Trade study captures the loss of customs revenue without offsetting it through a new tax.

ABSTRACT

Despite recent modifications, the Economic Partnership Agreement (EPA) between the European Union (EU) and West African (WA) countries is still being criticized for its potential detrimental effects on WA countries. This paper provides updated evidence on the impact of the EPA on these countries. A dynamic multicountry, multisector computable general equilibrium trade model with modeling of the dual-dual economy and with a consistent tariff aggregator is used to simulate a series of new scenarios that include updated information on the agreement. We also go beyond estimating macrolevel economic effects to analyze the impacts on poverty. The policy simulation results show that the implementation of the EPA between the EU and WA countries would have marginal but positive impacts on Burkina Faso and Côte d'Ivoire and negative impacts on Benin, Ghana, Nigeria, Senegal, and Togo. The impact on poverty indicators in Ghana and Nigeria would be marginal. From the perspective of WA countries, this study supports the view that recent EU concessions are not sufficient and that domestic fiscal reforms are needed in WA countries themselves.

Keywords: regional trade agreements, computable general equilibrium model, dual-dual model

JEL Classification: F11, F13, F15

ACRONYMS

ACP	African, Caribbean, and Pacific
CARICOM	Caribbean community
CARIFORUM	Caribbean Forum of the African, Caribbean, and Pacific Countries
CEMAC	Communauté Économique et Monétaire de l'Afrique Centrale
CEPII	Centre d'Etudes Prospectives et d'Informations Internationales
CES	constant elasticity of substitution
CFA	Communauté Financière d'Afrique
CGE	computable general equilibrium
CIS	Community of Independent States
COMESA	Common Market of Eastern and Southern Africa
EAC	East African Community
EBA	everything but arms
ECOWAS	Economic Community of West African States
EPA	Economic Partnership Agreements
EPADP	Economic Partnership Agreement development package
EU	European Union
GDP	gross domestic product
GSP	Generalized System of Preferences
GTAP	Global Trade Analysis Project
LDC	least-developed countries
ME & NA	Middle East and North Africa
MENA	Middle East and North Africa
MIRAGE	Modelling International Relationships in Applied General Equilibrium
MIRAGRODEP	Modelling International Relationships under Applied General Equilibrium for the African Growth and Development Policy Modeling Consortium
NAFTA	North American Free Trade Agreement countries
OECD	Organisation for Economic Co-operation and Development
PE	partial equilibrium
ROW	rest of the world
SADC	Southern African Development Community.
SAM	social accounting matrix
WA	West Africa

1. INTRODUCTION

Launched in 2000, the negotiation of Economic Partnership Agreements (EPAs) aimed to create seven free trade areas between the European Union (EU) and African, Caribbean, and Pacific (ACP) countries. The EPAs were supposed to take effect in 2008, but the negotiations took much longer than expected, in part because several elements of the reforms were criticized by ACP governments, particularly those of West Africa (WA).

The first criticism was that this trade reform would not provide WA countries with significantly better access to foreign markets. Among 16 countries in western Africa,[1] 12 are considered least-developed countries (LDCs)[2] and, as such, are granted access to the EU through the Everything But Arms (EBA) initiative, which gives them duty-free, quota-free access for all goods except arms. In 2015, other WA countries benefited from other specific trade regimes: Ghana and Côte d'Ivoire had duty-free access under an interim EPA agreement and Cape Verde was phasing out of its LDC status; these countries would lose these benefits if they did not sign and ratify the EPA. In this case, their exports would fall under the Generalized System of Preferences (GSP) system, which is significantly less beneficial. This system has already been applied to Nigeria.

The second criticism focused on the potential loss of public revenues associated with imports, free of any charge, of European products into WA countries. Import tariffs are an important source of public revenues in these countries, and for many, the EU is the main source of imported goods. According to the Global Trade Analysis Project (GTAP) database (Aguiar, Narayanan, and McDougall 2016), the EU represented 38.3 percent of Senegal's imports in 2015, 21.1 percent of Benin's, 33.5 percent of Burkina Faso's, and 33.8 percent of Côte d'Ivoire's. African countries are well known for having a restricted domestic fiscal base,[3] so decreased public revenues due to the EPA could endanger their governments' ability to provide public goods.

In response to these fears, the EU has accepted several concessions. The tariff agreement is now asymmetric, using most of the policy space provided by General Agreement on Tariffs and Trade Article XXIV regarding regional agreements: the EU implements free trade for WA countries' products, while WA countries only partially open their borders to European products. Moreover, the time granted to implement this reform is more gradual for the African countries. Finally, the EU has promised to include a development package. These concessions were accepted and the negotiations were concluded on February 6, 2014, in Brussels.

The objective of this article is to evaluate the effects of the WA EPA on countries in the Economic Community of West African States (ECOWAS) and Mauritania in terms of trade, welfare, production, government revenue, and poverty.

Since the launch of the EPAs, many studies have attempted to assess their impact on both ACP countries or regions and the EU, using partial or general equilibrium models and focusing on trade flows, fiscal revenues, welfare, economic growth, and regional integration. Table 1.1 provides a summary of the main studies that have addressed the topic.[4]

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[1] Benin, Burkina Faso, Cabo Verde, Côte d'Ivoire, Gambia, Ghana, Guinea, Guinea-Bissau, Liberia, Mali, Mauritania, Niger, Nigeria, Senegal, Sierra Leone, and Togo.

[2] Only Cabo Verde, Côte d'Ivoire, Ghana, and Nigeria are not LDCs.

[3] See, for example, Jacquemot (2005) and OECD (2010).

[4] The focus here will be on ACP regions instead of individual countries. There are many other studies assessing the impact on individual countries. Also, some of the studies presented here do focus on one or two specific countries along with the regional blocs.

Table 1.1 Summary of the main studies

Author(s)	Region(s) covered	Methodology used
Ndlela and Tekere (2003)	SADC	PE modeling
Busse, Borrmann, and Grossmann (2004)	ECOWAS+	PE modeling
Milner, Morrissey, and McKay (2005)	EAC	PE modeling
Karingi and others (2005)	Africa south of the Sahara	CGE modeling + PE modeling
Perez (2006)	ACP	CGE modeling
Berisha-Krasniki, Bouët, and Mevel (2008)	SADC, EAC, ECOWAS, CEMAC, CARIFORUM, Pacific	CGE modeling
Keck and Piermartini (2008)	SADC	CGE modeling
Fontagné, Laborde, and Mitaritonna (2011)	ECOWAS, CEMAC+, COMESA, SADC, CARIFORUM, Pacific	PE modeling

Source: Authors.
Note: All studies include the European Union by definition. ACP = African, Caribbean, and Pacific countries; CARIFORUM = Caribbean Forum of the African, Caribbean, and Pacific Countries; CEMAC = Communauté Économique et Monétaire de l'Afrique Centrale; CGE = computable general equilibrium; COMESA = Common Market of Eastern and Southern Africa; EAC = East African Community; ECOWAS = Economic Community of West African States; PE = partial equilibrium; SADC = Southern African Development Community.

Comparing all these quantitative studies is challenging because they use different methodologies, datasets, parameters, baselines, and country coverage. However, overall, they have found that given the asymmetry between current protection rates and the discrepancies in terms of economic performance, EPAs will increase EU exports to ACP countries more than ACP exports to the EU, although ACP exports would be higher under EPAs than under the GSP (Ndlela and Tekere 2003; Busse, Borrmann, and Grossmann 2004; Karingi et al. 2005; Perez 2006; Berisha-Krasniqi, Bouët, and Mevel 2008; Fontagné, Laborde, and Mitaritonna 2011). From a trade point of view, EU exporters thus appear to be the main beneficiaries of the agreement.

These studies also highlight the trade diversion effects on ACP countries for imports from non-EU countries. This effect is driven by the fall in import prices from the EU but depends on the market structure in ACP countries, which could reduce the tariff pass-through (Gasiorek and Winters 2004). Import surges from the EU are sometimes deemed harmful for agricultural sectors in some ACP countries.

Another key finding is that most of the gains in terms of access to EU markets may be captured by non-LDCs. This positive impact would mainly be limited to a few agricultural products, which are currently protected by the EU (particularly dairy products, sugar, and meat).

Some simulations also suggest that, on the one hand, EPAs could lead to some trade diversion for Africa, with negative effects on intra-African trade (Karingi et al. 2005). On the other hand, further gains could arise from intraregional liberalization for most countries under the EPAs (Keck and Piermartini 2008).

In addition to trade creation and diversion effects, one of the main findings of these studies is the loss of public tariff revenues for ACP countries as the agreement enters into force. This loss of tariff revenues is due both to the elimination of customs duties on imports from the EU and to trade diversion effects (replacement of imports from the rest of the world by untaxed imports from the EU). The impact on public revenues depends on the initial share of tariff revenues in overall government revenue. The average loss of tariff revenues is projected to be high, at 25 percent in the long run for ACP countries and 38 percent for ECOWAS countries (Fontagné, Laborde, and Mitaritonna 2011). The main challenge, then, is to increase the capacity of ACP countries to reorganize their fiscal base toward internal direct and indirect taxation.

Finally, some studies using general equilibrium models (Perez 2006; Berisha-Krasniqi, Bouët, and Mevel 2008; Keck and Piermartini 2008) have also addressed competitiveness and welfare issues. The easy access to and the lower prices of imported inputs from Europe could increase the competitiveness of ACP countries. One of the main advantages of the computable general equilibrium (CGE) approach is that it conducts a more thorough welfare analysis, whereas partial equilibrium models capture only trade creation and diversion effects.[5] In this regard, most of the studies find either a negative or a positive but limited impact on welfare for ACP countries. All these papers deserve serious consideration and provide interesting conclusions. However, this review of literature clearly highlights that a new analysis is needed, for several reasons.

First, since the most recent evaluation was published in 2011 and the most recent CGE analysis was published in 2008, a new evaluation must be conducted based on up-to-date data on tariffs, trade, and production and on detailed information about the contents of the reform—not only changes concerning tariffs at a detailed level but also the exact content of the development package included recently in the agreement by the EU. In particular, detailed and up-to-date data on tariffs are needed to determine whether one of the criticisms discussed earlier (that these trade regimes would not provide WA countries with significantly better access to foreign markets) is really valid. For example, WA countries adopted a common external tariff in 2012; this new development needs to be taken into account. This paper uses the most recent tariff and economic data available, including a dynamic baseline wherein the ECOWAS common external tariff is implemented, and our methodology includes a consistent tariff aggregator, a procedure that takes into account not only the level of tariffs but also their dispersion. We also evaluate whether the development package recently included in the agreement has a significant impact on WA countries.

Second, most classical CGE studies of international trade work with simple sets of assumptions about the labor market. However, these assumptions are not appropriate for developing countries. Our new CGE model makes a distinction between workers attached to the rural versus the urban sector and takes into account mobility between formal and informal sectors. In Africa south of the Sahara, intersectoral productivity and wage differentials are substantial, while trade policy reforms imply reallocation of productive factors between sectors. Calvès and Schoumaker (2004) concluded that the development of the informal sector has been more pronounced in sectors more exposed to international competition and that this development was accelerated with structural adjustment programs; in addition, Verick (2006) concluded that trade liberalization has led to the development of the informal sector in Africa.[6] Thus, one of the goals of this study is to verify whether the implementation of the EPA contributes to the development of the informal sector in WA countries.

Third, as already stated, the topic of fiscal revenue is a key issue. Consequently, this study undertakes a specific modeling effort to gauge the impact of the trade agreement on public revenues. Our approach prioritizes the consistent aggregator for import tariffs (see Laborde, Martin, and van der Mensbrugghe 2011), which allows us to capture the exclusion effects and the variance of tariffs at a detailed level. Moreover, our modeling approach captures inefficiencies in the collection of tariffs and taxes.

This paper provides a new evaluation of the impact of the EU-WA EPA. This evaluation is based on a dynamic, multiregion, multisector CGE model based on the most recent data on tariffs, trade, and production, as well as the most recent information included in the agreement concerning changes in tariffs and the exact contents of the development package. Our CGE model was designed with new specifications: (1) the rural-urban mobility of labor, (2) the existence of informal sectors characterized by low capitalistic intensity and no skilled labor alongside modern formal sectors with higher capitalistic intensity and skilled workers, (3) the mobility of unskilled labor between formal and informal sectors, (4) a consistent procedure to aggregate tariff revenues, and (5) an inefficient collection of tariffs and taxes.

[5] The paper by Milner, Morrissey, and McKay (2005) is an exception, performing a thorough short-run welfare analysis using a partial equilibrium model.

[6] On this issue, see also Golub and Mbaye (2002) and Lindauer and Velenchik (2002).

This study reaches several conclusions. Concerning border liberalization, the gains in access to foreign markets are limited or nil for WA countries, especially the region's LDCs. For non-LDCs, most of the gains in access to foreign markets come from the nonexecution of a threat: if these countries refuse the EPA, they will be granted the GSP European tariffs, which are higher tariffs than those currently paid. Consequently, trade creation is limited to a small number of products exported by non-LDCs; and we conclude on this trade creation effect only because in the baseline, we implement a European GSP protection on imports from these countries.

We also identify some trade diversion effects. Concerning the economic impact of the reform, under our preferred scenario of public closure (in which a lump-sum tax is implemented in compensation for variations in public revenues), the reform has a positive effect on welfare only for Burkina Faso and Côte d'Ivoire. It has a negative effect for Benin, Ghana, Nigeria, Senegal, and Togo. Although an income tax brings similar results, a consumption tax, implemented in compensation for variations in public revenues, brings slightly better results.

These findings raise several new policy issues. First, the trade creation effects are small and the development package has limited impact, bringing into question the design of the agreement. A second issue is how WA countries react to the loss of public revenues implied by the implementation of free trade for imports coming from the EU. Our analysis clearly illustrates the need for fiscal reform in these countries.

Section 2 discusses the methodology of this study, and Section 3 presents the results. Section 4 offers a sensitivity analysis, and Section 5 concludes.

2. METHODOLOGY

This section presents the methodology adopted to conduct this evaluation: first, the general features of MIRAGRODEP (Modelling International Relationships under Applied General Equilibrium for the African Growth and Development Policy Modeling Consortium),[7] the CGE model adopted for this evaluation; second, the specific assumptions adopted to tackle the dual-dual characteristics of WA economies (rural-urban mobility and displacement of unskilled workers between formal and informal sectors); third, the consistent tariff aggregator; fourth, the poverty toolbox; and fifth, the data.

General Features of MIRAGRODEP

MIRAGRODEP is a CGE model based on MIRAGE (Modelling International Relationships in Applied General Equilibrium).[8] It is a recursive, dynamic, multiregion, multisector model. In MIRAGRODEP, the government is explicitly modeled as different from private agents. Government income consists of taxes collected on production, on factors of production, on exports, on imports, on consumption, and on households' income.

MIRAGRODEP has already been utilized to study issues related to international trade and trade policy in Africa. Bouët, Deason, and Laborde (2014), in particular, used it to study the potential evolution of international trade in Africa under various trade liberalization scenarios, both regional and multilateral.

From the supply side in each sector, the production function is a Leontief function of value-added and intermediate inputs: for its production, one output unit needs x percent of an aggregate of productive factors (labor, unskilled and skilled; capital; land and natural resources) and $1 - x$ percent of intermediate inputs. The intermediate inputs function is an aggregate constant elasticity of substitution (CES) function of all goods, which means that substitutability exists between two intermediate goods, depending on the relative prices of these goods. This substitutability is constant and at the same level for any pair of intermediate goods. Similarly, in the generic version of the model, value-added is a CES function of unskilled labor, land, natural resources, and a bundle of skilled labor and capital. This nesting allows for the introduction of less substitutability between capital and skilled labor than between these two factors and others.

The utilization rate of production factors is assumed to be constant. The only factor with a fixed supply over time is natural resources. Capital supply is modified in each period to account for depreciation and investment. Growth rates of the labor supply are fixed exogenously following the evolution of the active population. Land supply is endogenous because it depends on the real remuneration of land.

Skilled labor is the only factor that is perfectly mobile. Installed capital and natural resources are sector specific. New capital is allocated among sectors according to an investment function. In non-WA countries (WA countries will be discussed later), unskilled labor is imperfectly mobile between agricultural and nonagricultural sectors, according to a constant elasticity of transformation function. Land is also imperfectly mobile between agricultural sectors.

Capital in a given region, whatever its origin (domestic or foreign), is assumed to be obtained by assembling intermediate inputs according to a specific combination. The capital good is the same regardless of the sector. In this version, we assume that all sectors operate under perfect competition, there are no fixed costs, and price equals marginal cost.

The demand side is modeled in each region through a representative agent whose propensity to save is constant. The rest of the national income is used to purchase final consumption. Preferences

[7] Appendix A contains a technical presentation of MIRAGRODEP. See Laborde, Robichaud, and Tokgoz (2013) for a complete presentation.

[8] MIRAGE is a multisector, multiregion CGE model devoted to trade policy analysis, developed at Centre d'Etudes Prospectives et d'Informations Internationales (CEPII), Paris, between 2001 and 2004. See Bchir and colleagues (2002) and Decreux and Valin (2007).

between goods are represented by a linear expenditure system–CES function, implying that consumption has a nonunitary income elasticity. The sector subutility function used in MIRAGRODEP is a nesting of four CES-Armington functions that define the origin of the goods. In this study, Armington elasticities are drawn from the GTAP 9 database and are assumed to be the same across regions.

The model includes three important assumptions: the external account closure, the government account closure, and the private account closure. The private account closure assumption concerns the savings-investment closure. The MIRAGRODEP model is neoclassical, meaning that the marginal propensity to save is constant such that variation in income leads to variation in savings, which brings variation in investment. The external account closure concerns the assumption on the current account. In MIRAGRODEP, the real exchange rate is adjusted in such a way that the current account balance is stable as a percentage of global gross domestic product (GDP). The government or public account closure assumption concerns how the public balance is affected when taxes are changed by a reform. This study assumes that each government maintains its public balance constant and that after a shock that reduces customs duties, a lump-sum tax (either negative or positive) is established in order to maintain real public expenses per capita constant, while the public budget balance is a constant percentage of GDP. With this assumption, the level of public services in each country is constant, and there is no variation in the public budget balance and no associated crowding-out effect on private investment. A lump-sum tax is efficient in the sense that it does not interfere with market mechanisms. Moreover, it is useful for measuring one imperfection associated with the reform: the magnitude of the lump-sum tax measures the cost imposed on each individual to maintain constant real public expenses per capita, and consequently constant provision of public goods.

However, a lump-sum tax may be considered politically unrealistic and more damaging for the poorest households. This is why we conduct a sensitivity analysis that includes different public closures. In particular, we suppose that real public expenses per capita and public balance are constant thanks to either an additional consumption tax or an additional income tax.

Most African economies have a relatively low rate of effective tax collection.[9] Thus, considering the tariff revenue to be equal to the product of nominal tariff and trade flows is a huge overestimation. Thus, we introduce a simple procedure intended to properly capture the fiscal costs of this inefficiency for WA countries in tax collection. An explicit set of parameters represents the efficiency of the tax collection system. This set consists of two parameters, a first one affecting the global collection of taxes in the economy and the second one specifically affecting the collection of customs import duties at the border. These parameters decrease the public collection of taxes while increasing the revenue of households; the share of taxes not received by the government is still captured by domestic private agents. When available, we use a country- and sector-specific efficiency ratio. Otherwise, we use a country-level efficiency ratio, calibrated to duplicate effective tariff revenues as indicated in International Monetary Fund financial reports.

The "Dual-Dual Economy" Assumption in WA Countries

To better model WA economies, we modified the representation of the labor market so as to reflect a "dual-dual economy." This expression, borrowed from Stifel and Thorbecke (2003), refers to the double dichotomy between urban and rural areas and formal and informal sectors. Two main features can help explain the idea of dualism: first, the existence of strong inequalities between *rural* and *urban regions* in terms of localization of activities and second, the dichotomy between *traditional technologies*, in which most firms are family owned, and *modern technologies* held by more complex organizations. This double dichotomy between sectors leads us to classify sectors into four categories: rural sectors are divided into formal (exporting agriculture, with capital-intensive technology) and informal (subsistence agriculture) sectors, and urban sectors are divided into formal (mainly manufacturing) and informal (mainly services).

[9] This is a key problem for states in Africa south of the Sahara, which has received new attention with the implementation of the EPAs (see Keen and Mansour 2010).

In countries with dual-dual modeling (that is, WA countries), skilled workers are employed only in formal sectors. However, amid these formal sectors, they may decide to migrate between urban and rural locations. Skilled workers get better salaries in urban areas, and the salary gap is constant. There may be different explanations for this prevailing wage gap. One is that everything else being equal, there is a preference for living in rural areas. Another is the existence of a monopolistic union that determines urban wages for skilled workers in formal urban sectors by maximization of its own utility, which depends on the number of the union's members and their salary level. This monopoly results in a salary higher than the one that would prevail without a monopolistic union.

Consequently, four equations determine the levels of wages and employment for skilled labor in countries with dual-dual modeling. If *r* is a country with dual-dual modeling, we have

$$WHu_{r,t} = WHr_{r,t}(1 + gap_{h_r}), \tag{1}$$

$$Hu_{r,t} + Hr_{r,t} = \overline{H}_{r,t}, \tag{2}$$

$$Hu_{r,t} = \textstyle\sum_{i\in urban(i,r)} H_{i,r}, \text{ and} \tag{3}$$

$$Hr_{r,t} = \textstyle\sum_{i\in rural(i,r)} H_{i,r}, \tag{4}$$

with $WHu_{r,t}$ being the remuneration of skilled labor in urban sectors in country *r* at time *t*, $WHr_{r,t}$ the remuneration of skilled labor in rural sectors in country *r* at time *t*, gap_{h_r} a constant positive parameter, $Hu_{r,t}$ the total demand for skilled labor in urban sectors of country *r* at time *t*, $Hr_{r,t}$ the total demand for skilled labor in rural sectors of country *r* at time *t*, and $\overline{H}_{r,t}$ the total supply of skilled labor in country *r* at time *t*. In addition, *urban(i,r)* is the set of urban sectors in country *r*, and *rural(i,r)* is the set of rural sectors in country *r*.

For unskilled workers, wages are lower in informal sectors than in formal sectors. There are potentially different explanations for this gap, including minimum wages, transaction costs, and higher productivity in formal sectors due to more capital-intensive production processes.

The mobility of unskilled labor between rural and urban areas is ruled by an equation of migration: migration stops when the salary in formal rural sectors, $WLr\_formal_{r,t}$, is equal to the expected salary that can be obtained in urban areas where an unskilled worker either works in an urban formal sector (Probability: $Prob\_Lu\_formal_{r,t}$) and gets a salary of $WLu\_formal_{r,t}$ or works in an urban informal sector (Probability: $1 - Prob\_Lu\_formal_{r,t}$) and gets a salary of $WLu\_informal_{r,t}$. This probability is the function of the share of the urban formal employment of unskilled labor, $Lu\_formal_{r.t}$, in total employment of unskilled labor in urban sectors, $Lu_{r,t}$. Consequently, there are 11 equations describing this double segmentation of the employment of unskilled labor in countries with dual-dual modeling:

$$WLr_{formal_{r,t}} = \text{Prob}_{Lu_{formal_{r,t}}} WLu_{formal_{r,t}} + [1 - \text{Prob\_}Lu\_formal_{r,t}]WLu\_informal_{r,t}, \tag{5}$$

$$\text{Prob\_}Lu\_formal_{r,t} = cp_r \frac{Lu\_formal_{r.t}}{Lu\_informal_{r.t} + Lu\_formal_{r,t}}, \tag{6}$$

$$Lu_{r,t} + Lr_{r,t} = \overline{L}_{r,t}, \tag{7}$$

$$Lu\_formal_{r,t} + Lu\_informal_{r.t} = Lu_{r,t}, \tag{8}$$

$$Lr\_formal_{r,t} + Lr\_informal_{r.t} = Lr_{r,t}, \tag{9}$$

$$Lu\_formal_{r,t} = \textstyle\sum_{formal(i,r)} Lu_{i.r,t}, \tag{10}$$

$$Lu\_informal_{r,t} = \sum_{informal(i,r)} Lu_{i.r,t}, \quad (11)$$

$$Lr\_formal_{r,t} = \sum_{formal(i,r)} Lr_{i.r,t}, \quad (12)$$

$$Lr\_informal_{r,t} = \sum_{informal(i,r)} Lr_{i.r,t}, \quad (13)$$

$$WLu\_formal_{r,t} = WLu\_informal_{r,t}(1 + \delta u_r), \text{ and} \quad (14)$$

$$WLr\_formal_{r,t} = WLr\_informal_{r,t}(1 + \delta r_r), \quad (15)$$

where cp_r is a positive constant; $Lu\_informal_{r.t}$ is urban informal employment of unskilled labor; $Lr_{r,t}$ is total employment of unskilled labor in rural sectors; $Lu\_informal_{r,t}$ is total demand for unskilled labor in urban informal sectors in country *r* at time *t*; $Lu\_formal_{r,t}$ is total demand for unskilled labor in urban formal sectors in country *r* at time *t*; $Lr\_informl_{r,t}$ is total demand for unskilled labor in rural informal sectors in country *r* at time *t*; $Lr\_formal_{r,t}$ is total demand for unskilled labor in rural formal sectors in country *r* at time *t*; $WLr\_informal_{r,t}$ is the remuneration of unskilled labor in rural informal sectors in country *r* at time *t*; δu_r is a positive constant; δr_r is a positive constant; $formal_{(i,r)}$ is the set of formal sectors in country *r*; and $informal_{(i,r)}$ is the set of informal sectors in country *r*.

The Consistent Tariff Aggregator

The consistent tariff aggregator approach (Laborde et al. 2011) has been implemented in MIRAGRODEP. This is an important element of the model because the project is conducted at a relatively low level of sector disaggregation (37 sectors). The consistent tariff aggregator approach allows us to take into account the variance in tariffs at the tariff line level.

Following Bach and Martin (2001), this procedure deals with the problem of aggregation when protection rates vary substantially within groups of commodities. Two different types of aggregators are constructed: one is optimal for decisions regarding expenditure levels and demand for consumption goods, and the other is optimal for aggregating tariffs when estimating tariff revenues. Tariffs at the tariff line level are aggregated outside the CGE to generate (1) the tariff revenue aggregator, τ_R, that provides the right tariff revenue and (2) the aggregator for expenditure, τ_e, that generates the right domestic price and is consistent with the volume measure for imports at domestic prices.

These values are computed in an aggregation module independent of the CGE, which requires solving a partial equilibrium model (with assumptions on preferences—that is, a nested structure of preferences, functional forms, and levels of elasticity) at the tariff line level to determine the new trade pattern within the aggregate under consideration. The technique developed by Anderson (2009) is used to facilitate applying this approach to a multicountry model. This technique restores global market clearing by taking into account the fact that quantity aggregates at domestic prices differ from quantity aggregates at international prices.

Using this aggregation procedure, we expect a more precise evaluation of the shock implied by the trade reform. For example, Laborde, Martin, and van der Mensbrugghe (2011) applied the technique in a modified version of the LINKAGE global general equilibrium model, taking into account the nested structure of import demand in that model. Using this aggregation procedure with a conservative estimate of the elasticity of substitution between six-digit tariff lines, the authors found a substantial augmentation of average tariffs when dispersion is high within a group of commodities, as well as an increase in the estimated welfare gains from complete liberalization of global trade barriers.

The Poverty Toolbox

We implement a poverty analysis using a top-down microsimulation approach. The advantage of this simulation is that there is no need to reconcile data from the macro model with data from the household survey. Furthermore, because microaccounting approaches cannot handle labor market issues (such as changes in unemployment), we use a behavioral, nonparametric, top-down approach (Ganuza, Paes de Barros, and Vos 2002; Vos and Sanchez 2010). This approach incorporates changes in the labor market by assuming that occupational shifts can be proxied by a random selection procedure.

A top-down microsimulation approach feeds the inputs from the macro model (changes in prices and returns on factors) into a micro module. It gives the first-order effects of the exogenous policy change at the household level. The counterfactual changes for labor market parameters (participation rate, unemployment, employment composition by sector, and wage structure) are then imposed on the data using a sequential random procedure consistent with the macro model. It is assumed that individuals comply with the following sequence: the individual first decides whether or not to participate in the labor market, and then the market decides whether or not that individual will be employed. In the third stage, the person decides in which sector to work, which determines a certain wage level.

Because random numbers are used to determine which persons change their labor force status, what their occupational category is, and how new mean labor incomes are assigned to individuals in the sample, the microsimulation exercise is repeated a large number of times in a Monte Carlo fashion. The assumption is that the effect of the random changes correctly reflects, on average, the impact of actual changes observed in the labor market. One can also build confidence intervals for the poverty and inequality indicators. The main difference between the nonparametric and the microaccounting approach is changes in employment status.

The Data

Social accounting matrix (SAM) and trade data in MIRAGRODEP are based on GTAP 9 (Aguiar, Narayanan, and McDougall 2016). The GTAP 9 database is a fully documented global database that contains complete bilateral trade, transport, and protection data among 140 regions for all 57 GTAP commodities for 2011. The GTAP 9 database contains the SAMs for eight WA countries (Benin, Burkina Faso, Côte d'Ivoire, Ghana, Guinea, Nigeria, Senegal, and Togo). We excluded data for Guinea because we found differences between GTAP data and national data obtained from various sources.

This evaluation is based on a geographical and sectoral disaggregation that includes 17 regions and 37 sectors. Lists of these regions and sectors, with GTAP correspondences, are presented in Appendix B. Among the 37 sectors, there are 14 agricultural and food sectors and 4 primary nonagricultural sectors. Among the 17 regions, there are 8 countries or regions from ECOWAS and 2 regions from Africa but not from ECOWAS.

In the developing countries on which this study focuses (Benin, Burkina Faso, Côte d'Ivoire, Ghana, Nigeria, Senegal, Togo, and the remaining ECOWAS countries, designated as "rest of ECOWAS"), informal sectors were selected after a review of the literature[10] and after consideration of the importance of capital and skilled labor in all sectors. In these eight countries/regions, there are 11 informal sectors: vegetables and fruits, oilseeds, plant fibers, other crops, other industries, rice, cereals, cattle, other animal products, other natural resources, and fisheries. In the countries of interest, formal sectors are the "other" sectors, and in all other countries, all sectors are formal.

Information on tariffs at the HS6 level[11] from the European Commission is used to construct the baseline and the scenario. Starting from a 2007 database, the baseline involves the EU GSP reform launched in January 2014, the ECOWAS common external tariff, and some transitory measures as defined in the new ECOWAS regulation. It also includes the other EPA signed with third-party countries (ACP countries) and specific preferences granted by the EU to Central American countries. The

[10] See Benjamin and Mbaye (2012) and De Vreyer and Roubaud (2013).

[11] Information was provided at the eight-digit level. A simple average is used between the six- and eight-digit levels.

ECOWAS members that are not LDCs (Ghana, Côte d'Ivoire, Cape Verde after the phasing out of its LDC status, and Nigeria) are given the EU GSP market access in this baseline even though initially they get a better preference with the ACP tariff. Other ECOWAS countries benefit from the EBA preference.

This baseline is used as a benchmark to measure the market access concessions granted in the reform by both parties. These concessions are implemented using the consistent aggregator approach (see above), considering the exact liberalization schedule with the proper dynamics and exceptions. We implement all the changes at the eight-digit level using a new tariff database based on TARIC (the Integrated Tariff of the European Communities) with information on both the partner and the regime.

In addition to having a market access component, the EPA between WA countries and the EU includes a development package known as the Economic Partnership Agreement development package (EPADP). The package involves a combination of aid for trade, infrastructure improvements, and upgrades to the region's production capacities. These different measures are mapped into key structural variables of the model (for example, productivity increase and reduction of trade costs). A development package is included in both the baseline and the scenario because the European Commission intends to adopt a development package regardless of the result of the negotiations. As explained by the European Commission, the development package is oriented more toward education in the baseline and more toward trade in the scenario.

The package consists of an "envelope" of €1.3 billion (euros) per year from 2015 to 2035 given by the European Commission, both in the baseline and in the scenario. However, although in the baseline it allocates 50 percent to trade infrastructure and 50 percent to general assistance (education, health, economic reform, and so on), it allocates 100 percent to trade infrastructure in the scenario.

We expect this package to have two impacts. First, in terms of demand, the package represents new expenditures that finance demand in a specific sector (the construction sector in the case of funds allocated to trade infrastructure and the public services sector in the case of funds allocated to general assistance). Second, in terms of supply, these funds have an impact on the split between the skilled labor force and the unskilled labor force when they go to the general assistance program (by augmenting the skilled labor force and decreasing the unskilled labor force), and they reduce trade costs when allocated to trade infrastructure.

The magnitude of these impacts has to be selected: by how much will €1 allocated to general assistance (respectively, trade infrastructure) augment the skilled labor force to the detriment of the unskilled labor force (respectively, reduce trade costs)? After a review of the literature (see, for example, Burnside and Dollar 2000; Easterly, Levine, and Roodman 2003; Hansen and Tarp 2001; Rajan and Subramanian 2005),[12] we base our approach on our preferred reference (Hansen and Tarp 2001) and calibrate these effects such that a 1.00 percent increase in the ratio of aid to GDP augments GDP by 0.15 percent.

We do not expect the EPADP to have much impact, for two reasons. First, the annual envelope (€1.3 billion) represents, in 2013, 0.2 percent of the total GDP of the ECOWAS region (US$755.6 billion,[13] according to the World Development Indicators). Second, this envelope is given in both the baseline and the scenario. Because we estimate the impact of this agreement using a comparison between the scenario and the baseline, the results are based only on the reallocation of half of these funds from general assistance to trade infrastructure.

To carry out poverty analysis, detailed information on households is needed, in turn requiring two elements. First, the household surveys must be relatively recent and publicly available. Second, they should include an income module in order to run the microsimulation model. Unfortunately, most household surveys focus only on expenditures (consumption) and seldom include an income component. Taking into account all these constraints, two countries were selected for the microsimulation exercise:

[12] It should be noted that this literature does not provide a consensus. For example, Burnside and Dollar (2000) concluded that aid has a conditional positive impact, but Easterly, Levine, and Roodman (2003) did not find any significant impact.

[13] All dollar amounts are in US dollars.

Nigeria, using the General Household Survey, carried out in 2010/2011, and Ghana, using the Ghana Living Standards Survey 5, carried out in 2005/2006.

It is worth noting that these two countries are representative of the region in many respects. In particular, they represent 75 percent of the region's GDP and 77 percent of its population (according to the latest figures available from the World Development Indicators database).

3. RESULTS

We first present the estimated impact of this reform at the macroeconomic level—that is, on GDP, welfare, and poverty. Second, we look for an explanation of these shocks by examining protection, trade, public revenues, production, remunerations of productive factors, and allocation of labor between rural and urban sectors and between formal and informal sectors.

Impact on Macroeconomic Variables and Poverty

Table 3.1 presents the macroeconomic results, particularly how GDP and welfare are affected by the reform. For all countries outside western Africa, the reform has almost no impact on GDP and welfare.[14] So we present all results first for the EU and then for ECOWAS countries.

Table 3.1 Rate of variation of gross domestic product and real income, 2035, scenario/baseline (in percentages)

Country/region	GDP	Welfare
European Union	0.0	0.0
Benin	0.2	–0.4
Burkina Faso	0.2	0.1
Côte d'Ivoire	0.3	0.3
Ghana	0.0	–0.2
Nigeria	0.0	–0.1
Senegal	0.4	–0.2
Togo	0.2	–0.5
Rest of ECOWAS	0.1	–0.3

Source: Authors' calculation.
Note: Rest of ECOWAS includes Cabo Verde, Gambia, Guinea, Guinea Bissau, Liberia, Mali, Niger, and Sierra Leone. ECOWAS = Economic Community of West African States; GDP = gross domestic product.

The welfare results are negative for Nigeria, Senegal, Benin, the rest of ECOWAS, and Togo, and positive for Burkina Faso and Côte d'Ivoire. In all WA countries, households are positively affected by a decreasing consumption price index but negatively affected by the lump-sum tax needed to maintain public expenses and the public budget balance constant. In all countries, the net change in welfare is small.

Table 3.1 indicates an increase in GDP in Senegal, Burkina Faso, and Côte d'Ivoire and a decrease in Benin, the rest of ECOWAS, and Togo. This again reflects contrasting forces. If local production is negatively affected by more imports from the EU, there are several mechanisms that have a positive impact on economic activity in these countries. As already stated, for non-LDCs, the implementation of the EPA improves access to European markets for local exporters. The liberalization of imports from Europe in these countries may also have several positive impacts on local production, because a depreciation of the real exchange rate associated with the deterioration of the current account improves competitiveness and exports. The competitiveness of local producers can also be improved through importation of cheaper inputs (intermediate consumption and capital goods). Finally, European goods are cheaper for local consumers and thus improve their purchasing power; as a result, local

[14] Welfare is here defined as an equivalent variation, that is to say, the monetary amount the representative agent would be indifferent about accepting in place of the implementation of the EPA reform.

consumers may increase their consumption of and demand for local products. In all WA countries, however, these effects are small.

The impact on welfare differs from the impact on GDP for Benin, Senegal, Togo, and the rest of ECOWAS, but the two impacts are very close for Burkina Faso, Côte d'Ivoire, and Nigeria.

Table 3.2 indicates the rate of variation of two GDP components in 2035 by volume, in the scenario compared with the baseline. In terms of national accounts, GDP may be decomposed as the sum of final private consumption demand, final public consumption demand, capital goods demand, and net foreign demand.

Table 3.2 Rate of variation of gross domestic product components, national accounts, by volume, 2035, scenario/baseline (in percentages)

Country/region	Final private consumption	Capital goods
Benin	–0.4	0.0
Burkina Faso	0.1	0.4
Côte d'Ivoire	0.3	1.0
Ghana	–0.2	0.3
Nigeria	–0.1	–0.1
Rest of ECOWAS	–0.3	0.0
Senegal	–0.1	0.9
Togo	–0.5	–0.1

Source: Authors' calculation.
Note: Rest of ECOWAS includes Cabo Verde, Gambia, Guinea, Guinea Bissau, Liberia, Mali, Niger, and Sierra Leone. ECOWAS = Economic Community of West African States.

By assumption, final public consumption demand and net foreign demand are constant in percentage of GDP in our model. So variation in GDP is driven by a variation in final private consumption demand, a variation in capital goods demand, or both. If we compare Table 3.1 with Table 3.2, it is clear that the variation in the final private consumption component of GDP and the variation in welfare are close. Thus, most of the difference between the variation in GDP and welfare in Table 3.1 is explained by the second column of Table 3.2.

The EPA implies a change in the demand for capital goods through different mechanisms. First, the reform implies variation in production in each sector, thanks in particular to (1) more imports competing with national production, (2) more exports worldwide, and (3) more demand addressed to the construction sector due to the development package. With changes in production come changes in the demand for productive factors, particularly the demand for capital goods. Second, when national income is augmented, private saving increases, and with constant foreign and public savings, investment is increased.

It is worth noting that all variations in demand for capital goods (Table 3.3) are greater than or equal to variations in private final consumption demand. This explains why in Table 3.1, variations in GDP are systematically greater than variations in welfare. It is also worth noting that the magnitude of this effect depends on the importance of the capital goods demand component in GDP. In Senegal, this share is so important that the significant increase in the demand for capital goods implies a substantial difference between welfare and GDP. In Côte d'Ivoire, on the other hand, the capital goods demand component represents a small share of GDP (the smallest amongst all ECOWAS countries) such that the significant increase in the demand for capital goods (+1.0 percent) is not translated into a variation in GDP significantly greater than the variation in welfare (Table 3.1).

Table 3.3 Impact of trade reform on percentage of population in poverty, 2035

Poverty threshold, per day	Percentage of population in poverty					
	Nigeria			Ghana		
	Base year	2035 Baseline	2035 Scenario	Base year	2035 Baseline	2035 Scenario
US$1.00	51.57	44.37	44.41	29.99	21.65	21.75
US$1.25	55.61	47.45	47.52	31.66	23.64	23.59

Source: Authors' calculation.

Table 3.3 presents the impact of the EPA reform on the poverty head count in Nigeria and Ghana. The poverty head count at $*x* per day is the percentage of the population living on less than $*x* per day at 2005 international prices (*x* is either 1.00 or 1.25). The base year refers to the year in which the household survey was conducted, that is, 2010/2011 for Nigeria and 2006/2007 for Ghana. All other figures are for 2035.

Interestingly, the baseline assumes conservative policies with no specific initiative, such as, for instance, achieving the Sustainable Development Goals. Our objective here is to see how the EPA marginally affects the poverty rate; we do not claim to develop a baseline considering pro-poor policies or inclusive growth.

It is worth noting that changes in poverty head counts due to the reform are marginal. As previously noted, this trade reform does not have a substantial impact on the economies of WA countries, particularly when it comes to factor remuneration (see below) or the consumer price index used to update the poverty line between the baseline and the scenario. For example, in Nigeria, the trade reform results in an augmentation of the poverty head count at $1.00 per day or $1.25 per day, but these changes are so small that it is hard to conclude on their significance.

Moreover, there is a significant diminution in poverty from the base year to 2035. In Nigeria, the poverty head count at $1.25 will decrease from 55.61 percent in 2010/2011 to 47.45 percent in 2035, and in Ghana, the poverty head count at $1.25 will decrease from 31.66 percent in 2006/2007 to 23.64 percent in 2035.

How Is Market Access Changed by the Reform?

The reform has a minor impact on global protection and global access to markets, as shown in Tables 3.4 and 3.5. Both tables present protection applied on total imports of goods (that is, the average degree of protectionism, with services excluded) and protection faced on all exports (that is, access to foreign markets) in 2015 and 2035. The B columns (baseline) present the average duty when no policy reform is implemented, and the S columns (scenario) present the average duty when the policy reform is implemented.

Table 3.4 Protection applied on all imports from all origins, baseline and scenario, 2015 and 2035 (in percentages)

	2015			2035		
Country/region	B	S	Variation	B	S	Variation
Benin	16.7	16.7	0.0	16.7	15.7	–1.0
Burkina Faso	6.2	6.2	0.0	6.2	4.5	–1.7
Côte d'Ivoire	8.1	8.1	0.0	8.1	6.4	–1.7
European Union	0.6	0.6	0.0	0.6	0.6	0.0
Ghana	10.7	10.7	0.0	10.7	9.1	–1.6
Nigeria	8.8	8.8	0.0	8.8	7.4	–1.3
Rest of ECOWAS	9.0	9.0	0.0	9.0	8.0	–1.0
Senegal	9.2	9.2	0.0	9.2	7.0	–2.2
Togo	12.5	12.5	0.0	12.5	11.4	–1.2

Source: Authors' calculation.
Note: Rest of ECOWAS includes Cabo Verde, Gambia, Guinea, Guinea Bissau, Liberia, Mali, Niger, and Sierra Leone. B = baseline; ECOWAS = Economic Community of West African States; S = scenario.

Table 3.5 Protection faced by all exports, baseline and scenario, 2015 and 2035 (in percentages)

	2015			2035		
Country/region	B	S	Variation	B	S	Variation
Benin	2.46	2.46	0.00	2.46	2.46	0.00
Burkina Faso	0.32	0.32	0.00	0.32	0.32	0.00
Côte d'Ivoire	2.91	1.59	–1.32	2.91	1.59	–1.32
European Union	1.85	1.85	0.00	1.85	1.82	–0.03
Ghana	1.47	0.81	–0.67	1.47	0.81	–0.67
Nigeria	0.26	0.23	–0.03	0.26	0.23	–0.03
Rest of ECOWAS	0.62	0.54	–0.09	0.62	0.54	–0.09
Senegal	3.27	3.27	0.00	3.27	3.27	0.00
Togo	1.33	1.33	0.00	1.33	1.33	0.00

Source: Authors' calculation.
Note: Rest of ECOWAS includes Cabo Verde, Gambia, Guinea, Guinea Bissau, Liberia, Mali, Niger, and Sierra Leone. B = baseline; ECOWAS = Economic Community of West African States; S = scenario.

We do not adopt bilateral imports as weights to calculate an average duty applied on imports or an average duty faced by exports because these are endogenous weights; bilateral imports depend directly on tariffs, and thus the higher the tariff, the lower the imports. When a tariff is so high that it prohibits imports, the weight would be 0. Consequently, for each average, we weigh a tariff imposed by country *s* on product *i* coming from country *r* with imports of product *i* by country *s* from all countries in the world.

The average protection applied by the EU on goods, already low in the baseline (0.600 percent from 2012 until 2035), is only marginally affected by the reform (from 0.643 percent to 0.639 percent in 2035). This is because the EU has already given free trade access to LDCs from ECOWAS. Import duties conceded to non-LDCs from ECOWAS by the EU were relatively low under the previous preferential regime. In the baseline—that is, if ECOWAS countries do not sign the agreement—the EU will give GSP preferences to non-LDC ECOWAS countries; however, this should imply only a minor augmentation of average protection between 2013 and 2014.

Even if ECOWAS countries implement a reduction of import duties on a limited range of goods coming from the EU, the decrease in average protection is more significant: from 9.2 percent to 7.0 percent for Senegal in 2035, implying a reduction by 220 basis points (bp) of average protection for this country. This is the largest reduction in average protection. The smallest reduction, 100 bp, occurs between Benin and the rest of ECOWAS. Most of the decrease in average protection comes from a partial liberalization of imports originating in the EU.

The reform also changes access to foreign markets for the countries studied, as illustrated in Table 3.5. Access to foreign markets is slightly improved for the EU, from 1.85 percent to 1.82 percent in 2035. It is not changed for Benin, Burkina Faso, Togo, or Senegal (the ECOWAS LDCs), but it is improved for Côte d'Ivoire (by 132 bp, from 2.91 percent to 1.59 percent), Ghana (by 67 bp, from 1.47 percent to 0.81 percent), Nigeria (by 3 bp, from 0.26 percent to 0.23 percent), and the rest of ECOWAS (by 9 bp, from 0.62 percent to 0.54 percent). For ECOWAS countries, the decrease in protection faced by all exports takes place as soon as 2015; for the EU, this decrease is delayed.

Consequently, this trade agreement entails an asymmetric opening of trade borders. WA countries open their borders to European products more than the EU opens its borders to WA countries. Concerning LDCs from ECOWAS (Benin, Burkina Faso, Senegal, and Togo), the trade agreement does not imply any improvement in access to foreign markets because these countries already benefit from the EBA preference and the free trade area with other ECOWAS countries; under the EPA, these countries open their borders to European goods. For the non-LDC ECOWAS countries (Côte d'Ivoire, Ghana, and Nigeria), the EPA results in more WA openness to European products than EU openness to WA products. The reduction of the EU's protection on imports is close to 0, while the EU gets a small but significant improvement in access to foreign markets, at 3 bp.

Table 3.6 indicates the protection applied on goods by the country in each column on products originating in the country in each row. It shows average protection in 2035 in both the baseline and the scenario. For example, in 2035, the average protection on goods that Benin imposes in the baseline on EU products is 13.6 percent, and it is 8.5 percent in the scenario.

The EPA is essentially a free trade area. In a classical and influential study, Viner (1950) pointed out two effects of free trade areas: a trade creation effect and a trade diversion effect. The first effect is beneficial and comes from new trade arising from the elimination of barriers to trade between members of the free trade area. The second effect is negative and consists of the replacement of a trade flow between a member of the area and a country not belonging to the area by a trade flow between two members of the area. The latter implies that the importing country will no longer import from the cheapest source; thus, this trade diversion effect is equivalent to a deterioration in its terms of trade.

Looking at how bilateral protection is affected by this trade reform (Table 3.6), we see that trade creation may be insignificant because tariff barriers on the EU's side are low. On the WA side, initial tariff barriers on EU products are significant, but their elimination may either create trade or divert trade because barriers remain at the same level on products originating from partners other than the EU and WA.

Table 3.6 Protection on goods imposed by country (in columns) on imports coming from country (in rows), baseline and scenario, 2035 (in percentages)

Country/region	Asia		Benin		Burkina Faso		CARICOM		CIS		Côte d'Ivoire		EU		Ghana		Latin Amer.	
	B	S	B	S	B	S	B	S	B	S	B	S	B	S	B	S	B	B
Asia	4.4	4.4	18.9	18.9	10.2	10.2	8.8	8.8	9.7	9.7	10.5	10.5	2.0	2.0	12.2	12.2	10.3	10.3
Benin	2.9	2.9	0.0	0.0	0.0	0.0	0.6	0.6	0.3	0.3	0.0	0.0	0.0	0.0	0.0	0.0	4.4	4.4
Burkina Faso	1.4	1.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CARICOM	7.8	7.8	1.7	1.7	1.0	1.0	3.8	3.8	14.9	14.9	1.7	1.7	1.3	1.3	11.2	11.2	3.5	3.5
CIS	2.1	2.1	8.0	8.0	3.8	3.8	6.3	6.3	0.2	0.2	2.5	2.5	0.7	0.7	7.5	7.5	3.4	3.4
Côte d'Ivoire	3.2	3.2	0.0	0.0	0.0	0.0	1.1	1.1	5.2	5.2	0.0	0.0	3.1	0.0	0.0	0.0	9.4	9.4
EU	6.7	6.7	13.6	8.5	8.5	3.5	8.6	8.6	8.0	8.0	10.1	4.6	0.0	0.0	9.9	3.8	8.7	8.7
Ghana	2.8	2.8	0.0	0.0	0.0	0.0	1.1	1.1	2.0	2.0	0.0	0.0	1.6	0.0	0.0	0.0	7.1	7.1
Latin Amer.	3.2	3.2	21.2	21.2	9.7	9.7	6.0	6.0	10.4	10.4	9.4	9.4	4.3	4.3	17.4	17.4	1.5	1.5
ME & NA	1.7	1.7	12.7	12.7	10.9	10.9	2.4	2.4	8.5	8.5	10.1	10.1	0.4	0.4	9.9	9.9	4.1	4.1
NAFTA	7.2	7.2	12.4	12.4	9.1	9.1	7.6	7.6	8.5	8.5	8.3	8.3	2.0	2.0	11.3	11.3	5.0	5.0
Nigeria	0.5	0.5	0.0	0.0	0.0	0.0	0.6	0.6	0.6	0.6	0.0	0.0	0.1	0.0	0.0	0.0	0.5	0.5
Rest of Africa	3.0	3.0	16.0	16.0	9.5	9.5	1.9	1.9	4.1	4.1	7.2	7.2	1.2	1.2	9.9	9.9	4.6	4.6
Rest of ECOWAS	0.9	0.9	0.0	0.0	0.0	0.0	5.9	5.9	0.3	0.3	0.0	0.0	0.3	0.0	0.0	0.0	6.6	6.6
ROW	4.2	4.2	14.1	14.1	9.3	9.3	10.5	10.5	6.6	6.6	8.5	8.5	0.9	0.9	9.6	9.6	8.3	8.3
Senegal	9.3	9.3	0.0	0.0	0.0	0.0	3.1	3.1	2.5	2.5	0.0	0.0	0.0	0.0	0.0	0.0	8.9	8.9
Togo	2.9	2.9	0.0	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.5

Table 3.6 Continued

Country/region	ME & NA		NAFTA		Nigeria		Rest of Africa		Rest of ECOWAS		ROW		Senegal		Togo	
	B	S	B	S	B	S	B	S	B	S	B	S	B	S	B	S
Asia	8.0	8.0	2.7	2.7	10.5	10.5	11.6	11.6	8.9	8.9	3.9	3.9	11.5	11.5	14.2	14.2
Benin	0.1	0.1	0.1	0.1	0.0	0.0	11.8	11.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Burkina Faso	0.2	0.2	0.0	0.0	0.0	0.0	0.4	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CARICOM	5.6	5.6	1.3	1.3	2.5	2.5	4.9	4.9	5.3	5.3	1.3	1.3	5.7	5.7	9.6	9.6
CIS	5.1	5.1	0.6	0.6	7.8	7.8	7.4	7.4	6.8	6.8	0.8	0.8	7.5	7.5	7.5	7.5
Côte d'Ivoire	11.4	11.4	0.5	0.5	0.0	0.0	12.1	12.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
EU	4.6	4.6	1.5	1.5	9.4	3.2	6.4	6.4	10.1	4.8	2.3	2.3	9.6	3.9	10.6	5.1
Ghana	0.9	0.9	0.1	0.1	0.0	0.0	7.7	7.7	0.0	0.0	0.4	0.4	0.0	0.0	0.0	0.0
Latin Amer.	8.1	8.1	0.9	0.9	10.3	10.3	9.4	9.4	15.5	15.5	3.5	3.5	11.5	11.5	16.5	16.5
ME & NA	3.9	3.9	0.6	0.6	9.2	9.2	4.3	4.3	12.4	12.4	1.0	1.0	10.1	10.1	13.2	13.2
NAFTA	4.2	4.2	0.4	0.4	8.6	8.6	7.0	7.0	9.7	9.7	1.2	1.2	8.5	8.5	9.2	9.2
Nigeria	5.4	5.4	0.0	0.0	0.0	0.0	2.1	2.1	0.0	0.0	0.9	0.9	0.0	0.0	0.0	0.0
Rest of Africa	4.7	4.7	0.3	0.3	9.4	9.4	6.1	6.1	10.2	10.2	2.2	2.2	9.1	9.1	9.1	9.1
Rest of ECOWAS	7.6	7.6	0.2	0.2	0.0	0.0	1.6	1.6	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0
ROW	5.4	5.4	1.8	1.8	9.7	9.7	4.9	4.9	9.1	9.1	2.0	2.0	9.5	9.5	8.8	8.8
Senegal	4.6	4.6	3.3	3.3	0.0	0.0	17.0	17.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0
Togo	2.1	2.1	0.0	0.0	0.0	0.0	11.7	11.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Source: Authors' calculations.
Note: Rest of ECOWAS includes Cabo Verde, Gambia, Guinea, Guinea Bissau, Liberia, Mali, Niger, and Sierra Leone. B = baseline; CARICOM = Caribbean Community; CIS = Community of Independent States; ECOWAS = Economic Community of West African States; EU = European Union; Latin Amer. = Latin America; ME & NA = Middle East and North Africa; NAFTA = North American Free Trade Agreement countries; ROW = rest of the world; S = scenario. Weight is world imports. Exporters are in rows and importers in columns.

Products exported by the EU to WA countries benefit from a significant improvement in access to markets: in 2035, thanks to the agreement, the average protection faced by the EU on its goods exported to Nigeria is decreased by 618 bp, to Ghana by 608 bp, and to Senegal by 572 bp. Products exported by African countries to the EU are initially free from any tax at the European border, or the average protection is low in the baseline in 2035 (for example, 1.17 percent for Nigeria) and is annulled with the scenario. In 2035, thanks to the agreement, the protection imposed by the EU on products coming from Côte d'Ivoire decreases by 310 bp, from Ghana by 164 bp, from Nigeria by 12 bp, and from the rest of ECOWAS by 27 bp. These findings confirm that the trade agreement entails an asymmetric opening of trade borders, to the disadvantage of WA countries.

Let us now consider the sectoral variation of protection implied by the agreement. Since protection varies only on goods exported by the EU to WA countries and by non-LDC WA countries (Nigeria, Côte d'Ivoire, and Ghana) to the EU, we focus on the sectoral variation of protection on these flows only.

Table 3.7 indicates the variation of protection implied by the EPA in 2035 on the EU's exports to WA countries. The sectors in which Europe benefits most from improvements in access to WA markets are fisheries (particularly in Benin, Burkina Faso, and the rest of ECOWAS), other minerals (particularly in Burkina Faso and Côte d'Ivoire), and vegetables and fruits (particularly in Benin and Côte d'Ivoire).

Table 3.7 Variation in protection by sector, scenario/baseline, 2035 (in percentages)

Sector	Benin	Burkina Faso	Côte d'Ivoire	Ghana	Nigeria	Rest of ECOWAS	Senegal	Togo
Beverages and tobacco	–1.6	–1.3	–3.4	–0.8	–1.8	–0.7	–2.2	–1.0
Cattle	0.0	–5.0	–9.5	–7.5	–9.1	–5.0	–5.7	0.0
Cereals	–5.0	–5.0	–5.0	–5.0	–5.0	–5.0	–5.0	–5.0
Capital goods	–7.2	–6.5	–6.8	–6.5	–6.5	–6.4	–6.3	–6.8
Chemicals	–3.1	–1.8	–3.7	–4.6	–4.4	–2.8	–3.8	–3.4
Dairy products	–1.2	–2.5	–2.4	–3.1	–3.1	–2.5	–2.4	–1.4
Electronics	–8.3	–6.9	–8.3	–9.1	–8.5	–8.0	–8.0	–8.3
Fossil fuel	–8.0	–7.9	–7.7	–7.9	–7.8	–7.9	–7.7	–7.8
Fisheries	–19.0	–19.8	–14.7	–17.3	–10.0	–18.7	–7.0	–11.4
Leather products	–4.9	–5.7	–5.2	–5.7	–6.5	–6.6	–6.1	–5.4
Other minerals	–8.9	–12.0	–10.1	–9.2	–9.0	–7.1	–9.9	–8.9
Red meat	0.0	0.0	–0.1	0.0	–1.1	–1.1	–0.9	0.0
White meat	0.0	0.0	–0.5	–1.1	–0.8	–1.2	–2.4	–0.1
Metals	–9.0	–9.0	–9.9	–8.8	–8.8	–10.2	–8.0	–8.5
Motor vehicles	–2.6	–6.2	–5.7	–5.5	–5.5	–5.8	–5.5	–4.7
Other crops	–7.8	–5.3	–8.0	–8.5	–15.8	–7.4	–5.7	–8.7
Other food	–1.9	–2.8	–5.8	–4.0	–2.3	–3.4	–4.7	–2.3
Other industries	–6.2	–4.3	–8.7	–2.3	–14.2	–3.1	–11.2	–4.4
Other natural resources	–5.0	–6.0	–5.2	–5.2	–5.1	–5.2	–5.0	–5.1
Oilseeds	–5.0	–5.0	–5.0	–5.0	–5.0	–5.3	–5.0	–7.5
Other animal products	–10.1	–8.0	–6.8	–6.3	–5.4	–5.0	–6.3	–5.2
Paper products	–3.1	–4.0	–4.8	–4.1	–5.3	–1.7	–4.2	–2.6
Plant fibers	–5.0	0.0	–5.0	0.0	–5.0	–5.0	–5.0	0.0
Rice	0.0	0.0	–0.2	–0.2	–0.1	–0.4	–0.6	–4.3
Sugar	0.0	0.0	–0.8	–0.2	0.0	0.0	0.0	0.0
Textiles	–1.5	–2.8	–3.9	–4.3	–2.5	–0.9	–3.2	–1.6
Utilities	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Vegetables and fruits	–16.1	–2.6	–2.7	–6.3	–10.7	–2.7	–0.7	–4.5
Vegetable oil	–5.0	–0.9	–1.8	–2.1	–2.7	–1.3	–7.2	–5.5
Wearing apparel	–1.7	–7.4	–3.7	–4.3	–4.2	–2.9	–3.6	–1.1
Wood products	–4.9	–4.6	–5.2	–5.5	–7.2	–5.6	–6.1	–4.6

Source: Authors' calculation.
Note: Rest of ECOWAS includes Cabo Verde, Gambia, Guinea, Guinea Bissau, Liberia, Mali, Niger, and Sierra Leone. ECOWAS = Economic Community of West African States. Exporter is European Union.

Concerning the protection applied by Europe on products from WA countries (Table 3.8), the sectors in which WA countries benefit most from improvements in access to European markets are dairy products (Côte d'Ivoire, Ghana, Nigeria), sugar (Côte d'Ivoire), rice (Côte d'Ivoire, Nigeria), and red meat (Côte d'Ivoire, Ghana, Nigeria); these three countries (Côte d'Ivoire, Ghana, and Nigeria) are the non-LDC countries from ECOWAS.

Table 3.8 Variation in protection by sector, scenario/baseline, 2035 (in percentages)

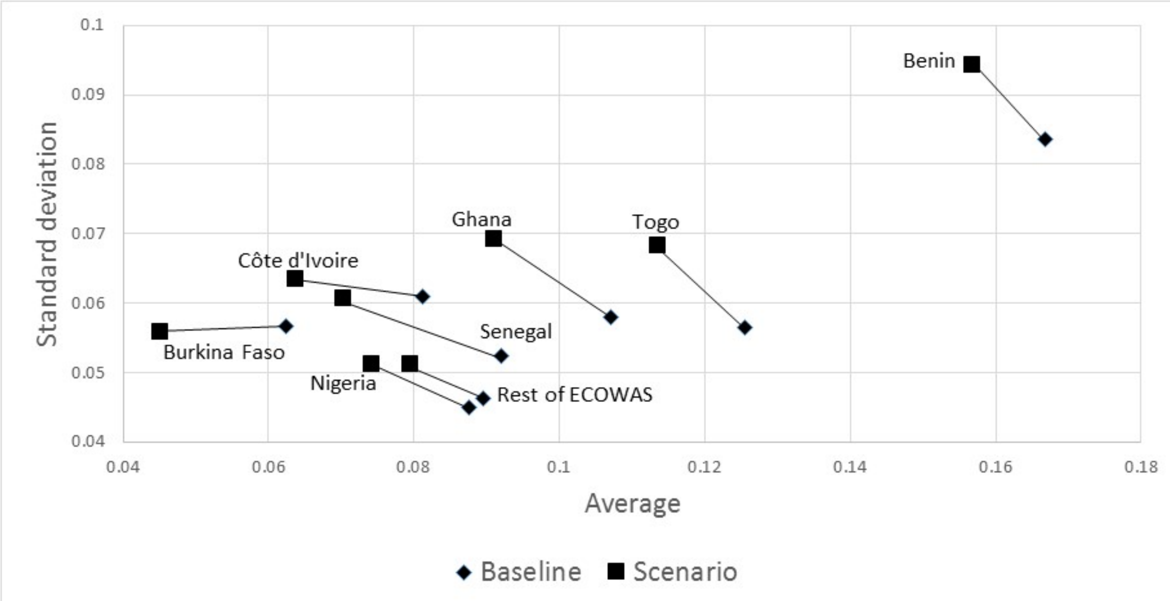
Sector	Benin	Burkina Faso	Côte d'Ivoire	Ghana	Nigeria	Rest of ECOWAS	Senegal	Togo
Beverages and tobacco	0.0	–0.1	–6.5	–4.6	–1.1	–5.9	0.0	0.0
Cattle	0.0	0.0	–7.1	–7.1	–8.8	–0.2	0.0	0.0
Cereals	0.0	0.0	–11.2	–11.4	–0.3	0.0	0.0	0.0
Capital goods	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Chemicals	0.0	0.0	0.0	0.0	–1.7	0.0	0.0	0.0
Dairy products	0.0	0.0	–25.6	–48.3	–15.0	–0.2	0.0	0.0
Electronics	0.0	0.0	–0.2	–0.4	–0.2	0.0	0.0	0.0
Fossil fuel	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Fisheries	0.0	0.0	–15.2	–3.8	–0.8	–0.1	0.0	0.0
Leather products	0.0	0.0	0.0	–2.2	0.0	0.0	0.0	0.0
Other minerals	0.0	0.0	–1.4	–0.1	–3.1	–0.8	0.0	0.0
Red meat	0.0	0.0	–20.0	–20.0	–29.6	–0.1	0.0	0.0
White meat	0.0	0.0	–14.9	–0.3	–25.1	0.0	0.0	0.0
Metals	0.0	0.0	0.0	–1.2	–0.4	0.0	0.0	0.0
Motor vehicles	0.0	0.0	–0.7	–0.2	–0.4	–1.2	0.0	0.0
Other crops	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Other food	0.0	0.0	–8.2	–9.0	–5.9	–2.8	0.0	0.0
Other industries	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Other natural resources	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Other animals	0.0	0.0	–2.4	–2.3	–0.2	0.0	0.0	0.0
Paper products	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Rice	0.0	0.0	–11.8	–5.5	–14.9	–1.7	0.0	0.0
Sugar	0.0	0.0	–51.1	–0.8	–0.8	0.0	0.0	0.0
Textiles	0.0	0.0	–0.6	–6.3	–3.4	–5.6	0.0	0.0
Vegetables and fruits	0.0	0.0	–8.2	–6.3	–0.8	–0.1	0.0	0.0
Vegetable oil	0.0	0.0	–2.7	–3.2	–0.2	0.0	0.0	0.0
Wearing apparel	0.0	0.0	–9.5	–9.5	–8.7	–7.5	0.0	0.0
Wood products	0.0	0.0	–0.1	–0.1	0.0	0.0	0.0	0.0

Source: Authors' calculation.
Note: Rest of ECOWAS includes Cabo Verde, Gambia, Guinea, Guinea Bissau, Liberia, Mali, Niger, and Sierra Leone. ECOWAS = Economic Community of West African States. Importer is European Union.

The degree of liberalization is different among ECOWAS countries and by sector. Here several effects are in play, but one is particularly important: the impact of sensitive products. Negotiations between the EU and ECOWAS countries led to the identification of sensitive products that are excluded from liberalization and of products for which the tariff removal will be complete. Our evaluation takes this clause into account at the HS6 level, before aggregating into average tariffs at the GTAP sector level through the consistent aggregator procedure. This is quite important because the efficiency cost of tariffs is linked to both the average level of protection and the dispersion of protection, inasmuch as the distortions implied by tariffs grow with the square of the tariff. In our analysis, we are able to explicitly capture the changes in tariff dispersion within a sector by using the consistent aggregator procedure, and to capture changes across sectors in the CGE framework.

Figure 3.1 indicates the impact of the reform in 2035 on the average and standard deviation of tariffs for the eight ECOWAS countries/regions.

Figure 3.1 Impact of the reform on ECOWAS countries' tariff average and standard deviation, 2035



Source: Authors' calculation.
Note: Rest of ECOWAS includes Cabo Verde, Gambia, Guinea, Guinea Bissau, Liberia, Mali, Niger, and Sierra Leone. Trade-weighted averages and standard deviations are depicted.

The inclusion of sensitive products implies that liberalization is complete for sectors like electronics, fisheries, fossil fuel, oilseeds, and other crops, while it is close to 0 in sectors like red meat, rice, sugar, and white meat. In sectors like dairy products, other food, vegetables and fruits, and wearing apparel, the rate of reduction differs significantly from one ECOWAS country to another. Consequently, if the tariff averages are reduced for all countries/regions, the tariff standard deviation of each country, except Burkina Faso, is augmented by the reform (shown by the shift toward the northwest corner of Figure 3.1). For Burkina Faso, this deviation is almost stable. It should be remembered that distortion increases with tariff average and tariff standard deviation.

Beyond intersectoral variance, intrasectoral variance matters as well. Shocks have been implemented at the HS6 level, and aggregation of tariffs from the HS6 level to the level of GTAP sectors has been conducted based on the consistent tariff aggregator. The EPA implies an augmentation of the HS6 line variance of tariffs, while average tariffs decrease for some sectors. For other fully liberalized sectors, the reform implies a reduction in the tariff variance and average through the elimination of existing tariff peaks. The consistent aggregator approach allows us to fully capture the welfare and terms-of-trade implications of this issue in the CGE and also provides a robust way to identify the sectors in which this issue is more acute. By looking at the evolution of the ratio $\frac{1+\tau_e}{1+\tau_R}$, we can track the evolution of the intrasectoral distortions.[15] This ratio is equal to 1 when tariffs are homogenous within a sector. Following the reform, this ratio increases by more than 5 percent in 12 percent of cases. Togo is the most affected country (one-third of its sectors will see increases); other meats (poultry, pigs) and wood products are the two sectors that face the most important and widespread intrasectoral distortions. However, and except for the two sectors just referred to, this problem is not important for Côte d'Ivoire, Ghana, Nigeria, and Senegal, showing that the regional liberalization plan will not lead to intrasectoral efficiency losses. More surprising is the significant number of cases (9 percent) in which the liberalization plan manages to significantly reduce (that is, by more than 5 percent) intrasectoral distortions, despite the

[15] We use the power of the tariff $(1+\tau)$ instead of the tariff itself (τ) for a more relevant and robust assessment.

exceptions for sensitive products. This is particularly true for nonmeat animal products, live animals (particularly due to tariff removal on breeders and hatchlings), dairy products, and fisheries. This mixed pattern shows how a detailed and rigorous quantitative assessments is needed, because no simple answers can be provided ex ante. Our results also provide an important insight about potential outcomes: from the beginning, we see a mix of positive and negative drivers at stake, and the net effects of the reform could be quite limited.

Impact on Trade and Customs Revenues

A cut in import tariffs has a direct effect on trade and tariff revenues. Table 3.9 indicates the impact of the reform on exports and imports, by volume, by country (or region) in 2035. We do not show countries for which results are nil (or very close to 0).

Table 3.9 Impact of the reform on total trade by country, all sectors, 2035, constant US dollars (in percentages)

Country/region	Exports	Imports
European Union	0.2	0.1
Benin	2.5	0.7
Burkina Faso	2.6	3.2
Côte d'Ivoire	2.5	3.3
Ghana	2.9	1.6
Nigeria	1.3	1.0
Senegal	3.7	1.4
Togo	1.3	0.4
Rest of ECOWAS	1.5	0.6

Source: Authors' calculation.
Note: Rest of ECOWAS includes Cabo Verde, Gambia, Guinea, Guinea Bissau, Liberia, Mali, Niger, and Sierra Leone. Intraregional trade is excluded for European Union and rest of ECOWAS. ECOWAS = Economic Community of West African States.

At the global level, the impact of the reform on trade is modest: world trade of all commodities increases by only 0.02 percent in 2035. However, some countries or regions see a significant variation in exports and imports (Table 3.9). In 2035, Côte d'Ivoire imports are augmented by 3.3 percent, Senegal's exports by 3.7 percent, and Burkina Faso's imports by 3.2 percent, while the EU's exports and imports are raised by only 0.1 percent (intra-EU trade included). If intra-EU trade is excluded, the augmentation is 0.2 percent. The difference in trade effects between EU and ECOWAS countries is related to asymmetry in country size.

It has frequently been stated that the exports and imports of some African countries are too concentrated geographically, particularly toward or from the EU. For example, MIRAGRODEP suggests that in 2035, 32.3 percent of Côte d'Ivoire's exports of goods and services are shipped toward the EU. This is not the case for all WA countries. For example, for Burkina Faso, this share is only 5.6 percent. However, the EPA leads WA countries to concentrate their exports toward the EU. For Côte d'Ivoire, for example, the share of the EU in total exports is augmented from 32.3 percent to 35.0 percent due to the reform.

However, the EPA has a different impact on ECOWAS countries depending on whether or not they are LDCs. In the case of a non-LDC country like Côte d'Ivoire, for example, the EPA implies a decrease in European protection on products exported (from 3.1 percent to 0.0 percent in 2035; Table 3.6) at the same time that trade barriers on Côte d'Ivoire's products remain at the same level in other places (Table 3.6). Thus, the reform gives Côte d'Ivoire's producers better access to European markets, and exports to this destination are augmented (+11 percent) while those destined for other places decrease (in 2035, Côte d'Ivoire's exports to Asia decrease by 0.7 percent, to the Middle East and North Africa by 0.7 percent, and to countries in the North American Free Trade Agreement [NAFTA] by 0.3 percent; these figures are not presented in Table 3.10).

Table 3.10 Impact of the reform on bilateral trade in value, free-on-board price, all sectors, 2035 (in percentages)

Country/ region	European Union	Nigeria	Senegal	Benin	Burkina Faso	Côte d'Ivoire	Ghana	Rest of ECOWAS	Togo
European Union	0.0	22.5	18.8	20.2	29.2	18.4	29.9	34.1	21.7
Nigeria	2.4	n.a.	–10.5	–0.4	–5.5	–2	–23.1	–0.5	–0.1
Senegal	3.1	0.0	n.a.	–0.7	1.2	0.9	0.2	–1	–0.7
Benin	3.2	–0.4	–4.1	n.a.	–1.8	–0.9	0	–2.1	–1.2
Burkina Faso	2.1	–1.5	–10.7	–2.5	n.a.	–7.3	–0.8	–1.3	–2.1
Côte d'Ivoire	11	–4.1	–5.1	–2.8	–7.6	n.a.	–5.1	–3.2	–2.6
Ghana	7.3	–1.5	–4.7	0.0	–2.4	–3.2	n.a.	–1.7	–1.8
Rest of ECOWAS	2.5	–4.4	–2.6	–1.4	–1.8	–1.7	–1.5	–1.3	–1.6
Togo	1.6	–2.9	–4.4	–1.7	–1.8	–1.2	–1.4	–2.7	n.a.

Source: Authors' calculation.
Note: Rest of ECOWAS includes Cabo Verde, Gambia, Guinea, Guinea Bissau, Liberia, Mali, Niger, and Sierra Leone. ECOWAS = Economic Community of West African States; n.a. = not applicable. Exporters are in rows and importers in columns.

In the case of an LDC ECOWAS country, the process is different. For example, Senegal does not see any improvement in access to either EU or non-EU destinations; rather, the EPA leads Senegal to open its borders to European products. This opening increases Senegal's imports and could deteriorate the current account balance. The model assumes that Senegal's current account balance remains constant, implying a depreciation of the real exchange rate, which increases Senegal's competitiveness toward other destinations. Due to the EPA, in 2035, Senegal's exports to Asia increase by 3.8 percent, to the Middle East and North Africa by 2.5 percent, and to NAFTA countries by 2.9 percent; these figures are not presented in Table 3.10.

At the large-sector level (agrifood, industry, services), Table 3.11 shows how trade is affected for the main countries/regions of concern. Any rate of variation may be misleading because it can correspond to a small initial value: for example, Nigerian exports in the agrifood sector are augmented by 7.2 percent in 2035 due to the implementation of EPA, but in the baseline in 2035, agrifood exports represent only 0.5 percent of total Nigerian exports of goods and services.

Table 3.11 Impact of the reform on exports and imports in value by country and large sectors, scenario and baseline, 2035 (in percentages)

	Exports			Imports		
Country/region	Agrifood	Industry	Services	Agrifood	Industry	Services
Nigeria	7.2	1.1	2.3	–0.1	3.3	–2
Senegal	1.7	2.7	2.7	0.6	2.5	–2.4
Benin	0.5	1.9	4.8	–0.3	0.9	–2.7
Burkina Faso	1.0	2.4	1.7	0.9	4.5	–1.6
Côte d'Ivoire	5.5	–1.4	0.0	3.5	4.3	0.4
Ghana	3.2	2.4	1.2	0.4	2.3	–1.8
Rest of ECOWAS	0.8	1.2	1.1	0.5	0.7	–1.0
Togo	0.4	0.4	3.3	–0.7	0.7	–2.6

Source: Authors' calculation.
Note: Rest of ECOWAS includes Cabo Verde, Gambia, Guinea, Guinea Bissau, Liberia, Mali, Niger, and Sierra Leone. ECOWAS = Economic Community of West African States.

It is worth noting that Côte d'Ivoire's and Ghana's agrifood exports are significantly raised by the EPA, as are industrial imports in Burkina Faso and Côte d'Ivoire.

Table 3.12 shows how exports by sector in the main study countries vary, first by rate of variation (in value, in percentages, for 2035) and second in variation (in millions of US dollars). Four EU sectors see their exports augmented by more than $1 billion in 2035 due to the reform: fossil fuel ($5.5 billion), capital goods ($3.6 billion), other crops ($1.7 billion), and metals ($1.5 billion). Most of the augmentation of EU exports of fossil fuel is toward Nigeria, because this country's protection on European products decreases by 708 bp (Table 3.6), and toward Ghana, because its protection on European products decreases by 709 bp. European exports of capital goods are substantially raised for Nigeria, the rest of ECOWAS, and Ghana. These three regions decrease their protection on capital goods coming from the EU by, respectively, 640 bp, 650 bp, and 640 bp.

On the African side, there is limited growth of exports in value terms, especially for Senegal and Togo. The greatest increases in Senegal's and Togo's exports are in the metals sector, at $89 million and $23 million, respectively. For Nigeria and Côte d'Ivoire, both of which will fall under the GSP program if they do not sign the EPA, exports are augmented more substantially, at $2.2 billion in the fossil fuel sector for Nigeria and $758 million for Côte d'Ivoire in the other food sector (the EU's import duty on other food products coming from Côte d'Ivoire is decreased by 800 bp).

Table 3.12 Impact of the reform on exports in value by country and by sector, 2035

	Rate of variation: Scenario/baseline (percentage)								
Sector	European Union	Nigeria	Senegal	Benin	Burkina Faso	Côte d'Ivoire	Ghana	Rest of ECOWAS	Togo
Vegetables and fruits	–0.16	2.53	1.10	0.48	0.48	4.75	4.76	0.35	0.25
Oilseeds	–0.14	2.50	1.79	0.25	0.98	–0.92	0.24	0.69	0.31
Plant fibers	–0.12	2.42	2.12	0.40	1.10	–1.32	0.57	0.53	0.48
Other crops	8.37	5.79	2.70	1.37	3.06	–1.22	0.30	–4.71	0.55
Vegetable oil	–0.02	4.16	3.75	0.88	1.91	0.02	1.39	0.95	–0.26
Other food	0.02	16.53	1.65	–0.15	0.09	19.45	12.74	1.55	–0.17
Textiles	–0.09	12.75	3.86	0.22	2.04	–1.37	0.96	4.38	–0.33
Wearing apparel	–0.08	22.98	4.17	0.48	2.52	14.46	20.39	19.94	–1.21
Leather products	–0.04	3.95	5.13	0.59	2.52	–3.57	–1.66	1.18	–0.28
Chemicals	0.04	9.42	3.94	1.60	0.63	–0.77	1.27	2.27	–1.40
Motor vehicles	0.06	0.58	–5.36	3.32	–2.09	1.18	2.01	5.13	0.89
Electronics	0.21	2.27	4.17	5.71	–5.88	–4.44	13.23	–0.70	0.79
Other industries	0.21	7.84	4.36	2.03	2.01	–2.45	0.28	1.72	2.35
Construction	–0.07	1.04	2.53	1.49	1.53	0.76	0.56	1.69	1.39
Rice	–0.17	27.47	1.11	–0.41	0.44	1.31	10.11	4.73	0.27
Cereals	0.10	3.07	3.01	–0.33	–0.79	1.55	22.79	1.17	1.11
Sugar	–0.12	3.08	2.33	0.47	1.69	–1.66	–0.47	0.79	0.64
Cattle	–0.05	2.87	1.90	0.00	–1.65	6.39	5.60	–1.94	0.06
Other animals	–0.04	1.43	1.17	0.44	–0.51	5.52	2.38	0.75	0.35
Other natural resources	0.17	0.44	0.00	0.13	0.10	–0.18	0.29	0.31	0.34
Fisheries	0.01	0.69	0.83	–0.34	0.43	39.60	2.60	0.43	0.41
Fossil fuel	2.22	0.89	14.84	–2.14	1.86	–5.38	8.06	0.54	–18.29
Red meat	–0.11	234.46	5.31	1.63	2.13	40.17	45.37	3.22	2.48
White meat	–0.10	105.97	5.26	1.92	2.23	10.78	1.14	1.56	1.16
Dairy products	0.14	3.17	1.49	0.41	–1.61	–0.71	1.33	0.01	–2.03
Beverages and tobacco	0.01	0.86	0.29	0.26	–0.61	–0.87	1.68	5.41	–0.87
Wood products	0.05	3.22	1.58	1.20	1.86	–0.55	0.70	1.55	0.45
Paper products	0.10	1.32	2.25	0.83	2.52	–3.05	1.12	–0.4	–1.52
Other minerals	0.41	–1.27	–2.48	9.40	–1.07	–4.34	–1.01	–3.07	–2.18
Metals	0.24	4.87	4.92	2.19	2.56	–0.74	2.66	2.54	2.88
Capital goods	0.19	4.21	2.89	3.86	1.01	0.15	–0.61	2.46	0.03
Utilities	–0.04	2.78	13.94	6.48	3.72	–0.19	4.17	2.98	1.12
Trade	–0.06	2.06	2.19	1.44	1.12	–0.38	0.83	0.39	1.14
Transportation	–0.08	2.57	4.49	13.39	2.62	0.42	2.06	1.56	8.75
Business services	–0.07	1.96	1.87	0.98	1.17	–0.65	0.57	0.25	0.37
Other services	–0.08	2.30	1.71	0.63	0.71	–0.27	0.55	0.67	1.25
Public services	–0.16	1.91	1.18	0.67	1.38	0.10	0.30	0.50	0.26

Table 3.12 Continued

Sector	Variation: Scenario – baseline (US$million)								
	European Union	Nigeria	Senegal	Benin	Burkina Faso	Côte d'Ivoire	Ghana	Rest of ECOWAS	Togo
Vegetables and fruits	–107.70	5.20	1.90	5.00	0.50	130.00	101.90	5.40	0.20
Oilseeds	–14.40	4.30	0.30	0.00	0.40	–0.30	0.20	1.40	0.20
Plant fibers	–1.70	3.10	1.50	3.30	9.00	–14.20	0.40	7.80	1.80
Other crops	1,715.80	14.70	0.10	0.10	0.00	–68.00	18.50	–20.60	6.90
Vegetable oil	–7.10	0.40	8.50	1.10	0.10	0.30	1.00	0.20	–0.10
Other food	45.10	47.40	25.00	0.00	0.00	758.00	183.40	57.80	–0.10
Textiles	–118.50	9.70	2.10	0.10	1.00	–4.00	1.60	10.10	–0.20
Wearing apparel	–84.20	1.20	2.40	0.00	0.30	2.20	5.80	27.10	–0.50
Leather products	–42.50	41.40	5.70	0.00	0.50	–7.40	–1.90	3.20	0.00
Chemicals	681.70	193.00	67.00	0.50	0.30	–28.40	17.80	87.60	–1.60
Motor vehicles	798.50	0.50	–4.40	0.40	–0.20	1.90	1.30	6.70	0.70
Electronics	880.60	28.90	3.60	0.30	–0.10	–1.20	28.40	–1.60	0.10
Other industries	219.70	4.60	4.50	0.10	0.40	–0.70	1.20	4.30	1.70
Construction	–72.40	1.30	4.90	0.10	0.00	0.70	0.00	6.50	0.00
Rice	–4.60	1.60	0.10	0.00	0.00	0.10	1.40	0.60	0.00
Cereals	51.00	0.40	0.10	–0.10	0.00	0.10	12.30	0.30	0.00
Sugar	–10.60	0.10	0.10	0.20	0.00	–0.50	0.00	0.00	0.10
Cattle	–5.30	0.00	0.10	0.00	0.00	0.00	0.10	–0.70	0.00
Other animals	–12.50	0.10	0.30	0.00	0.00	0.10	0.30	0.20	0.00
Other natural resources	189.20	2.90	0.00	0.60	0.10	–0.40	8.00	46.00	3.10
Fisheries	1.80	0.40	0.80	0.00	0.00	0.30	0.50	0.60	0.00
Fossil fuel	5,512.80	2,173.30	31.90	–0.10	17.10	–69.50	132.50	25.30	–0.10
Red meat	–32.00	10.90	0.60	0.80	0.00	0.00	0.60	4.00	0.00
White meat	–86.70	0.90	0.30	0.20	0.10	0.30	0.00	5.70	0.10
Dairy products	125.10	0.00	0.10	0.00	0.00	0.00	0.60	0.00	–0.40
Beverages and tobacco	16.00	0.90	0.50	0.00	–0.10	–1.80	0.80	1.50	–0.40
Wood products	92.30	2.10	1.40	1.10	0.10	–3.80	5.80	2.00	0.20
Paper products	270.80	0.80	1.00	0.50	0.00	–3.90	0.30	–0.40	–0.20
Other minerals	552.20	–2.00	–36.60	0.30	–0.10	–3.90	–2.20	–7.90	–15.40
Metals	1,531.90	130.40	89.00	80.10	170.10	–5.10	255.30	165.80	23.40
Capital goods	3572.30	222.50	10.20	1.00	2.00	1.50	–5.50	35.00	0.10
Utilities	–22.40	8.40	0.00	0.00	0.60	–0.30	14.50	19.80	0.00
Trade	–159.80	1.10	2.00	1.70	0.40	–0.10	0.10	2.50	0.10
Transportation	–502.20	35.60	37.80	48.60	1.00	2.90	27.00	26.30	18.10
Business services	–999.50	3.50	20.20	2.50	0.70	–5.70	10.80	3.00	0.40
Other services	–94.30	0.40	1.20	2.10	0.20	0.00	2.00	9.60	0.30
Public services	–140.70	12.80	2.90	0.30	0.30	1.30	2.40	2.70	0.60

Source: Authors' calculation.
Note: Rest of ECOWAS includes Cabo Verde, Gambia, Guinea, Guinea Bissau, Liberia, Mali, Niger, and Sierra Leone. ECOWAS = Economic Community of West African States.

Table 3.13 shows how imports by sector in the main study countries are affected, again first by a rate of variation (in value, in percentages, and in 2035) and second by variation in millions of US dollars.

Table 3.13 Impact of the reform on imports, in value, by country and by sector, 2035

Sector	Rate of variation: Scenario/baseline (percentage)								
	European Union	Nigeria	Senegal	Benin	Burkina Faso	Côte d'Ivoire	Ghana	Rest of ECOWAS	Togo
Vegetables and fruits	0.2	–0.9	–1.1	1.4	–1.1	3.2	0.0	0.7	0.2
Oilseeds	0.0	–1.7	2.7	–0.2	0.7	3.0	0.2	0.0	–0.6
Plant fibers	0.1	6.7	–1.5	11.9	–1.0	4.8	–0.1	2.5	0.7
Other crops	0.4	12.7	2.1	3.4	15.2	26.5	1.5	1.2	0.0
Vegetable oil	0.1	–1.1	0.2	–0.5	–1.2	2.3	–0.1	–0.3	–0.6
Other food	0.3	–1.1	3.3	–0.3	0.4	5.7	1.0	0.9	–1.1
Textiles	0.1	–1.2	–1.1	–0.7	–1.0	1.1	–0.7	–0.1	–0.6
Wearing apparel	0.1	–0.7	–1.3	–0.7	16.2	5.3	–0.2	1.2	–1.0
Leather products	0.1	0.0	–0.8	–0.7	1.3	3.8	–0.3	0.3	–0.8
Chemicals	0.1	0.4	1.4	0.2	–0.2	3.6	0.4	1.2	0.6
Motor vehicles	0.1	0.2	1.6	0.5	7.3	6.4	1.0	2.3	1.3
Electronics	0.1	9.2	6.7	1.3	13.3	7.2	4.9	3.9	3.1
Other industries	0.1	2.3	6.8	0.6	7.0	8.3	0.2	1.0	1.0
Construction	0.1	0.3	–1.6	–1.4	–0.8	1.2	–0.1	–0.6	–1.4
Rice	0.1	–1.9	–0.9	–0.4	–0.4	0.5	–1.1	–0.7	–1.0
Cereals	0.1	–1.2	3.4	5.7	9.5	5.4	1.8	4.7	6.7
Sugar	0.1	–1.2	–1.4	–0.5	–1.1	1.7	–0.1	–0.3	–0.8
Cattle	0.1	0.9	9.0	–0.4	3.7	3.0	1.4	1.8	–0.9
Other animals	0.0	3.4	2.7	4.6	5.9	8.6	2.8	2.7	5.0
Other natural resources	0.1	8.8	0.4	10.0	5.0	3.0	0.5	4.1	2.0
Fisheries	0.0	1.7	2.6	5.0	2.2	5.8	2.1	8.9	–0.3
Fossil fuel	0.3	27.1	3.5	6.8	3.4	–0.4	7.2	1.8	4.9
Red meat	0.1	–3.6	–4.3	–1.8	–1.8	0.4	–0.7	–1	–2.9
White meat	0.1	–3.6	–0.1	–1.6	–1.7	–1.7	0.3	–0.2	–2.2
Dairy products	0.1	0.5	0.8	–0.3	3.7	3.5	3.6	3.5	–0.7
Beverages and tobacco	0.1	0.0	0.1	0.3	–0.2	4.1	–0.4	–0.5	–0.6
Wood products	0.1	2.5	1.1	0.1	1.0	8.7	1.5	2.9	1.0
Paper products	0.1	2.2	3.7	1.2	1.3	7.5	0.7	1.4	–0.6
Other minerals	0.1	1.5	6.3	0.9	2.5	9.4	1.2	0.8	–0.7
Metals	0.1	0.9	3.6	0.7	5.5	8.4	0.5	2.9	1.0
Capital goods	0.1	1.9	2.3	0.5	9.3	6.3	4.2	0.2	0.2
Utilities	0.1	–2.5	–9.5	–1.9	–2.8	1.1	–2.8	–2.2	–1.8
Trade	0.1	–2.2	–1.8	–1.7	–1.2	0.5	–1.1	–0.4	–1.2
Transportation	0.1	–2.2	–3.2	–8.6	–1.7	0.1	–2.6	–1.2	–6.3
Business services	0.1	–1.7	–2.0	–1.2	–1.2	0.6	–1.1	–0.4	–1.1
Other services	0.1	–2.0	–2.5	–1.7	–1.1	0.2	–1.2	–1.5	–2.5
Public services	0.1	–2.6	–2.8	–1.7	–2.1	–1.1	–1.4	–1.5	–2.1

Table 3.13 Continued

Sector	Variation: Scenario – baseline (US$million)								
	European Union	Nigeria	Senegal	Benin	Burkina Faso	Côte d'Ivoire	Ghana	Rest of ECOWAS	Togo
Vegetables and fruits	156.4	–3.5	–3.3	1.0	–0.8	1.3	–0.1	2.0	0.1
Oilseeds	8.1	–1.2	0.4	0.0	0.1	0.0	0.0	0.0	0.0
Plant fibers	1.9	1.5	–2.2	0.0	0.0	0.3	–0.1	0.0	0.0
Other crops	391.1	926.4	2.7	0.5	7.6	6.5	1.1	0.9	0.0
Vegetable oil	31.3	–27.4	0.6	–3.7	–1.9	1.3	–0.5	–2.2	–3.1
Other food	805.6	–322.4	27.7	–0.8	2.3	88.4	28.3	16.8	–5.6
Textiles	160.2	–59.1	–7.4	–23.1	–0.7	5.0	–11.8	–1.2	–8.0
Wearing apparel	288.9	–10.8	–0.9	–1.0	2.0	1.3	–1.1	1.0	–1.7
Leather products	118.0	0.7	–0.4	–2.5	0.6	2.4	–2.7	0.8	–1.2
Chemicals	1,006.9	92.3	32.8	6.0	–1.8	98.1	27.9	56.0	6.5
Motor vehicles	634.3	32.7	15.3	7.1	19.2	39.8	47.6	56.5	5.5
Electronics	621.8	372.6	21.9	4.3	19.0	25.5	78.0	46.2	10.2
Other industries	367.0	62.3	6.8	7.6	1.4	23.9	2.3	3.4	2.1
Construction	59.7	0.3	–1.3	–0.9	0.0	0.3	0.0	–1.4	–0.1
Rice	3.3	–394.0	–12.2	–1.9	–0.8	7.5	–12.3	–7.4	–1.7
Cereals	31.6	–138.4	20.7	0.3	9.7	27.8	8.1	22.8	2.5
Sugar	11.6	–33.0	–7.9	–1.0	–1.6	2.8	–0.7	–2.1	–2.1
Cattle	3.7	0.5	0.2	0.0	0.0	0.0	0.0	0.1	0.0
Other animals	7.9	1.8	1.4	0.5	0.1	1.0	1.6	1.5	0.0
Other natural resources	115.4	149.1	1.2	9.0	3.1	3.9	0.4	24.9	0.6
Fisheries	7.4	0.4	0.1	0.0	0.0	0.4	0.1	0.1	0.0
Fossil fuel	2,942.4	2,450.4	107.8	124.1	28.3	–9.2	378.6	64.3	41.2
Red meat	32.0	–25.7	–1.2	0.0	–0.1	0.4	–1.0	–0.1	0.0
White meat	39.8	–44.1	0.0	–2.1	0.0	–0.3	2.4	0.0	–0.1
Dairy products	43.6	11.9	2.8	–0.1	1.5	5.5	12.7	3.7	–0.4
Beverages and tobacco	45.8	–0.5	0.2	0.4	–0.7	10.9	–3.2	–3.0	–0.7
Wood products	142.2	52.1	1.6	0.2	0.3	5.0	3.8	12.5	1.3
Paper products	151.1	78.2	11.1	0.5	1.4	30.9	10.2	3.3	–1.1
Other minerals	131.6	62.4	13.2	4.9	13.8	44.6	13.2	20.0	–4.5
Metals	1,130.4	157.7	41.5	13.2	21.4	73.1	17.6	111.5	6.1
Capital goods	2,039.6	586.3	56.3	22.2	91.0	115.3	268.6	112.6	5.8
Utilities	83.8	–3.7	–0.4	–3.3	–1.7	0.2	–14.0	–2.5	–2.3
Trade	257.9	–132.5	–1.6	–0.6	–0.8	0.9	–4.1	–0.6	–0.6
Transportation	380.2	–187.4	–19.9	–10.9	–4.3	0.6	–38.0	–14.3	–6.9
Business services	790.6	–518.4	–19.7	–3.5	–2.7	13.7	–12.5	–6.8	–1.6
Other services	144.1	–167.2	–6.2	–0.1	–0.6	0.9	–4.9	–1.9	–0.1
Public services	67.4	–188.0	–3.4	–0.4	–0.8	–1.9	–4.2	–19.3	–0.1

Source: Authors' calculation.
Note: Rest of ECOWAS includes Cabo Verde, Gambia, Guinea, Guinea Bissau, Liberia, Mali, Niger, and Sierra Leone. ECOWAS = Economic Community of West African States.

It is worth noting that for fossil fuels, Nigeria's and the EU's imports are significantly raised by this reform; the interpretation here is that Nigeria augments its exports of raw petroleum toward the EU and its imports of refined oil from the same place.

On the European side, the largest augmentation of imports takes place in the fossil fuel, capital goods, chemicals, and metals sectors. On the African side, the largest augmentation takes place in the fossil fuel sector in Benin, Ghana, Nigeria, Senegal, and Togo and in the capital goods sector in Burkina Faso, Côte d'Ivoire, and Ghana.

For four ECOWAS countries, the impact of the trade reform is positive for their trade balance in agricultural goods. The agricultural surplus is increased in Benin (+1.1 percent), Ghana (+2.2 percent), and Togo (+1.0 percent), while the agricultural deficit is reduced in Senegal (+0.4 percent). For four countries (or region), on the other hand, the impact is negative; the agricultural deficit is increased in Nigeria (–1.0 percent), while the agricultural surplus is reduced in Burkina Faso (–3.6 percent), Côte d'Ivoire (–0.3 percent), and the rest of ECOWAS (–0.2 percent). The substantial reduction of the agricultural surplus in Burkina Faso is related to a significant increase in imports of cereals and other crops.

Customs duties make up a nontrivial element of public revenues in Africa. As shown in Table 3.14, public revenues coming from the collection of import duties are negatively affected by the reform, from –7.5 percent in Benin to –25.8 percent in Burkina Faso. This is a key implication of the trade agreement because reduced customs duties can potentially affect the ability of Africa's public sectors to finance public services. The results are driven by the direct losses linked to the liberalization of EU imports, mitigated by the sensitive products provision, as well as the indirect loss of tariffs coming from trade diversion. For example, initial ECOWAS imports originating in the United States in the baseline are dutiable. Because the trade reform implies that ECOWAS duties on imports from the United States are unchanged while those on imports from the EU are decreased or even canceled, ECOWAS imports from the United States are replaced by duty-free imports from the EU. This is a case of trade diversion, which implies a loss of collected customs duties. The drivers of this loss are the share of products originating in the EU in ECOWAS total imports, the common external tariff applied on these products, the effective rate of duty collection, the distribution of sensitive products, and how these products affect each country's import basket.

Table 3.14 Rate of variation in collected import duties, 2035, scenario/baseline (in percentages)

Country/region	Variation
European Union	–0.3
Benin	–7.5
Burkina Faso	–25.8
Côte d'Ivoire	–17.0
Ghana	–14.1
Nigeria	–13.1
Senegal	–22.3
Togo	–10.9
Rest of ECOWAS	–10.4

Source: Authors' calculation.
Note: Rest of ECOWAS includes Cabo Verde, Gambia, Guinea, Guinea Bissau, Liberia, Mali, Niger, and Sierra Leone. ECOWAS = Economic Community of West African States.

In this central scenario, we do assume that the public budget balance is a constant proportion of GDP and that a lump-sum tax is implemented to offset the loss of customs duties, so that when public revenues are cut, real public expenses per capita remain constant. This lump-sum tax ranges from $2.41 (Burkina Faso) to $17.51 (Ghana) per person per year; it is $4.95 in Côte d'Ivoire, $5.02 in Nigeria, $6.02 in the rest of ECOWAS, $11.79 in Benin, $12.37 in Togo, and $14.70 in Senegal.

Impact of the Reform on Production and Payments for Factors of Production

We now evaluate the impact of the trade reform on production by sector. The first-order effect of a trade agreement on production is through its impact on national exports and national imports. However, there are second-order effects. First, by changing the price of intermediate goods and by affecting the equilibrium of markets for productive factors, a trade reform also affects the cost of inputs and consequently the level of production. Another effect consists of changing households' income and public revenues and consequently the level of demand for each good. Finally, it is worth noting that this trade reform includes a development package that involves a demand effect and a supply effect on activity.

Table 3.15 indicates the impact of the trade reform on production in volume by sector in 2035, with the rate of variation on the left and the distribution of production in 2035 in the reference scenario on the right.

Table 3.15 Impact of the reform on production, by country and sector, constant US dollars, 2035 (in percentages)

	Rate of variation (percentage), scenario/baseline								
Sector	European Union	Nigeria	Senegal	Benin	Burkina Faso	Côte d'Ivoire	Ghana	Rest of ECOWAS	Togo
Vegetables and fruits	–0.2	0.0	0.2	–0.1	0.2	0.9	0.2	0.0	0.0
Oilseeds	–0.2	0.1	0.1	0.3	0.5	0.6	–0.1	0.2	0.3
Plant fibers	–0.2	1.5	0.5	0.5	1.0	2.0	0.3	0.7	0.6
Other crops	1.0	–4.5	–2.8	–1.7	–3.6	–0.7	0.3	–2.3	0.6
Vegetable oil	–0.1	2.0	1.5	0.6	0.6	0.1	0.3	0.2	–0.5
Other food	–0.1	0.7	0.2	–0.7	–0.2	15.3	1.7	0.5	–0.9
Textiles	–0.1	1.6	1.4	0.4	0.3	–0.8	0.4	1.1	–0.2
Wearing apparel	–0.1	–0.1	0.2	–0.4	–0.4	0.1	0.0	2.3	–0.8
Leather products	–0.1	2.3	1.9	0.8	0.2	–1.3	–0.7	0.3	–0.6
Chemicals	0.0	3.2	1.9	0.0	0.6	–1.0	0.6	1.6	–1.1
Motor vehicles	0.0	–0.4	–4.1	3.9	–3.6	–3.0	3.7	–1.9	2.3
Electronics	0.1	–2.6	–4.0	4.8	–11.7	–11.6	16.1	–5.2	–7.0
Other industries	0.0	1.0	0.1	2.4	0.7	–0.7	1.7	0.0	0.0
Construction	0.0	1.4	1.1	0.2	0.9	2.0	0.5	1.3	0.1
Rice	–0.1	2.0	0.4	–0.1	0.4	0.3	0.3	0.2	–0.5
Cereals	0.0	0.1	–1.9	0.1	–0.3	–4.4	–0.2	–0.7	–0.8
Sugar	–0.1	1.6	0.9	0.4	0.5	0.7	0.2	0.5	0.9
Cattle	0.0	0.0	–0.5	–0.2	–0.1	1.9	–1.0	–0.3	–0.6
Other animals	–0.1	0.3	–0.4	–0.2	–0.2	1.9	–0.5	–0.1	–0.6
Other natural resources	0.0	–0.6	0.2	–0.3	1.4	0.0	0.4	0.5	0.3
Fisheries	0.0	–0.1	–0.1	–0.3	–0.1	0.0	–0.2	–0.1	–0.6
Fossil fuel	0.5	0.1	4.9	–3.8	0.4	–1.9	–3.8	0.2	–11.6
Red meat	–0.1	0.0	0.0	0.1	–0.1	0.1	0.0	0.0	–0.6
White meat	–0.1	0.5	–0.3	0.2	–0.1	0.9	–0.4	0.3	–0.6

Table 3.15 Continued

Sector	Share in total production (percentage), baseline								
	European Union	Nigeria	Senegal	Benin	Burkina Faso	Côte d'Ivoire	Ghana	Rest of ECOWAS	Togo
Dairy products	0.0	–1.2	–0.9	–0.5	–1.2	–1.9	–1.8	–0.5	–1.4
Beverages and tobacco	0.0	0.6	–0.1	–0.7	–0.1	–0.1	–0.4	–0.7	–1.1
Wood products	0.0	–0.9	0.2	0.0	0.0	0.0	–0.2	–0.8	–1.1
Paper products	0.0	–1.4	–0.9	–0.3	–1.0	–1.5	–1.2	–0.3	–0.7
Other minerals	0.1	–1.3	–0.8	13.4	–0.7	–3.0	–0.1	–1.8	–0.1
Metals	0.1	1.8	3.8	2.5	2.4	–2.1	1.2	1.4	2.7
Capital goods	0.1	–0.5	0.0	4.3	–3.9	–4.1	–1.7	1.6	0.0
Utilities	0.0	0.0	2.0	3.9	0.6	1.2	1.1	1.3	0.7
Trade	0.0	–0.1	0.5	–0.1	0.0	0.1	–0.2	0.0	0.0
Transportation	0.0	0.7	2.6	9.0	1.1	0.5	–0.2	0.8	4.3
Business services	0.0	0.4	0.2	0.0	0.0	–0.1	–0.2	–0.1	–0.5
Other services	0.0	0.4	–0.5	–0.6	–0.3	0.0	–0.6	–0.6	–1.0
Public services	0.0	–0.6	–1.2	–0.9	–0.6	–0.7	–0.9	–0.8	–1.2
Agrifood	0.0	–0.1	0.0	–0.2	–0.1	2.3	0.3	0.0	–0.3
Industry	0.1	–0.1	1.4	1.2	0.7	–1.4	–0.1	0.7	0.4
Services	0.0	0.1	0.6	0.5	0.1	0.2	–0.1	0.0	0.4
Vegetables and fruits	0.3	12.2	1.8	11.4	0.9	7.5	10.9	5.4	0.9
Oilseeds	0.1	2.2	1.2	1.3	0.3	1.7	0.6	0.7	0.4
Plant fibers	0.0	0.1	0.5	2.3	2.2	4.2	0.2	1.6	2.3
Other crops	0.2	1.5	0.0	0.1	0.4	7.0	3.3	0.6	7.2
Vegetable oil	0.1	0.0	0.8	0.7	0.5	2.1	0.2	0.3	0.8
Other food	1.9	0.7	7.6	4.6	3.4	4.0	3.7	5.2	3.6
Textiles	0.6	0.2	1.0	0.3	0.8	1.2	0.3	0.8	0.7
Wearing apparel	0.5	0.4	1.0	0.2	0.8	1.1	0.6	0.7	0.8
Leather products	0.4	0.2	0.4	0.0	0.1	0.5	0.4	0.4	0.2
Chemicals	4.6	0.7	4.6	6.7	1.9	6.4	2.0	4.4	2.0
Motor vehicles	3.8	1.0	0.2	0.0	0.7	0.5	0.0	0.3	0.4
Electronics	1.2	1.3	0.2	0.0	0.2	0.1	0.1	0.3	0.4
Other industries	0.8	0.1	1.3	0.0	0.9	2.1	0.2	0.9	1.4
Construction	8.3	3.3	12.2	21.2	6.5	3.8	10.6	5.1	15.6
Rice	0.0	0.7	0.6	0.3	0.1	0.9	0.7	1.3	0.8
Cereals	0.3	4.0	0.9	1.6	6.5	0.1	1.9	1.9	6.1
Sugar	0.1	0.1	0.5	0.2	0.4	0.3	0.0	0.1	0.0
Cattle	0.4	1.5	1.0	0.3	4.0	0.1	0.1	0.7	0.6
Other animals	0.3	0.4	2.0	0.8	1.3	0.8	0.5	0.6	1.4
Other natural resources	0.5	0.9	1.3	1.8	7.9	1.7	1.7	8.5	6.4
Fisheries	0.1	0.9	1.4	0.7	0.2	0.4	1.4	0.7	0.6
Fossil fuel	1.8	27.1	1.7	0.0	2.0	3.1	1.8	3.4	0.0

Table 3.15 Continued

Sector	Share in total production (percentage), baseline								
	European Union	Nigeria	Senegal	Benin	Burkina Faso	Côte d'Ivoire	Ghana	Rest of ECOWAS	Togo
Red meat	0.2	4.5	1.2	0.6	2.1	0.4	0.8	1.0	0.4
White meat	0.5	0.6	1.2	1.2	0.6	0.8	0.4	1.0	0.9
Dairy products	0.9	0.0	0.6	0.2	0.3	0.0	0.3	1.0	0.1
Beverages and tobacco	1.1	0.5	1.1	2.2	4.0	1.5	2.0	1.5	1.1
Wood products	0.8	0.4	0.9	1.4	0.6	1.5	1.1	0.8	0.6
Paper products	2.3	0.4	1.0	1.1	0.2	1.2	0.4	1.3	0.4
Other minerals	1.2	0.1	2.5	0.0	2.1	0.9	0.6	0.6	5.6
Metals	3.2	0.6	3.4	10.7	13.2	3.2	8.1	6.6	5.6
Capital goods	6.6	5.4	0.7	0.1	3.6	1.5	5.3	1.6	1.3
Utilities	1.8	1.4	2.5	0.3	2.8	2.7	3.8	1.9	0.5
Trade	9.2	11.3	13.3	5.6	4.6	8.5	6.8	9.3	11.4
Transportation	5.6	2.7	4.3	3.1	3.7	4.9	8.5	5.7	6.5
Business services	26.3	4.1	19.1	7.8	7.5	15.6	4.4	9.8	3.7
Other services	4.6	1.0	2.0	4.3	5.0	1.6	8.0	7.9	2.7
Public services	9.7	7.2	4.0	6.7	7.7	6.0	8.3	6.2	6.5
Agrifood	6.4	30.2	22.4	28.6	27.0	31.9	27.1	23.6	27.3
Industry	28.2	38.8	20.3	22.4	35.2	25.0	22.4	30.5	25.9
Services	65.4	30.9	57.3	49.0	37.8	43.1	50.5	45.9	46.9

Source: Authors' calculation.
Note: Rest of ECOWAS includes Cabo Verde, Gambia, Guinea, Guinea Bissau, Liberia, Mali, Niger, and Sierra Leone. ECOWAS = Economic Community of West African States.

On the European side, the impact on sectoral production is close to 0, with a significant effect on production only in the fossil fuel sector (+0.5 percent) and the other crops sector (+1 percent). These two significant augmentations of production stem from more exports to Nigeria.

On the African side, the transportation sector is positively affected, particularly in Benin, Senegal, and Togo, due to the reallocation of funds in favor of trade infrastructure within the development package. In Côte d'Ivoire, a 15.3 percent increase in the production of the other food sector is noteworthy, while in Benin, the metals sector, a large sector, sees its production augmented by 2.5 percent.

Table 3.16 presents the rates of variation implied by the trade reform in 2035 as percentages, by country, in the consumption price index and in productive factors' real remuneration.

Table 3.16 Rate of variation in factors' real remuneration, scenario/baseline (percentage)

Country/region	Skilled labor	Capital	Unskilled labor	Natural resources	Land	Consumption price index
European Union	0.0	0.0	0.0	0.1	0.1	0.0
Benin	0.3	0.7	0.4	1.0	0.4	–0.5
Burkina Faso	–0.2	0.3	0.2	0.7	0.1	–0.5
Côte d'Ivoire	0.5	–0.4	0.8	–0.9	1.0	–0.1
Ghana	0.4	0.3	0.5	0.6	0.6	–0.4
Nigeria	–0.1	0.6	–0.2	1.3	–0.2	–0.7
Senegal	0.8	0.3	0.5	–0.8	0.2	–0.9
Togo	0.9	0.5	0.6	0.8	0.4	–0.6
Rest of ECOWAS	0.6	0.4	0.3	0.5	0.1	–0.4

Source: Authors' calculation.
Note: Rest of ECOWAS includes Cabo Verde, Gambia, Guinea, Guinea Bissau, Liberia, Mali, Niger, and Sierra Leone. ECOWAS = Economic Community of West African States.

The impact of the EPA reform on factors' real remuneration in the EU is close to nil. For the WA countries, it is worth noting that the reform is positive for unskilled labor and land (except in Nigeria) and is either positive or negative for other production factors. An augmentation of the remuneration of unskilled labor is important for the reform's potential impact on poverty.

The implementation of the EPA leads to a reduction of border protection that directly reduces the consumption prices of imported goods and indirectly reduces the consumption prices of domestic goods due to a competition effect. This effect leads to an improvement of purchasing power for domestic agents, ranging from 0.1 percent in Côte d'Ivoire to 0.9 percent in Senegal.

Local prices also fall in the latter country due to a necessary adjustment of the real exchange rate following the augmentation of this country's imports from the EU. This phenomenon is related to the external closure of the model. To keep the current account balance constant, there is no variation in nominal exchange rate;[16] therefore, the adjustment takes place through a variation in prices. These differentiated variations in prices by country imply an intrazone adjustment of real exchange rates.

We focus on unskilled labor because that is the most important productive factor for a poverty analysis. In Nigeria, Senegal, Benin, and Burkina Faso, the nominal remuneration of this factor is reduced by the reform due to less demand for unskilled labor. In Nigeria, this decrease is due to a reduction in the production of the "other crops" sector by 4.5 percent, inasmuch as this sector absorbs 4.4 percent of total unskilled labor (2035, baseline) and the demand for this factor is reduced by 4.7 percent.

In Côte d'Ivoire, the reduction in consumption prices is relatively small. An increase in the real remuneration of unskilled labor stems from an increase in demand for such labor from the vegetables and fruits and the plant fibers sectors, which absorb 24.3 percent and 11.3 percent of total unskilled labor, respectively, and which increase their demand for this factor by 0.7 percent and 1.9 percent, respectively, due to the EPA. If the "other crops" sector, which absorbs 20.8 percent of the total unskilled labor force, reduces its demand by 1.1 percent, the global impact on total demand is positive.

Table 3.17 presents the reallocation of unskilled and skilled labor between formal and informal sectors and between urban and rural sectors. For each type of labor and each type of mobility, the share of this type of labor in the total force (in the baseline in 2035) is indicated, and then the variation of this ratio in bp is indicated. For example, in Ghana in 2035, the share of unskilled labor working in the formal sectors will be 36.7 percent if the trade agreement is not signed. The trade reform should decrease this ratio by 0.0006 bp.

[16] It should be noted again that a majority of countries in WA (Benin, Burkina Faso, Senegal, Côte d'Ivoire, and others) have a fixed exchange rate against the euro in a regime called the CFA (Communauté Financière d'Afrique) franc, in which €1 = 655.957 CFA francs. However, they actually have heterogeneous inflation rates leading to heterogeneous evolution of their real exchange rate.

Table 3.17 Reallocation of unskilled and skilled labor, 2035

Country/region	Unskilled labor working in formal sectors / total unskilled labor force		Unskilled labor working in urban sectors / total unskilled labor force		Skilled labor working in urban sectors / total skilled labor force	
	Share (%)—baseline	Variation (bp)	Share (%)—baseline	Variation (bp)	Share (%)—baseline	Variation (bp)
Nigeria	24.37	0.0003	28.12	0.0002	99.68	–0.0001
Senegal	48.19	0.0017	52.39	0.0015	99.14	0.0000
Benin	18.65	–0.0002	25.76	–0.0003	99.74	0.0000
Burkina Faso	16.03	–0.0003	22.15	0.0007	99.39	0.0000
Côte d'Ivoire	30.54	–0.0014	38.14	–0.0019	99.90	0.0000
Ghana	36.70	–0.0006	42.89	–0.0007	100.00	0.0000
Rest of ECOWAS	26.99	0.0007	31.32	0.0008	99.89	0.0000
Togo	28.80	0.0007	35.21	0.0008	100.00	0.0000

Source: Authors' calculation.
Note: Rest of ECOWAS includes Cabo Verde, Gambia, Guinea, Guinea Bissau, Liberia, Mali, Niger, and Sierra Leone. bp = basis points; ECOWAS = Economic Community of West African States.

The changes for unskilled labor are small except in Senegal and Côte d'Ivoire, where the trade reform implies, respectively, more and fewer unskilled people (in percentage of total labor force) working in both the formal and urban sectors. In Côte d'Ivoire, the vegetables and fruits sector and the plant-based fibers sector (both informal and rural) expand with the reform. In Senegal, three sectors are important for unskilled labor: business (formal sector), vegetables and fruits (informal), and other animals (informal). There is a small expansion of activity in the first two sectors, while the third sees a limited contraction (Table 3.17). For skilled labor, the reallocation flows are even smaller.

The shocks studied in this research are not large and may even be considered small. Reallocations of production are limited. Calculating the effects of this policy reform on the share of formal sectors (or urban sectors) in total production in value by country, we systematically find a variation of less than 0.1 percent; for example, the share of formal sectors in total production in value in Nigeria in 2035 will increase from 75.25 percent to 75.34 percent due to the implementation of the EPA.

4. OTHER SCENARIOS AND POLICY DISCUSSION

To verify the robustness of our results, we follow two different directions. First, we check whether the dual-dual modeling and the implementation of the development package have significantly influenced the results. Second, we study the fiscal closure of the model.

The Roles of the Dual-Dual Hypothesis and the Development Package

We conduct three sensitivity analyses: the same scenario without the dual-dual modeling (called NoDD-DP), the same scenario without the development package (called DD-NoDP), and the same scenario without dual-dual modeling and without the development package (called NoDD-NoDP). We compare these three scenarios with the central scenario, called in this section DD-DP. Because all of the results would be too long to show here, we show only the results concerning the impact of the reform on trade, on GDP and welfare, and on the collection of import duties.[17]

This sensitivity analysis shows that the results obtained with dual-dual modeling and the development package are not significantly dependent on these two assumptions. Table 4.1 shows how the impact on trade—more precisely the total exports and total imports by region/country in volume—is affected by these scenarios. For each variable, exports and imports, the first column recalls the results obtained in the previous section (that is, with dual-dual modeling and with the development package); the rest of the table then indicates the results obtained under the three alternative assumptions. Table 4.1 clearly demonstrates that neither assumption has a significant impact on how trade is affected by the reform.

Table 4.1 Impact of reform on trade, sensitivity analysis, 2035 (in percentages)

	Total exports volume				Total imports volume			
Country/region	DD-DP	NoDD-DP	DD-NoDP	NoDD-NoDP	DD-DP	NoDD-DP	DD-NoDP	NoDD-NoDP
Rest of the world	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Asia	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NAFTA countries	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Latin America	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CARICOM countries	–0.1	–0.1	–0.1	–0.1	0.2	–0.2	–0.2	–0.1
European Union	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Community of Independent States	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Middle East and North Africa	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Nigeria	1.3	1.3	1.5	1.4	1.1	1.0	1.2	1.1
Senegal	3.7	3.6	3.6	3.6	1.5	1.4	1.4	1.4
Benin	2.5	2.5	2.4	2.4	0.7	0.7	0.7	0.7
Burkina Faso	2.6	2.7	2.7	2.7	3.2	3.2	3.2	3.3
Côte d'Ivoire	2.5	2.4	2.4	2.4	3.3	3.3	3.3	3.2
Ghana	2.9	2.9	2.9	2.9	1.6	1.6	1.6	1.6
Rest of ECOWAS	1.5	1.5	1.5	1.5	0.6	0.6	0.6	0.6
Togo	1.3	1.2	1.2	1.2	0.4	0.4	0.4	0.3
Rest of Africa	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Source: Authors' calculation.
Note: Rest of ECOWAS includes Cabo Verde, Gambia, Guinea, Guinea Bissau, Liberia, Mali, Niger, and Sierra Leone. CARICOM = Caribbean Community; DD-DP = central scenario (with dual-dual modeling and development package); DD-NoDP = scenario without development package; ECOWAS = Economic Community of West African States; NAFTA = North American Free Trade Agreement; NoDD-DP = scenario without dual-dual modeling; NoDD-NoDP = scenario without dual-dual modeling and without development package.

[17] Other comparisons may be requested from the authors.

In Tables 4.2 and 4.3, we verify that neither the impact of the EPA on welfare and GDP nor its impact on the collection of import duties is significantly modified if dual-dual modeling, the EPADP, or both are removed from this modeling exercise.

Table 4.2 Impact of reform on gross domestic product and welfare, sensitivity analysis, 2035 (in percentages)

Country/region	GDP (constant US dollars)				Welfare (equivalent variation)			
	DD-DP	NoDD-DP	DD-NoDP	NoDD-NoDP	DD-DP	NoDD-DP	DD-NoDP	NoDD-NoDP
Rest of the world	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Asia	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NAFTA countries	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Latin America	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CARICOM	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
European Union	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Community of Independent States	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Middle East and North Africa	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Nigeria	0.0	0.0	0.0	0.0	0.1	–0.1	–0.1	–0.1
Senegal	0.4	0.3	0.4	0.3	0.2	–0.2	–0.1	–0.2
Benin	0.2	–0.2	–0.2	–0.2	0.4	–0.4	–0.3	–0.3
Burkina Faso	0.2	0.2	0.3	0.3	0.1	0.1	0.2	0.2
Côte d'Ivoire	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.4
Ghana	0.0	0.0	0.0	0.0	0.2	–0.2	–0.2	–0.2
Rest of ECOWAS	0.1	–0.1	–0.1	–0.1	0.3	–0.3	–0.3	–0.3
Togo	0.2	–0.2	–0.2	–0.2	0.5	–0.5	–0.5	–0.5
Rest of Africa	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Source: Authors' calculation.
Note: Rest of ECOWAS includes Cabo Verde, Gambia, Guinea, Guinea Bissau, Liberia, Mali, Niger, and Sierra Leone. CARICOM = Caribbean Community; DD-DP = central scenario (dual-dual modeling and development package); DD-NoDP = scenario without development package; ECOWAS = Economic Community of West African States; GDP = gross domestic product; NAFTA = North American Free Trade Agreement; NoDD-DP = scenario without dual-dual modeling; NoDD-NoDP = scenario without dual-dual modeling and without development package.

Table 4.3 Impact of reform on collection of import duties, sensitivity analysis (in percentages)

Country/region	DD-DP	NoDD-DP	DD-NoDP	NoDD-NoDP
Rest of the world	0.0	0.0	0.0	0.0
Asia	0.0	0.0	0.0	0.0
NAFTA countries	0.0	0.0	0.0	0.0
Latin America	0.0	0.0	0.0	0.0
CARICOM	–0.2	–0.2	–0.2	–0.2
European Union	–0.3	–0.3	–0.3	–0.3
Community of Independent States	0.0	0.0	0.0	0.0
Middle East and North Africa	0.0	0.0	0.0	0.0
Nigeria	–13.1	–13.1	–13.1	–13.0
Senegal	–22.3	–22.3	–22.3	–22.3
Benin	–7.5	–7.5	–7.5	–7.5
Burkina Faso	–25.8	–25.8	–25.8	–25.8
Côte d'Ivoire	–17.0	–16.9	–17.0	–16.9
Ghana	–14.1	–14.1	–14.1	–14.1
Rest of ECOWAS	–10.4	–10.3	–10.4	–10.3
Togo	–10.9	–10.8	–10.9	–10.8
Rest of Africa	0.0	0.0	0.0	0.0

Source: Authors' calculation.
Note: Rest of ECOWAS includes Cabo Verde, Gambia, Guinea, Guinea Bissau, Liberia, Mali, Niger, and Sierra Leone. CARICOM = Caribbean Community; DD-DP = central scenario (dual-dual modeling and development package); DD-NoDP = scenario without development package; ECOWAS = Economic Community of West African States; NAFTA = North American Free Trade Agreement; NoDD-DP = scenario without dual-dual modeling; NoDD-NoDP = scenario without dual-dual modeling and without development package.

Concerning the EPADP, this is not a surprising result: as demonstrated earlier, not only is the total envelope implied in this package small, but it is also included in both the baseline and the scenario. The difference between the scenario and the baseline captures a modification by only half of the allocation of the total envelope, from education to reduction of trade costs. Moreover, we calibrate the aid efficiency according to a rule stating that the impact of aid on local GDP is positive but small. Consequently, it was largely expected that the noninclusion of the development package would not significantly affect the results.

Identically, concerning dual-dual modeling, the impact on trade and the impact on GDP, welfare, and collection of import duties are not significantly affected by this hypothesis. This new modeling introduces mechanisms for reallocation of labor, both skilled and unskilled, between formal and informal activities and between urban and rural sectors. As shown in Table 3.17, in all ECOWAS countries, the EPA implies marginal reallocations of unskilled labor between formal and informal sectors and between urban and rural sectors; thus, implementing the EPA does not present a large economic shock for WA countries. Overall, these countries do not improve their access to foreign markets, with the exception of non-LDC countries (Côte d'Ivoire and Nigeria, for instance); however, even in these latter countries, the gain in market access is small. If these countries open their borders, it is only for products coming from the EU, and the EPA includes many exceptions concerning this liberalization. Finally, as demonstrated earlier, the EPADP has only a marginal effect.

Consequently, the EPA does not imply a significant reallocation of production between formal and informal sectors on the one side or between urban and rural sectors on the other side.

Changing the Fiscal Closure

Concerning the fiscal closure, we conduct three sensitivity analyses, using the following scenarios:

- Implementation of an additional income tax as a percentage of the income tax already imposed, such that the public goods sold are a constant proportion of GDP. This scenario is called INC.
- Implementation of an additional consumption tax as a percentage of the consumption tax already imposed, such that the public goods sold are a constant proportion of GDP. We implement a tax only on final consumption (private and public) and on consumption of capital goods. We do not implement a consumption tax on intermediate consumption because this is not a realistic policy option. This scenario is called CONS.
- No implementation of any tax in compensation for the loss of customs duties. Public expenses adjust to this variation in public revenues such that public goods sold are maintained constant in proportion to GDP. This scenario is called EXP.

The first two scenarios are realistic policy options; however, a supplementary consumption tax is regressive, while a supplementary income tax leaves relative inequality unchanged and reduces absolute inequality. It should be noted that a consumption tax is more easily implemented by policy makers than is a new income tax. The last scenario, EXP, is more difficult to interpret because when public revenues are decreased, public expenses also decrease, and the provision of public goods is necessarily affected.

Before comparing these three scenarios with the central scenario (called *central* in this section), we first provide estimations of the magnitude of these additional taxes (Table 4.4). As an illustration, if Senegal's government decides to offset the loss of customs duties by levying a lump-sum tax, this tax will be $14.70 per person in 2035. If the government chooses instead to tax individual income, this additional income tax will be 0.9 percent.[18] If the government chooses to tax consumption, the additional consumption tax will be 0.7 percent.

Table 4.4 Level of additional taxes to offset the loss of customs duties, 2035

Country/region	Lump-sum tax (in US dollars per capita)	Additional income tax (%)	Additional consumption tax (%)
Nigeria	5.02	0.2	0.1
Senegal	14.70	0.9	0.7
Benin	11.79	1.4	0.7
Burkina Faso	2.41	0.2	0.2
Côte d'Ivoire	4.95	0.3	0.3
Ghana	17.51	0.6	0.5
Rest of ECOWAS	6.02	1.2	0.7
Togo	12.37	1.9	1.1

Source: Authors' calculation.
Note: Rest of ECOWAS includes Cabo Verde, Gambia, Guinea, Guinea Bissau, Liberia, Mali, Niger, and Sierra Leone. ECOWAS = Economic Community of West African States.

[18] The lump-sum tax of $14.70 represents 0.9 percent of average income per capita in 2035 in Senegal, so it is approximately equal to the additional income tax. We obtain a similar conclusion for all ECOWAS countries.

Let us now compare these three robustness tests with the central scenario in terms of their impact on economic variables. For the sake of brevity, we show only the results concerning the impact of the reform on trade, on GDP and welfare, and on poverty. The central scenario in which the government implements a lump-sum tax to offset the variation in customs duties is called LS in Table 4.5, which shows the impact on trade of the central scenario and of the three alternative fiscal closure scenarios. Variations in total export volume and import volume are slightly different from those obtained in the central scenario (LS).

Table 4.5 Impact of reform on trade, sensitivity analysis, 2035 (in percentages)

	Total exports volume				Total imports volume			
Country/region	**EXP**	**LS**	**INC**	**CONS**	**EXP**	**LS**	**INC**	**CONS**
Nigeria	1.4	1.3	1.3	1.4	1.1	1.1	1.5	1.3
Senegal	4.1	3.7	3.7	3.3	1.6	1.5	1.4	1.5
Benin	3.4	2.5	2.5	2.6	0.9	0.7	0.7	0.7
Burkina Faso	2.8	2.6	2.6	2.7	3.4	3.2	3.2	3.6
Côte d'Ivoire	2.6	2.5	2.5	2.5	3.4	3.3	3.3	3.3
Ghana	3.2	2.9	2.9	2.8	1.8	1.6	1.6	1.8
Rest of ECOWAS	1.7	1.5	1.5	2.0	0.7	0.6	0.6	0.7
Togo	2.2	1.3	1.3	1.4	0.7	0.4	0.4	0.5

Source: Authors' calculation.
Note: Rest of ECOWAS includes Cabo Verde, Gambia, Guinea, Guinea Bissau, Liberia, Mali, Niger, and Sierra Leone. CONS = consumption tax scenario; ECOWAS = Economic Community of West African States; EXP = public expenses scenario; INC = income tax scenario; LS = lump-sum tax, or central, scenario. All scenarios are described in the body of the text.

The augmentation of imports is generally more important when there is no compensation for the loss of customs duties through increasing another tax. The increases obtained through either a lump-sum tax or an additional income tax are similar.

The impact of the EPA reforms on GDP and welfare differs more significantly when one considers an alternative fiscal closure; this is particularly true of the impact on welfare (Table 4.6).

Table 4.6 Impact of reform on gross domestic product and welfare, sensitivity analysis, 2035 (in percentages)

	EXP		LS		INC		CONS	
Country/region	**GDP**	**Welfare**	**GDP**	**Welfare**	**GDP**	**Welfare**	**GDP**	**Welfare**
Nigeria	0.0	0.1	0.0	–0.1	–0.2	–0.3	0.1	0.0
Senegal	0.4	0.6	0.4	–0.2	0.4	–0.2	1.0	–0.1
Benin	0.0	0.2	–0.2	–0.4	–0.2	–0.4	1.2	–0.4
Burkina Faso	0.4	0.5	0.2	0.1	0.2	0.1	0.5	0.3
Côte d'Ivoire	0.4	0.7	0.3	0.3	0.3	0.3	0.6	0.3
Ghana	0.1	0.4	0.0	–0.2	0.0	–0.2	0.6	–0.1
Rest of	0.1	0.4	–0.1	–0.3	–0.1	–0.3	1.1	–0.4
ECOWAS Togo	0.0	0.5	–0.2	–0.5	–0.2	–0.5	1.6	–0.4

Source: Authors' calculation.
Note: Rest of ECOWAS includes Cabo Verde, Gambia, Guinea, Guinea Bissau, Liberia, Mali, Niger, and Sierra Leone. CONS = consumption tax scenario; ECOWAS = Economic Community of West African States; EXP = public expenses scenario; GDP = gross domestic product; INC = income tax scenario; LS = lump-sum tax, or central, scenario. All scenarios are described in the body of the text.

In the EXP scenario, all welfare variations are positive in 2035; in all alternative scenarios, they are all negative, except for Burkina Faso and Côte d'Ivoire. In the EXP scenario, public expenses are decreased (by 8.5 percent in Senegal and Togo and by 4.5 percent in Benin) to maintain the public deficit as a constant proportion of GDP after the loss of customs duties. This scenario does not affect the representative household's welfare because the model does not account for the provision of a public good (security, justice, and so forth) by each government. However, we may assume that such a reduction could jeopardize the provision of public goods in all WA countries.

In other scenarios, the model imposes a new tax that is levied to maintain real public goods per capita constant. Even if the lump-sum tax is not politically realistic, it clearly illustrates how much each citizen has to pay for public goods to be maintained. This tax decreases individual private available income, reducing welfare in six of eight countries/regions. Compensating for the loss of customs duties by an additional income tax results in a similar scenario.

If an additional consumption tax is levied, the impact on the representative household's welfare is only slightly modified; available private income is not affected by a new tax on consumption, but consumption prices are distorted by the new tax. This solution is interesting in terms of its impact on GDP. Not only are public expenses an important portion of total demand and maintained constant per capita, but imports are taxed through this additional consumption tax, which increases the domestic price of goods produced locally and abroad.

Table 4.7 illustrates the impact of the EPA on poverty under two alternative fiscal scenarios. We do not perform a microsimulation for the additional consumption tax (CONS scenario) because the microsimulation is operated on the revenue side of the household survey.

Table 4.7 Impact of reform on poverty, sensitivity analysis, 2035 (in percentages)

	Nigeria				
Poverty threshold, US$/day	Base year	2035 baseline	EXP	LS	INC
$1.00	51.57	44.37	44.36	44.41	44.32
$1.25	55.61	47.45	47.42	47.52	47.42
	Ghana				
Poverty threshold, US$/day	Base year	2035 baseline	EXP	LS	INC
$1.00	29.99	21.65	21.66	21.75	21.73
$1.25	31.66	23.64	23.53	23.59	23.56

Source: Authors' calculation.

Note: EXP = public expenses scenario; INC = income tax scenario; LS = lump-sum tax, or central, scenario. All scenarios are described in the body of the text.

As expected, although the EXP scenario implies a slight decrease in the poverty head count (except in Ghana, where it is almost constant under the $1.00 per day definition of poverty), the LS scenario, which levies a lump-sum tax that is constant per capita irrespective of the level of individual income, brings an increase in the poverty head count (again, except in Ghana, where it is slightly increased under the $1.25 per day definition of poverty). The additional income tax is more efficient than the lump-sum tax in terms of poverty reduction.

5. CONCLUDING REMARKS

The objective of this research was to evaluate the economic, trade, and poverty impact of the EPA between the EU and the ECOWAS countries. This agreement consists of a free trade area between the signatory countries, complemented by a development package. The evaluation is based on a dynamic, multicountry, multisector general equilibrium model, MIRAGRODEP, and a microsimulation focused on Nigeria and Ghana using the final text of the agreement.

We conclude that globally, the EPA's impact is either positive or negative for ECOWAS countries; although trade is increased overall, the impact on GDP and welfare in these countries is either positive or negative. If consumption prices are reduced due to the reform, the loss of customs duties requires implementation of a new tax, which reduces welfare.

This study raises a number of issues concerning the trade agreement. First, the effects of this agreement are small, if not tiny. This is not a surprise: due to both the characteristics of current trade policies and the characteristics of the agreement, the reduction in trade barriers is not large. Moreover, the magnitude of the development package is limited.

Second, there is a substantial difference in the economic mechanisms at play between ECOWAS LDCs and non-LDCs. For the latter group, increased exports come from a reduction in trade restrictions implemented by the EU, along with a simultaneous reduction of their own trade barriers on European products. For the former group, the immediate impact of the agreement is only a reduction of their protection on European products. More imports lead to a deterioration of LDCs' trade balance, which brings real depreciation through a reduction in domestic prices. This internal devaluation helps restore these countries' competitiveness and positively impacts their exports.

Third, the EPA agreement raises the issue of a fiscal adjustment. Customs tariffs represent an important part of public revenues in ECOWAS countries (around 34 percent in both Côte d'Ivoire and Senegal, for example). However, the EPA entails a significant reduction in customs duties because the EU is an important and significant trading partner in the region. To maintain public expenses and the provision of public goods constant, ECOWAS governments will have to find an alternative source of public revenues.

This research adopts a central scenario in which a lump-sum tax is raised to compensate for this loss of public revenue. A sensitivity analysis is conducted in which a tax, either an additional consumption tax or an additional income tax, is imposed in order to maintain the public expenses per capita constant. This analysis illustrates that the EPA could affect households' income and welfare by affecting the public revenues of ECOWAS countries. The fiscal closure rule, in which no alternative tax is raised to offset the loss of customs duties, and public expenses adjust to maintain the public budget balance as a constant percentage of GDP, implies that the provision of public services is altered under the EPA; thus the measurement of welfare is uncertain.

In conclusion, the benefits of the EPA between the EU and WA countries appear small, if not negative, for WA countries. WA countries should find a source of increased growth from other trade agreements, either multilateral or regional. For example, the implementation of a continental free trade area could create more economic expansion.

The EPA does present an important opportunity and stimulus to continue domestic tax reforms and to move away from trade taxes. This reform will ease any future adjustments regarding other trade liberalization experiences. By entering into unilateral liberalization or regional agreements (at the continent level or with other key partners such as the United States or China), WA countries will also eliminate the trade deviation consequences of the EPA. Therefore, despite limited impacts, the EPA can trigger deeper and wider integration by supporting needed domestic reform. This is an important policy perspective that requires further evaluation.

APPENDIX A: TECHNICAL PRESENTATION OF MIRAGRODEP-DD

MIRAGRODEP is a computable general equilibrium model based on MIRAGE. It is a multiregion, multisector, dynamically recursive[19] computable general equilibrium model. MIRAGE was initially developed at the Centre d'Etudes Prospectives et d'Informations Internationales (CEPII) and is devoted to trade policy analysis.

This appendix presents a complete technical description of the model used in this study. It is based on Laborde, Robichaud, and Tokgoz (2013). Specific equations describing the dual-dual hypothesis (DD) have been added for this project.

Social accounting matrix and trade data in MIRAGRODEP are based on GTAP 9 (Aguiar, Narayanan and McDougall, 2016). The GTAP database is a fully documented global database that contains complete bilateral trade information as well as transport and protection linkages among 140 regions for all 57 GTAP commodities for 2011 For MIRAGRODEP the base year is 2011, and the outlook period is from 2012 to 2035. Trade policy data come from MAcMap-HS6 (Bouët et al., 2008).

Model Structure

Dimensions and Sets

The MIRAGRODEP model distinguishes multiple sectors (activities or industries), each producing one single commodity (good or product). Sectors and commodities are referred to using index *i* or *j,* both representing the exact same elements. The subset *Transport* refers to transportation commodities and sectors.

MIRAGRODEP is a global dynamic model. Each variable is thus indexed in time (index *t*) and by region using indexes *r* (origin country), *s* (destination country), and *rr* and *ss,* corresponding, respectively, to the same elements.

Set *f* refers to the five factors of production: skilled labor (index *SkLab*), unskilled labor (*UnSkLab*), natural resources (*NatlRes*), capital (*Capital*), and land (*Land*). As discussed below, it is assumed that unskilled workers are not perfectly mobile across sectors of production. Hence, sectors are grouped according to the area, rural (*L1*) or urban (*L2*), both elements being included in the set *Ltype.*

In the dual-dual version of MIRAGRODEP, *formal(i,r)* is a subset of sectors in each country: it includes all formal sectors, and *informal(i,r)* is its complement and includes all informal sectors. In the developing countries on which this study focuses—Benin, Burkina Faso, Côte d'Ivoire, Ghana, Nigeria, Senegal, Togo, and the rest of the ECOWAS region[20]—informal sectors have been selected after a review of literature[21] and after considering the importance of capital and skilled labor in all sectors, because informal sectors are not supposed to hire skilled labor and are supposed to be relatively noncapitalistic. In those countries of interest, formal sectors are the sectors not classified as informal, and in all other countries all sectors are formal. Table A.1 indicates the breakdown of formal and informal sectors in WA countries.

[19] Dynamically recursive models do not include the expected value of variables in future periods. In addition, the value of variable *X* at the end of period *t* is the initial value of variable *X* at the beginning of period *t* + 1.

[20] These eight countries/regions are all the elements of a subset of *r*, the set of countries, and this subset is called *r_dual(r)*.

[21] See Benjamin and Mbaye (2012) and De Vreyer and Roubaud (2013).

Table A.1 Formal versus informal sectors

Informal sector	Formal sector	Formal sector
Oilseeds	Other food	Beverages and tobacco
Vegetables and fruits	Vegetable oil	Dairy products
Other crops	Leather products	Other minerals
Other industries	Textiles	Paper products
Plant fibers	Wearing apparel	Wood products
Cattle	Chemicals	Capital goods
Cereals	Electronics	Metals
Rice	Motor vehicles	Utilities
Other animals	Construction	Trade
Fisheries	Fossil fuel	Business services
Other natural resources	Red meat	Other services
	Rice	Public services
	White meat	Transportation

Source: Authors.

The dual-dual version of MIRAGRODEP also makes a distinction between rural and urban sectors—that is to say, economic activities that are supposed to take place in rural and urban areas. This is the basis for modeling rural-urban migration. Table A.2 indicates the decomposition between rural and urban sectors.

Table A.2 Rural versus urban sectors

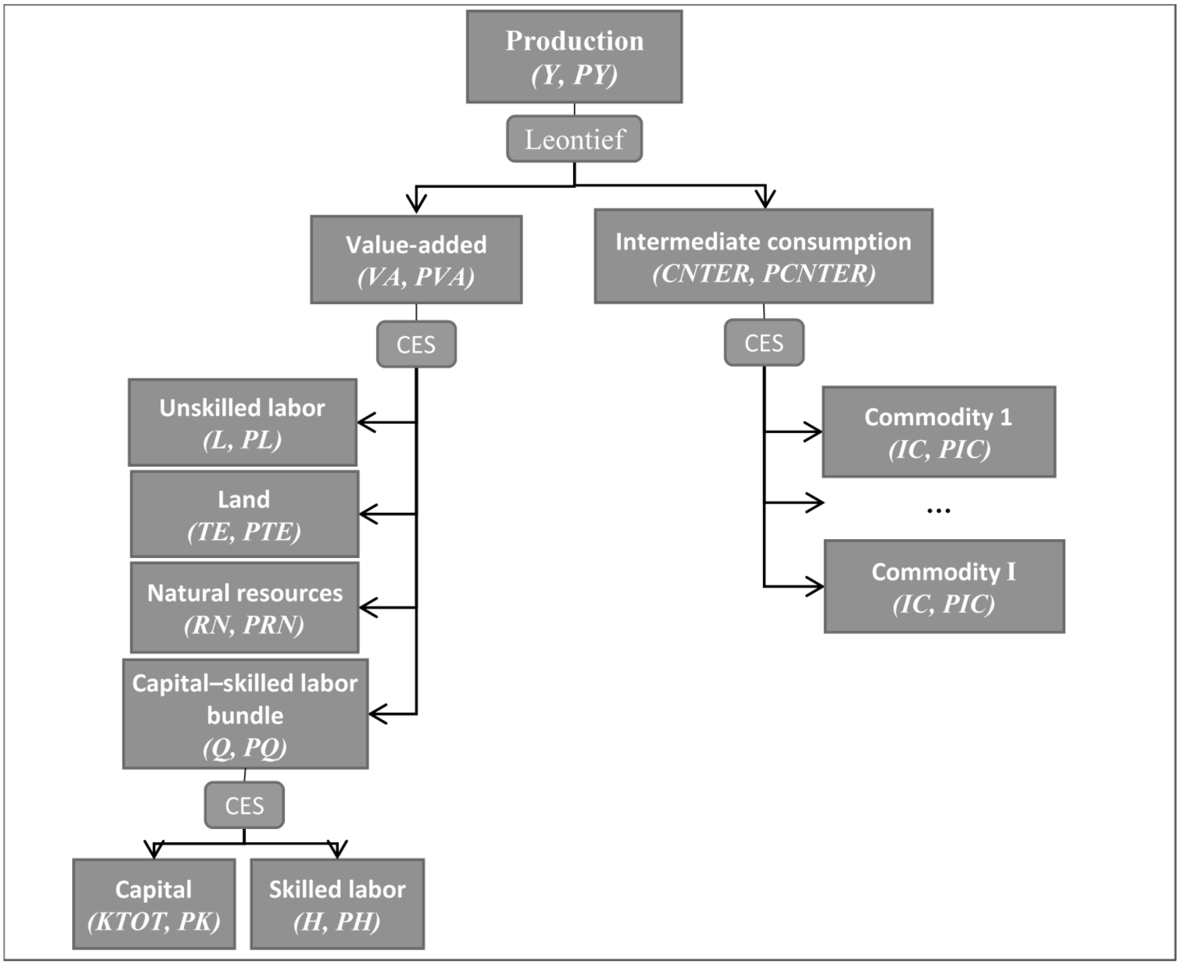
Rural sector	Urban sector	Urban sector
Cattle	Electronics	Capital goods
Cereals	Chemicals	Other minerals
Oilseeds	Other food	Dairy products
Other animals	Other industries	Utilities
Other crops	Wearing apparel	Wood products
Plant fibers	Textiles	Beverages and tobacco
Rice	Leather products	Paper products
Sugar	Motor vehicles	Metals
Vegetables and fruits	Vegetable oil	White meat
	Construction	Trade
	Other natural resources	Transportation
	Fisheries	Business services
	Fossil fuel	Other services
	Red meat	Public services

Source: Authors.

Production

The production in each sector and in each region follows the nested structure depicted in Figure A.1. At the top level, total output, Yj,r,t, is a Leontief function of total value-added, VAj,r,t, and total intermediate consumption, CNTERj,r,t. In other words, there are no substitution possibilities between the two aggregated inputs; they are used in perfect complementarity, and thus their shares in total production are constant.

Figure A.1 Nested production function



Source: Authors.
Note: CES = constant elasticity of substitution. The acronym for each variable, followed by its corresponding price designation, appears in parentheses.

Mathematically,

$Y_{j,r,t} = a_{j,r}^{VA}\ VA_{j,r,t}$ and

$Y_{j,r,t} = a_{j,r}^{CNTER}\ CNTER_{j,r,t}$,

with

$a_{j,r}^{VA}$ = Value-added scale coefficient and

$a_{j,r}^{CNTER}$ = Total intermediate consumption scale coefficient.

Hence, the producer price of output *PYj,r,t* is a weighted sum of the price of value-added, *PVAj,r,t*, and the price of total intermediate consumption, *PCNTERj,r,t.* Therefore,

$$PY_{j,r,t}\ Y_{j,r,t} = PVA_{j,r,t}\ VA_{j,r,t} + PCNTER_{j,r,t}\ CNTER_{j,r,t}.$$

At the second level, on the value-added side, total value-added is a combination of unskilled labor, *Lj,r,t*; land, *TEj,r,t*; natural resources, *RNj,r,t*; and the capital–skilled labor bundle, *Qj,r,t.*[22] It is assumed that these inputs are imperfect substitutes for one another, which is represented through the use of a constant elasticity of substitution (CES) function.[23] The representative firm minimizes its costs subject to the CES aggregator, yielding the following first-order conditions:

$$L_{j,r,t} = a_{j,r}^{L}\ VA_{j,r,t}\ PGF_{r,t}{}^{\sigma_j^{VA}-1}\left(\frac{PVA_{j,r,t}}{PL_{j,r,t}}\right)^{\sigma_j^{VA}},$$

$$TE_{j,r,t} = a_{j,r}^{TE}\cdot VA_{j,r,t}\cdot PGF_{r,t}{}^{\sigma_j^{VA}-1}\cdot\left(\frac{PVA_{j,r,t}}{PTE_{j,r,t}}\right)^{\sigma_j^{VA}},$$

$$RN_{j,r,t} = a_{j,r}^{RN}\cdot VA_{j,r,t}\cdot PGF_{r,t}{}^{\sigma_j^{VA}-1}\left(\frac{PVA_{j,r,t}}{PRN_{j,r,t}}\right)^{\sigma_j^{VA}}, \text{ and}$$

$$Q_{j,r,t} = a_{j,r}^{Q}\cdot VA_{j,r,t}\cdot PGF_{r,t}{}^{\sigma_j^{VA}-1}\cdot\left(\frac{PVA_{j,r,t}}{PQ_{j,r,t}}\right)^{\sigma_j^{VA}},$$

with

$a_{j,r}^{L}$ = Unskilled labor coefficient,

$a_{j,r}^{TE}$ = Land coefficient,

$a_{j,r}^{RN}$ = Natural resources coefficient,

$a_{j,r}^{Q}$ = Capital–skilled labor aggregate coefficient,

σ_j^{VA} = Value-added elasticity, and

$PGF_{r,t}$ = Total factor productivity.

[22] It is noteworthy that in informal sectors there is no skilled labor and this bundle is only capital.

[23] It might be worth noting that some parameters are solely indexed in *j*. That is the case, for example, for the elasticity used in the value-added functions (σ_j^{VA}). This specification implies that the same parameter is used for all regions but that it differs from one sector to another.

It follows that the price of value-added is a weighted sum of the price of unskilled labor, *PL j,r,t*; the price of land, *PTE j,r,t*; the price of natural resources, *PRNj,r,t*; and the aggregated price of capital and skilled workers, *PQj,r,t* (in informal sectors, the price of capital). Thus,

$$PVA_{j,r,t}\ VA_{j,r,t} = PL_{j,r,t}\ L_{j,r,t} + PTE_{j,r,t}\ TE_{j,r,t} + PRN_{j,r,t}\ RN_{j,r,t} + PQ_{j,r,t}\ Q_{j,r,t}.$$

The price paid by the producer for each factor differs from the price received by households by the amount of taxes, which can be negative in cases wherein factors are subsidized. The model also distinguishes ad valorem taxes from taxes that are applied on volume. Hence,

$$PL_{j,r,t} = WLt_{Ltype,r,t}\ \left(1 + taxf^{VAL}_{UnSkLab,j,r,t}\right) + PIndC_{r,t}\ taxf^{VOL}_{UnSkLab,j,r,t},$$

$$PTE_{j,r,t} = WTE_{j,r,t}\ \left(1 + taxf^{VAL}_{Land,j,r,t}\right) + PIndC_{r,t}\ taxf^{VOL}_{Land,j,r,t}, \text{ and}$$

$$PRN_{j,r,t} = WRN_{j,r,t}\ \left(1 + taxf^{VAL}_{NatlRes,j,r,t}\right) + PIndC_{r,t}\ taxf^{VOL}_{NatlRes,j,r,t},$$

with

$WLt_{ltype,r,t}$ = Rate of return on unskilled labor (net of taxes),

$WTE_{j,r,t}$ = Rate of return on land (net of taxes),

$WRN_{j,r,t}$ = Rate of return on natural resources (net of taxes),

$PIndC_{r,t}$ = Consumer price index,

$taxf^{VAL}_{f,j,r,t}$ = Rate of factor-based taxes (ad valorem), and

$taxf^{VOL}_{f,j,r,t}$ = Rate of factor-based taxes (on volume).

In countries *r_dual* with dual-dual modeling, in the previous equation, $WLt_{Ltype,r,t}$ is replaced by $WLurbaninf_{r\_dual,t}$ in urban and informal sectors, by $WLruralinf_{r\_dual,t}$ in rural and informal sectors, by $WLurbanfor_{r\_dual,t}$ in urban and formal sectors, and by $WLruralfor_{r\_dual,t}$ in rural and formal sectors. Consequently, in these countries, there are four equilibrium rates of return on unskilled labor (net of taxes):

$WLurbaninf_{r\_dual,t}$ = Rate of return on unskilled labor in urban informal sectors (net of taxes),

$WLruralinf_{r\_dual,t}$ = Rate of return on unskilled labor in rural informal sectors (net of taxes),

$WLurbanfor_{r\_dual,t}$ = Rate of return on unskilled labor in urban formal sectors (net of taxes), and

$WLruralfor_{r\_dual,t}$ = Rate of return on unskilled labor in rural formal sectors (net of taxes).

At the bottom level, for formal sectors on the value-added side, capital, *KTOTj,r,t,* and skilled labor, *Hj,r,t,* are combined through a CES function, once again to represent the imperfect substitutability between the two factors of production. Minimization of production costs subject to the CES aggregator gives the following demand functions:

$$H_{j,r,t} = a^{H}_{j,r}\, Q_{j,r,t} \left(\frac{PQ_{j,r,t}}{PH_{j,r,t}}\right)^{\sigma_j^{CAP}} \text{ and}$$

$$KTOT_{j,r,t} = a^{K}_{j,r}\, Q_{j,r,t} \left(\frac{PQ_{j,r,t}}{PK_{j,r,t}}\right)^{\sigma_j^{CAP}},$$

with

$a^{H}_{j,r}$ = Skilled labor coefficient,

$a^{K}_{j,r}$ = Capital coefficient, and

σ^{CAP}_{j} = Capital–skilled labor elasticity.

The price of the capital–skilled labor bundle is thus a weighted sum of the rental rate of capital, *PKj,r,t,* and the price of skilled labor, *PHj,r,t:*

$$PQ_{j,r,t}\, Q_{j,r,t} = PK_{j,r,t}\, KTOT_{j,r,t} + PH_{j,r,t}\, H_{j,r,t}.$$

Again, the prices paid for the factors of production differ from the amount received by households because there are taxes levied on each of them:

$$PH_{j,r,t} = WH_{r,t}\left(1 + taxf^{VAL}_{SkLab,j,r,t}\right) + PIndC_{r,t}\, taxf^{VOL}_{SkLab,j,r,t} \text{ and}$$

$$PK_{j,r,t} = WK_{j,r,t}\left(1 + taxf^{VAL}_{Capital,j,r,t}\right) + PIndC_{r,t}\, taxf^{VOL}_{Capital,j,r,t},$$

with

$WH_{r,t}$ = Rate of return on skilled labor (net of taxes) and

$WK_{j,r,t}$ = Rate of return on capital (net of taxes).

For informal sectors, we get $\forall(i,r) \in informal\ (i,r), KTOT_{i,r,t} = Q_{i,r,t}$ and $PQ_{i,r,t} = PK_{i,r,t}$. On the intermediate consumption side, the commodities (index *i*) used in the production process are assumed to be imperfect substitutes. Once again, a CES function is used to represent this imperfect substitutability, and cost minimization yields the demand for each input, *ICi,j,r,t*:

$$IC_{i,j,r,t} = a^{IC}_{i,j,r}\, CNTER_{j,r,t} \left(\frac{PCNTER_{j,r,t}}{PIC_{i,j,r,t}}\right)^{\sigma^{IC}},$$

with

$a^{IC}_{i,j,r}$ = Intermediate consumption scale coefficient and

σ^{IC} = Intermediate consumption elasticity.

The price of total intermediate consumption is a weighted sum of the price paid for each commodity, $PIC_{i,j,r,t}$:

$$PCNTER_{j,r,t}\ CNTER_{j,r,t} = \sum_i PIC_{i,j,r,t}\ IC_{i,j,r,t}.$$

The price of each input is subject to taxes, $taxicc_{i,j,r,t}$, and thus differs from the price received by producers for that input, $PDEMTOT_{i,r,t}$:

$$PIC_{i,j,r,t} = PDEMTOT_{i,r,t}\left(1 + taxicc_{i,j,r,t}\right).$$

Income and Savings

Households

Households are assumed to be homogeneous, and they own all factors of production. They hence receive all the payments made for factors of production. They also receive transfers from the government, which are indexed to take into account population growth and the evolution of the price index:

$$\begin{aligned} REVH_{r,t} = \sum_j \Bigg\{ & WRN_{j,r,t}\ RN_{j,r,t} + WTE_{j,r,t}\ TE_{j,r,t} + WH_{r,t}\ H_{j,r,t} \\ & + \sum_{Ltype} WLt_{Ltype,r,t}\ L_{j,r,t} + \sum_s WK_{j,s,t}\ K_{j,r,s,t} \Bigg\} \\ & + Pop^{ag}_{totpop,r,t} TRH_{r,t}\ PIndC_{r,t} \end{aligned}$$

with

$REVH_{r,t}$ = Households' income,

$TRH_{r,t}$ = Public transfers to households, and

$Pop^{ag}_{totpop,r,t}$ = Population.

Households savings, $SAVH_{r,t}$, is a fixed proportion, epa_r, of their income net of indirect taxes, $RECDIR_{r,t}$, and the rest of their income is dedicated to their consumption budget, $BUDH_{r,t}$:

$SAVH_{r,t} = epa_r\ (REVH_{r,t} - RECDIR_{r,t})$ and

$BUDH_{r,t} = REVH_{r,t} - SAVH_{r,t} - RECDIR_{r,t}.$

Government

The income of the government, $REVG_{r,t}$, consists of taxes collected on production, $RECPROD_{i,r,t}$; on factors of production, $RECFAC_{i,r,t}$; on exports, $RECEXP_{i,r,t}$; on imports, $RECDD_{i,r,t}$; on consumption, $RECCONS_{i,r,t}$; and on households' income, $RECDIR_{r,t}$:

$$\begin{aligned} REVG_{r,t} = \sum_i \{ & RECPROD_{i,r,t} + RECFAC_{i,r,t} + RECEXP_{i,r,t} + RECDD_{i,r,t} \\ & + RECCONS_{i,r,t}\} + RECDIR_{r,t}. \end{aligned}$$

Taxes on production are collected on the value of output of each activity. It is important to note that tax rates should be considered net rates, that is, taxes net of subsidy. Hence, all tax rates can be either positive or negative:

$$RECPROD_{i,r,t} = taxP_{i,r,t}\, PY_{i,r,t}\, Y_{i,r,t}\ ,$$

with

$taxP_{i,r,t}$ = Production tax rate.

Receipts from taxes on factors of production are the sum of the volume and value taxes on each factor:

$$\begin{aligned} RECFAC_{j,r,t} = PIndC_{r,t}\, \big(& taxf^{VOL}_{Land,j,r,t}\, TE_{j,r,t} + taxf^{VOL}_{NatlRes,j,r,t}\, RN_{j,r,t} \\ & + taxf^{VOL}_{SkLab,j,r,t}\, H_{j,r,t} + taxf^{VOL}_{UnSkLab,j,r,t}\, L_{j,r,t} \\ & + taxf^{VOL}_{Capital,j,r,t}\, KTOT_{j,r,t}\big) + taxf^{VAL}_{Land,j,r,t}\, WTE_{j,r,t}\, TE_{j,r,t} \\ & + taxf^{VAL}_{NatlRes,j,r,t}\, WRN_{j,r,t}\, RN_{j,r,t} + taxf^{VAL}_{SkLab,j,r,t}\, WH_{r,t}\, H_{j,r,t} \\ & + taxf^{VAL}_{UnSkLab,j,r,t} \sum_{Ltype} WLt_{Ltype,r,t}\, L_{j,r,t} \\ & + taxf^{VAL}_{Capital,j,r,t}\, WK_{j,r,t}\, KTOT_{j,r,t} \end{aligned}$$

Exports may be subject to three taxes: taxes on production, $taxP_{i,r,t}$; regular taxes on exports, $taxEXP_{i,r,s,t}$; and export tax that is the equivalent of the multifiber arrangement quota premium, $taxAMF_{i,r,s,t}$:

$$RECEXP_{i,r,t} = PY_{i,r,t}\, \left(1 + taxP_{i,r,t}\right)\, \textstyle\sum_s \left(taxEXP_{i,r,s,t} + taxAMF_{i,r,s,t}\right) TRADE_{i,r,s,t},$$

with

$TRADE_{i,r,s,t}$ = Exports of commodity i from country r to country s.

Duties, $DD_{i,s,r,t}$, are collected on imports evaluated at the cost, insurance, and freight (CIF) price, $PCIF_{i,s,r,t}$:

$$RECDD_{i,r,t} = \textstyle\sum_s DD_{i,s,r,t}\, PCIF_{i,s,r,t}\, TRADE_{i,s,r,t}.$$

Taxes are levied on households' consumption, $CH_{i,r,t}$; government current expenditure on goods and services, $CG_{i,r,t}$; commodities sold for investment purposes, $KG_{i,r,t}$; and intermediate consumption, $IC_{i,j,r,t}$. Each buyer faces a specific tax rate, respectively, $taxcc_{i,r,t}$, $taxgc_{i,r,t}$, $taxkgc_{i,r,t}$, and $taxicc_{i,j,r,t}$.

$$\begin{aligned} RECCONS_{i,r,t} = PDEMTOT_{i,r,t}\, \Big\{ & taxcc_{i,r,t}\, CH_{i,r,t} + taxgc_{i,r,t}\, CG_{i,r,t} \\ & + taxkgc_{i,r,t}\, KG_{i,r,t} + \sum_j taxicc_{i,j,r,t}\ IC_{i,j,r,t} \Big\} \end{aligned}$$

Finally, the government collects direct taxes on households' income:

$$RECDIR_{r,t} = taxdir_{r,t}\, REVH_{r,t}.$$

Government savings, $SAVG_{r,t}$, is assumed to be a fixed proportion, $PUBSOLD_r$, of GDP at market prices, $GDPMP_{r,t}$. Finally, the budget allocated to public current expenditure on goods and services, $BUDG_{r,t}$, is determined residually:

$$SAVG_{r,t} = PUBSOLD_r \; GDPMP_{r,t} \text{ and}$$

$$BUDG_{r,t} = REVG_{r,t} - SAVG_{r,t} - Pop^{ag}_{totpop,r,t} \; TRH_{r,t} \; PIndC_{r,t} \, .$$

Demand

Domestic absorption of each commodity, *DEMTOTi,r,t,* is the sum of consumer demand, *CHi,r,t*; demand from public administrations, *CGi,r,t*; intermediate demand, *ICi,j,r,t*; and demand for investment purposes, *KGi,r,t:*

$$DEMTOT_{i,r,t} = CH_{i,r,t} + CG_{i,r,t} + \textstyle\sum_j IC_{i,j,r,t} + KG_{i,r,t}.$$

Private Demand

Households' demand is characterized by a linear expenditure system–CES specification. This specific utility function allows the evolution of the demand structure of each region to be accounted for as its income level changes. In addition, the elasticity of substitution is constant only among the sectoral consumptions over and above a minimum level. The minimal level of consumption can vary across regions (for example, in a developing versus a developed country):

$$CH_{i,r,t} = \; Pop^{ag}_{totpop,r,t} \left(cmin_{i,r} + a^C_{i,r} \; AUX_{r,t} \left(\frac{P_{r,t}}{PC_{i,r,t}} \right)^{\sigma^C_r} \right),$$

with

$cmin_{i,r}$ = Minimal consumption of commodity i (per capita),

$a^C_{i,r}$ = Household consumption coefficient,

$AUX_{r,t}$ = Utility,

$P_{r,t}$ = Shadow price of utility,

$PC_{i,r,t}$ = Price of final private consumption, and

σ^C_r = Households' consumption elasticity of substitution.

Households maximize their utility subject to their consumption budget, *BUDHr,t,* from which one can derive the shadow price of utility, *Pr,t:*

$$BUDH_{r,t} = \textstyle\sum_i PC_{i,r,t} \; CH_{i,r,t} \text{ and}$$

$$P_{r,t} \; AUX_{r,t} = \textstyle\sum_i PC_{i,r,t} \left(\frac{CH_{i,r,t}}{Pop^{ag}_{totpop,r,t}} - cmin_{i,r} \right).$$

The price paid by households for each commodity, *PCi,r,t*, differs from the amount received by suppliers, *PDEMTOTi,r,t*, by the amount of taxes collected, *taxcci,r,t*:

$$PC_{i,r,t} = PDEMTOT_{i,r,t} \; (1 + taxcc_{i,r,t}).$$

Finally, the consumer price index, *PIndCr,t*, is a Fisher index:

$$PindC_{r,t} = \sqrt{\left[\frac{\sum_i PC_{i,r,t}\, CH^{O}_{i,r}}{\sum_i PC^{O}_{i,r}\, CH^{O}_{i,r}}\right]\left[\frac{\sum_i PC_{i,r,t}\, CH_{i,r,t}}{\sum_i PC^{O}_{i,r}\, CH_{i,r,t}}\right]},$$

with

$CH^{O}_{i,r}$ = Benchmark value of households' consumption and

$PC^{O}_{i,r}$ = Benchmark value of final private consumption.

Public Demand

Government spending on each commodity is a fixed share, $\alpha^{G}_{i,r}$, of total public expenditure on goods and services, *BUDGr,t,* and government purchases are subject to taxes, *taxgci,r,t*:

$$PCG_{i,r,t}\, CG_{i,r,t} = \alpha^{G}_{i,r}\, BUDG_{r,t} \text{ and}$$

$$PCG_{i,r,t} = PDEMTOT_{i,r,t}\,(1 + taxgc_{i,r,t}),$$

with

$PCG_{i,r,t}$ = Price of final public consumption.

Demand for Investment Purposes

Finally, demand for investment purposes, *KGi,r,t,* is characterized by a CES function. Cost minimization subject to the CES aggregator yields the following demand function:

$$KG_{i,r,t} = a^{KG}_{i,r}\, INVTOT_{r,t} \left(\frac{PINVTOT_{r,t}}{PKG_{i,r,t}}\right)^{\sigma^{KG}},$$

with

$a^{KG}_{i,r}$ = Capital good scale coefficient,

$INVTOT_{r,t}$ = Total investment,

$PINVTOT_{r,t}$ = Price of investment,

$PKG_{i,r,t}$ = Price of capital good consumption, and

σ^{KG} = Capital good elasticity.

The aggregated price of capital, *PINVTOTr,t*, is thus a weighted sum of the price paid for each commodity, *PKGi,r,t*:

$$PINVTOT_{r,t}\, INVTOT_{r,t} = \textstyle\sum_i PKG_{i,r,t}\, KG_{i,r,t}.$$

Again, the price paid by the purchaser differs from the amount received by the seller because taxes apply:

$$PKG_{i,r,t} = PDEMTOT_{i,r,t}\,(1 + taxkgc_{i,r,t}).$$

Demand by Geographic Origin

MIRAGRODEP is a bilateral trade model consistent with the Armington assumption: commodities are assumed to be heterogeneous according to their origin and thus imperfect substitutes for one another (Armington 1969). Nested CES functions are used to reflect preferences among varieties originating from different countries. Therefore, countries can export and import the same product at the same time due to consumer preferences for different varieties. The price transmission between domestic and international markets is imperfect and highly dependent on the choice of the CES trade elasticities and the initial share of trade.

At the top level, total demand, $DEMTOT_{i,r,t}$, combines aggregated imports, $M_{i,r,t}$, and local production, $D_{i,r,t}$, through a CES function. From cost minimization subject to the CES aggregator, the following demand functions can be derived:

$$D_{i,r,t} = a^{D}_{i,r}\,DEMTOT_{i,r,t}\left(\frac{PDEMTOT_{i,r,t}}{PD_{i,r,t}}\right)^{\sigma_i^{ARM}} \text{ and}$$

$$M_{i,r,t} = a^{M}_{i,r}\,DEMTOT_{i,r,t}\left(\frac{PDEMTOT_{i,r,t}}{PM_{i,r,t}}\right)^{\sigma_i^{ARM}},$$

with

$a^{D}_{i,r}$ = Local demand scale coefficient,

$a^{M}_{i,r}$ = Total import demand scale coefficient,

σ_i^{ARM} = Armington elasticity,

$PD_{i,r,t}$ = Price of demand for domestic commodity, and

$PM_{i,r,t}$ = Aggregated price of imports.

Consequently, the price of the aggregated commodity, $PDEMTOT_{i,r,t}$, is a weighted sum of aggregated imports, $PM_{i,r,t}$, and the price of the domestically produced commodity, $PD_{i,r,t}$, which differs from the amount received by the producer, $PY_{i,r,t}$, because taxes, $taxP_{i,r,t}$, apply:

$$PDEMTOT_{i,r,t}\,DEMTOT_{i,r,t} = PD_{i,r,t}\,D_{i,r,t} + PM_{i,r,t}\,M_{i,r,t} \text{ and}$$

$$PD_{i,r,t} = PY_{i,r,t}\,(1 + taxP_{i,r,t}).$$

At the second level (Figure A.2), total imports, $M_{i,r,t}$, is a CES combination of imports from the different trading partners, $DEMA_{i,s,r,t}$. Cost minimization under the CES aggregation constraint leads to the following demand function:

$$DEMA_{i,s,r,t} = a^{IMP}_{i,s,r}\,M_{i,r,t}\left(\frac{PM_{i,r,t}}{PDEMA_{i,s,r,t}}\right)^{\sigma_i^{IMP}},$$

with

$a_{i,s,r}^{IMP}$ = Import demand scale coefficient,

σ_{i}^{IMP} = Import elasticity, and

$PDEMA_{i,s,r,t}$ = Price of bilateral trade.

This specification implies that the price of aggregated imports is a weighted sum of the price paid to the different partners. The price paid by the purchaser differs from the CIF price because import duties, $DD_{i,s,r,t}^{A}$, apply:

$$PM_{i,r,t}\ M_{i,r,t} = \sum_s PDEMA_{i,s,r,t}\ DEMA_{i,s,r,t} \quad \text{and}$$

$$PDEMA_{i,s,r,t} = PCIF_{i,s,r,t}\left(1 + DD_{i,s,r,t}^{A}\right).$$

In addition, the CIF price is determined by the production costs, on which taxes apply, plus the transportation costs:

$$PCIF_{i,s,r,t} = PY_{i,s,t}\left(1 + taxEXP_{i,s,r,t} + taxAMF_{i,s,r,t}\right)\left(1 + taxP_{i,s,t}\right) + MUO_{i,s,r}\ PTr_{i,s,r,t},$$

with

$Ptr_{i,s,r,t}$ = Price of transportation per commodity exported and

$MUO_{i,s,r}$ = Transport coefficient.

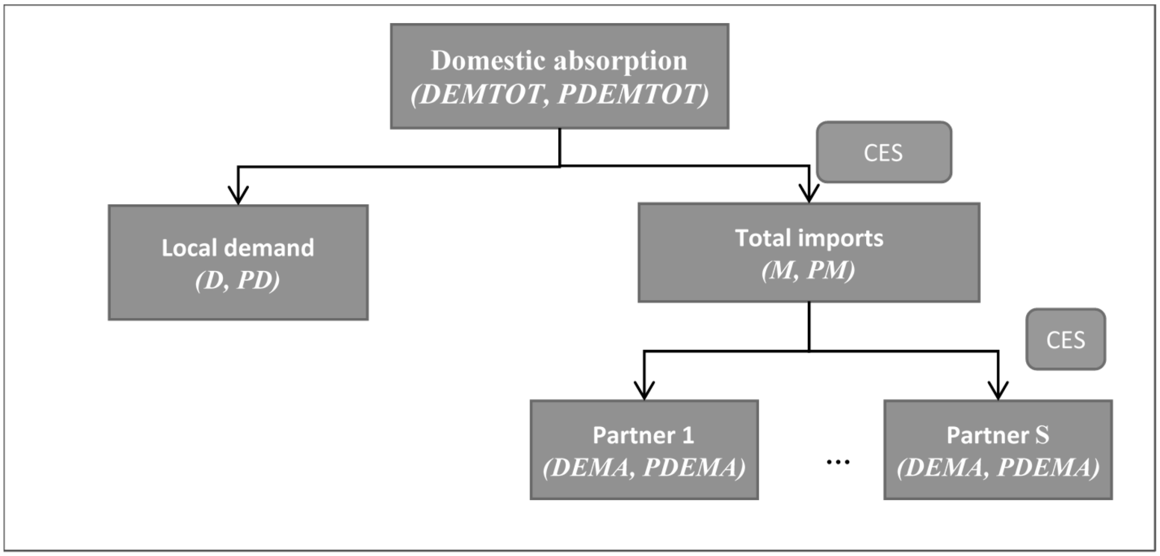
Following the consistent aggregator methodology as defined in Laborde, Martin, and van der Mensbrugghe (2011), aggregation of variables differs according to whether the variables are estimated at world prices or at domestic prices. Hence, the shadow price of bilateral trade, *PDEMi,s,r,t,* is evaluated as follows:

$$PDEM_{i,s,r,t} = PCIF_{i,s,r,t}\left(1 + DD_{i,s,r,t}\right),$$

which leads to the definition of the aggregator *TRADEi,s,r,t*:

$$DEMA_{i,s,r,t}\ PDEMA_{i,s,r,t} = PDEM_{i,s,r,t}\ TRADE_{i,s,r,t}.$$

Figure A.2 Demand by geographic origin



Source: Authors.
Note: CES = constant elasticity of substitution. The acronym for each variable, followed by its corresponding price designation, appears in parentheses.

Demand for Transportation Services

The volume of transportation, $Tr_{i,s,r,t}$, required to move commodity *i* imported by region *r* from region *s* is a fixed proportion, $MUO_{i,s,r}$, of total imports, $TRADE_{i,s,r,t}$:

$$Tr_{i,s,r,t} = MUO_{i,s,r}\ TRADE_{i,s,r,t}.$$

Transportation demand per mode, $TrMode_{Transport,i,s,r,t}$, is then determined as being a fixed share, $a^{Tr}_{Transport,i,s,r}$, of total transportation demand. Implicitly, then, total demand for transportation is a function of the Cobb-Douglas type. Hence, the exact price formulation for the aggregated price of transportation, $PTr_{i,s,r,t}$, is the dual form of a Cobb-Douglas function:

$$PTrMode_{Transport,t}\ TrMode_{Transport,i,s,r,t} = a^{Tr}_{Transport,i,s,r,t}\ Tr_{i,s,r,t}\ PTr_{i,s,r,t} \text{ and}$$

$$PTr_{i,s,r,t} = \prod_{Transport} PTrMode_{Transport,t}^{a^{Tr}_{Transport,i,s,r}},$$

with

$PTrMode_{Transport,t}$ = Price of transport per mode and

$PTr_{i,r,s,t}$ = Price of transport by commodity and partners.

Supply and Market Clearing

Transportation Market

The world supply of transportation services per mode, *WorldTrTransport,t,* adheres to a Cobb-Douglas specification. It follows that the supply from each region, *TrSupplyTransport,r,t,* is a constant share of the world value of transportation:

$$WorldTr_{Transport,t} = c^{T}_{Transport} \prod_r TrSupply_{Transport,r,t}^{a^{TrSupply}_{Transport,r}} \text{ and}$$

$$PY_{Transport,r,t}\left(1 + taxP_{Transport,r,t}\right) TrSupply_{Transport,r,t} = a^{TrSupply}_{Transport,r}\, PTrMode_{Transport,t}\, WorldTr_{Transport,t}\,,$$

with

$c^{T}_{Transport}$ = Scale coefficient and

$a^{TrSupply}_{Transport,r}$ = Share of each region in world transport production.

The market for transportation clears because demand for transportation is equal to supply. Equilibrium on the transportation market determines world prices of transportation per mode, *PTrModeTransport,t*:

$$WorldTr_{Transport,t} = \sum_{i,r,s} TrMode_{Transport,i,r,s,t}.$$

Commodity Market

In each region, the supply of each commodity is equal to the demand. Market clearing determines the price of each commodity, *PYi,r,t*:

$$Y_{i,r,t} = D_{i,r,t} + \sum_s TRADE_{i,r,s,t} + TrSupply_{i,r,t}.$$

Factors of Production Market

Labor Market

The total supply of skilled workers, $\overline{H}_{r,t}$, is fixed and grows exogenously. Skilled workers are assumed to be perfectly mobile across formal sectors, and there is no unemployment. Hence, the equilibrium between supply and demand determines the wage rate:

$$\overline{H}_{r,t} = \sum_{(j,r)\in formal(j,r)} H_{j,r,t}\,.$$

In countries with dual-dual modeling, skilled workers are employed only in formal sectors, but amid formal sectors they may decide to migrate to urban or rural locations. Skilled workers get better salaries in urban areas. There may be different explanations for this prevailing wage gap. One is that everything else being equal, there is a preference for living in rural areas. Another is the existence of a monopolistic union that determines the wages of skilled workers in formal urban sectors by maximization of its utility, which depends on the number of the union's members and their salary level; this situation results in a salary higher than the one that would prevail without a monopolistic union.

Consequently, four equations determine the levels of wages and employment for skilled labor in countries with dual-dual modeling. If *r* is a country with dual-dual modeling, we have

$$WHu_{r,t} = WHr_{r,t}(1 + gap_{h_r}),$$

$$Hu_{r,t} + Hr_{r,t} = \bar{H}_{r,t},$$

$Hu_{r,t} = \sum_{i \in urban(i,r)} H_{i,r}$, and

$$Hr_{r,t} = \sum_{i \in rural(i,r)} H_{i,r},$$

with

$WHu_{r,t}$ = Remuneration of skilled labor in urban sectors in country *r* at time *t*,

$WHr_{r,t}$ = Remuneration of skilled labor in rural sectors in country r at time t,

gap_{h_r} = A constant positive parameter;

$Hu_{r,t}$ = Total demand for skilled labor in urban sectors in country r at time t,

$Hr_{r,t}$ = Total demand for skilled labor in rural sectors in country r at time t, and

$\bar{H}_{r,t}$ = Total supply of skilled labor in country r at time t.

For unskilled workers, $\overline{L}_{r,t}$, total supply is exogenous and grows at an exogenous rate. In countries without dual-dual modeling, it is assumed that unskilled workers cannot move freely between rural and urban areas. A constant elasticity of transformation (CET) is used to characterize the regional supply of unskilled workers. Unskilled workers maximize their income subject to the CET aggregator, which leads to the following supply function:

$$Lt_{Ltype,r,t} = b^{Lt}_{Ltype,r}\, \bar{L}_{r,t} \left(\frac{WLt_{Ltype,r,t}}{\overline{WL}_{r,t}}\right)^{\sigma^L},$$

with

$Lt_{Ltype,r,t}$ = Labor supply on the Ltype market,

$b^{Lt}_{Ltype,r}$ = Labor scale coefficient,

$\overline{WL}_{r,t}$ = Aggregated wage for unskilled workers, and

σ^L = Labor elasticity.

It follows that the aggregated wage for unskilled workers, $\overline{WL}_{r,t}$, is a weighted sum of the wages received on each market:

$$\overline{WL}_{r,t}\, \bar{L}_{r,t} = \sum_{Ltype} WLt_{Ltype,r,t}\, Lt_{Ltype,r,t},$$

which is determined by the equilibrium between supply and demand:

$$Lt_{Ltype,r,t} = \sum_j L_{j,r,t}.$$

In countries with dual-dual modeling, unskilled workers' wages are lower in informal sectors than in formal sectors. There are potentially different explanations for this gap: minimum wages, transaction costs, or higher productivity in formal sectors due to a capital-intensive process of production. According to whether unskilled workers are in the urban or the rural sector, this gap may differ.

The mobility of unskilled labor between rural and urban areas is ruled by an equation of migration: migration stops when the salary in formal rural sectors, $WLr\_formal_{r,t}$, is equal to the expected salary that can be obtained in urban areas where either an unskilled worker works in the urban formal sector (probability $Prob\_Lu\_formal_{r,t}$) and gets a salary of $WLu\_formal_{r,t}$, or works in an urban informal sector (probability $1 - Prob\_Lu\_formal_{r,t}$) and gets a salary of $WLu\_informal_{r,t}$. This probability is a function of the share of the urban formal employment of unskilled labor, $Lu\_formal_{r.t}$, in total employment of unskilled labor in urban sectors, $Lu_{r,t}$. Consequently, there are 11 equations describing this double segmentation of the employment of unskilled labor in countries with dual-dual modeling:

$$WLr\_formal_{r,t} = Prob\_Lu\_formal_{r,t} WLu\_formal_{r,t} + [1 - Prob\_Lu\_formal_{r,t}] WLu\_informal_{r,t},$$

$$Prob\_Lu\_formal_{r,t} = cp_r \frac{Lu\_formal_{r.t}}{Lu\_informal_{r.t} + Lu\_formal_{r,t}},$$

$$Lu_{r,t} + Lr_{r,t} = \bar{L}_{r,t},$$

$$Lu\_formal_{r,t} + Lu\_informal_{r.t} = Lu_{r,t},$$

$$Lr\_formal_{r,t} + Lr\_informal_{r.t} = Lr_{r,t},$$

$$Lu\_formal_{r,t} = \sum_{formal(i,r)} Lu_{i.r,t},$$

$$Lu\_informal_{r,t} = \sum_{informal(i,r)} Lu_{i.r,t},$$

$$Lr\_formal_{r,t} = \sum_{formal(i,r)} Lr_{i.r,t},$$

$$Lr\_informal_{r,t} = \sum_{informal(i,r)} Lr_{i.r,t},$$

$$WLu\_formal_{r,t} = WLu\_informal_{r,t}(1 + \delta u_r), \text{ and}$$

$$WLr\_formal_{r,t} = WLr\_informal_{r,t}(1 + \delta r_r),$$

with

cp_r = A positive constant,

$Lu\_informal_{r.t}$ = Urban informal employment of unskilled labor,

$Lr_{r,t}$ = Total employment of unskilled labor in rural sectors,

$Lu\_informal_{r,t}$ = Total demand for unskilled labor in urban informal sectors in country r at time t,

$Lu\_formal_{r,t}$ = Total demand for unskilled labor in urban formal sectors in country r at time t,

$Lr\_informal_{r,t}$ = Total demand for unskilled labor in rural informal sectors in country r at time t,

$Lr\_formal_{r,t}$ = Total demand for unskilled labor in rural formal sectors in country r at time t,

$WLr\_informal_{r,t}$ = Remuneration of unskilled labor in rural informal sectors in country r at time t,

δu_r = A positive constant, and

δr_r = A positive constant.

Land Market

Land mobility across sectors is assumed to be imperfect. Land supply, $\overline{TE}_{r,t}$, behaves as an isoelastic function of the real return on land, implying that the greater the real overall return on land, the greater will be the overall supply of land:

$$\overline{TE}_{r,t} = \overline{TE}_r^O \left(\frac{\overline{WTE}_{r,t}}{P_{r,t}}\right)^{\sigma_r^{TE}},$$

with

$\overline{TE}_r^O$ = Benchmark value of total land supply,

$\overline{WTE}_{r,t}$ = Aggregated price for land, and

σ_r^{TE} = Total land supply elasticity.

To represent the imperfect mobility of land, the supply of land for each activity, *TEj,r,t,* is determined following a CET aggregation. Landowners maximize their income subject to the CET aggregator, which leads to the following first-order condition:

$$TE_{j,r,t} = b_{j,r}^{TE}\,\overline{TE}_{r,t}\left(\frac{WTE_{j,r,t}}{\overline{WTE}_{r,t}}\right)^{\sigma^{TE}},$$

with

$b_{j,r}^{TE}$ = Land scale coefficient and

σ^{TE} = Land elasticity.

It follows that the aggregated price of land is the weighted sum of the prices received in each activity:

$$\overline{WTE}_{r,t}\,\overline{TE}_{r,t} = \sum_j WTE_{j,r,t}\,TE_{j,r,t}.$$

Capital Market

At each period, the capital stock invested by region *s* in activity *j* in region *r*, *Kj,s,r,t,* is given by the depreciated stock of capital inherited from the preceding period plus new investment, *INVj,s,r,t*:

$$K_{j,s,r,t} = K_{j,s,r,t-1}(1-\delta_r) + INV_{j,s,r,t}\ ,$$

with

δ_r = Depreciation rate,

where the investment per activity and destination region depend on the rate of return on capital, the aggregated price of new capital, and capital stock:[24]

$$INV_{j,s,r,t} = B_{s,t}\,a_{j,s,r}\,KTOT_{j,r,t}\,e^{\alpha\left(\frac{WK_{j,r,t}}{PINVTOT_{r,t}}\right)},$$

with

$B_{s,t}$ = Scale coefficient for investment,

$a_{j,s,r}$ = Investment scale coefficient, and

α = Elasticity of investment to return on capital.

The total investment made in region *r*, *INVTOTr,t*, is simply the sum of the investments made in each sector of the region:

$$INVTOT_{r,t} = \sum_{j,s} INV_{j,s,r,t}\ .$$

In each sector, the total supply of capital equals demand, which determines the rate of return on capital specific to this sector, *WKi,r,t*:

$$KTOT_{i,r,t} = \sum_s K_{i,s,r,t}\ .$$

Macroeconomic Constraints

In each region, total investment must be equal to total savings:

$$SAVH_{r,t} + SAVG_{r,t} - CAB_{r,t} = \sum_{i,s} PINVTOT_{s,t}\,INV_{i,r,s,t}\ ,$$

where *CABr,t* represents the current account balance, which is a constant share, *SOLDr,t,* of world GDP, *PIBMVALt*:

$$CAB_{r,t} = PIBMVAL_t\,SOLD_{r,t}.$$

[24] For a complete discussion of investment behaviour, see Decreux and Valin (2007).

World GDP is simply the sum of regional GDPs, *GDPMRr,t*:

$$PIBMVAL_t = \sum_r GDPMP_{r,t}.$$

Consistent with the system of national accounting, each region's GDP at market prices is given by the sum of payments for factors of production and for indirect taxes:

$$GDPMP_{r,t} = \sum_j PVA_{j,r,t}\, VA_{j,r,t} + \sum_i \{RECPROD_{i,r,t} + RECEXP_{i,r,t} + RECDD_{i,r,t} + RECCONS_{i,r,t}\}.$$

Finally, real GDP, *GDPVOLr,t*, is computed by dividing GDP at market prices by a consumer price index:

$$GDPVOL_{r,t} = \frac{GDPMP_{r,t}}{\prod_i PC_{i,r,t}\, pondC_{i,r}}.$$

Economic Closure

In MIRAGRODEP, every economic agent balances income and expenditures: the income of households equals the spending of households (consumption, savings, and transfers), and firms' spending (including payment for capital) equals firms' revenue. At the global level, savings must be equal to investment. At the country level, a gap between the two variables can occur due to international capital movement. Nevertheless, constraints on current account surpluses or deficits are also considered, leading to real exchange rate adjustments (determining relative international prices among economies). Furthermore, supply equals demand for all commodities and all factors in the economy.

APPENDIX B: GEOGRAPHICAL AND SECTORAL DISAGGREGATION AND CORRESPONDENCE WITH GTAP REGIONS AND SECTORS

Table B.1 Geographical disaggregation

MIRAGRODEP code	Label
ASIA	Asia
Benin	Benin
Burkina	Burkina Faso
CARICOM	Caribbean Community
CIS	Community of Independent States
CotedIvoire	Côte d'Ivoire
E28	European Union
Ghana	Ghana
LAC	Latin America
MENA	Middle East and North Africa
NAFTA	North American Free Trade Agreement
Nigeria	Nigeria
RAFRICA	Rest of Africa
RECOWAS	Rest of ECOWAS
ROW	Rest of the world
Senegal	Senegal
Togo	Togo

Source: Authors.
Note: Rest of ECOWAS includes Cabo Verde, Gambia, Guinea, Guinea Bissau, Liberia, Mali, Niger, and Sierra Leone. ECOWAS = Economic Community of West African States.

Table B.2 Correspondence with GTAP regions

GTAP code	Label	MIRAGRODEP code
AUS	Australia	ROW
CHN	China	ASIA
HKG	Hong Kong	ASIA
IDN	Indonesia	ASIA
JPN	Japan	ASIA
KHM	Cambodia	ASIA
KOR	South Korea	ASIA
LAO	Laos	ASIA
MYS	Malaysia	ASIA
NZL	New Zealand	ROW
PHL	Philippines	ASIA
SGP	Singapore	ASIA
THA	Thailand	ASIA
TWN	Taiwan	ASIA
XEA	Rest of East Asia	ASIA

Table B.2 Continued

GTAP code	Label	MIRAGRODEP code
XOC	Rest of Oceania	ROW
ARG	Argentina	LAC
AUT	Austria	E28
BEL	Belgium	E28
BGD	Bangladesh	ASIA
BOL	Bolivia	LAC
BRA	Brazil	LAC
CAN	Canada	NAFTA
CHL	Chile	LAC
COL	Colombia	LAC
CRI	Costa Rica	LAC
CYP	Cyprus	E28
CZE	Czech Republic	E28
DNK	Denmark	E28
DOM	Dominican Republic	CARICOM
ECU	Ecuador	LAC
EST	Estonia	E28
FIN	Finland	E28
GTM	Guatemala	LAC
HND	Honduras	LAC
IND	India	ASIA
JAM	Jamaica	CARICOM
LKA	Sri Lanka	ASIA
MEX	Mexico	NAFTA
NIC	Nicaragua	LAC
NPL	Nepal	ASIA
PAK	Pakistan	ASIA
PAN	Panama	LAC
PER	Peru	LAC
PRI	Puerto Rico	CARICOM
PRY	Paraguay	LAC
SLV	El Salvador	LAC
TTO	Trinidad and Tobago	CARICOM
URY	Uruguay	LAC
USA	United States of America	NAFTA
VEN	Venezuela	LAC
VNM	Vietnam	ASIA
XCA	Rest of Central America	LAC
XCB	Rest of the Caribbean	CARICOM
XNA	Rest of North America	NAFTA
XSA	Rest of South Asia	ASIA
XSE	Rest of Southeast Asia	ASIA

Table B.2 Continued

GTAP code	Label	MIRAGRODEP code
XSM	Rest of South America	LAC
ALB	Albania	CIS
ARE	United Arab Emirates	MENA
ARM	Armenia	CIS
AZE	Azerbaijan	CIS
BGR	Bulgaria	E28
BHR	Bahrain	MENA
BLR	Belarus	CIS
CHE	Switzerland	ROW
DEU	Germany	E28
ESP	Spain	E28
FRA	France	E28
GBR	United Kingdom	E28
GEO	Georgia	CIS
GRC	Greece	E28
HRV	Croatia	E28
HUN	Hungary	E28
IRL	Ireland	E28
IRN	Iran, Islamic Republic of	MENA
ISR	Israel	MENA
ITA	Italy	E28
JOR	Jordan	MENA
KAZ	Kazakhstan	CIS
KGZ	Kyrgyzstan	CIS
KWT	Kuwait	MENA
LTU	Lithuania	E28
LUX	Luxembourg	E28
LVA	Latvia	E28
MLT	Malta	E28
MNG	Mongolia	CIS
NLD	Netherlands	E28
NOR	Norway	ROW
OMN	Oman	MENA
POL	Poland	E28
PRT	Portugal	E28
QAT	Qatar	MENA
ROU	Romania	E28
RUS	Russian Federation	CIS
SAU	Saudi Arabia	MENA
SVK	Slovakia	E28
SVN	Slovenia	E28
SWE	Sweden	E28
TUR	Turkey	MENA
UKR	Ukraine	CIS
XEE	Rest of Eastern Europe	CIS
XEF	Rest of European Free Trade Association	ROW
XER	Rest of Europe	CIS

Table B.2 Continued

GTAP code	Label	MIRAGRODEP code
XSU	Rest of former Soviet Union	CIS
XWS	Rest of western Asia	MENA
BEN	Benin	Benin
BFA	Burkina Faso	Burkina
BWA	Botswana	RAFRICA
CIV	Côte d'Ivoire	CotedIvoire
CMR	Cameroon	RAFRICA
EGY	Egypt	MENA
ETH	Ethiopia	RAFRICA
GHA	Ghana	Ghana
GIN	Guinea	RECOWAS
KEN	Kenya	RAFRICA
MAR	Morocco	MENA
MDG	Madagascar	RAFRICA
MOZ	Mozambique	RAFRICA
MUS	Mauritius	RAFRICA
MWI	Malawi	RAFRICA
NAM	Namibia	RAFRICA
NGA	Nigeria	Nigeria
RWA	Rwanda	RAFRICA
SEN	Senegal	Senegal
TGO	Togo	Togo
TUN	Tunisia	MENA
TZA	Tanzania	RAFRICA
UGA	Uganda	RAFRICA
XAC	South Central Africa	RAFRICA
XCF	Central Africa	RAFRICA
XEC	Rest of eastern Africa	RAFRICA
XNF	Rest of North Africa	MENA
XSC	Rest of South African Customs Union	RAFRICA
XTW	Rest of the world	ROW
XWF	Rest of western Africa	RECOWAS
ZAF	South Africa	RAFRICA
ZMB	Zambia	RAFRICA
ZWE	Zimbabwe	RAFRICA

Source: Authors.
Note: GTAP = Global Trade Analysis Project.

Table B.3 Sectoral disaggregation

MIRAGRODEP code	Label
bevtob	Beverages and tobacco
cattle	Cattle
cereals	Cereals
cgd	Capital goods
cns	Construction
crp	Chemicals
dairy	Dairy products
ele	Electronics
ffl	Fossil fuels
fish	Fisheries
lea	Leather products
mat	Other minerals
meatc	Red meat
meato	White meat
metals	Metals
mvh	Motor vehicles
ocr	Other crops
ofd	Other food
omf	Other industries
onr	Other natural resources
osd	Oilseeds
otherAni	Other animal products
otherserv	Other services
paper	Paper products
pfb	Plant fibers
privser	Business services
pubserv	Public services
rice	Rice
sug	Sugar
tex	Textiles
trade	Trade
trans	Transportation
utilities	Utilities
v_f	Vegetables and fruits
vol	Vegetable oil
wap	Wearing apparel
woodp	Wood products

Source: Authors.

Table B.4 Correspondence with GTAP sectors

GTAP code	Label	MIRAGRODEP code
b_t	Beverages and tobacco products	bevtob
c_b	Sugar cane, sugar beets	sug
cmt	Meat: cattle, sheep, goats, horses	meatc
coa	Coal	ffl
crp	Chemical, rubber, plastic products	crp
ctl	Cattle, sheep, goats, horses	cattle
ele	Electronic equipment	ele
fmp	Metal products	metals
frs	Forestry	onr
fsh	Fishing	fish
gas	Gas	ffl
gro	Cereal grains nec	cereals
i_s	Ferrous metals	metals
lea	Leather products	lea
lum	Wood products	woodp
mil	Dairy products	dairy
mvh	Motor vehicles and parts	mvh
nfm	Metals nec	metals
nmm	Mineral products nec	mat
oap	Animal products nec	otherAni
ocr	Crops nec	ocr
ofd	Food products nec	ofd
oil	Oil	ffl
omn	Minerals nec	onr
omt	Meat products nec	meato
osd	Oilseeds	osd
otn	Transport equipment nec	cgd
p_c	Petroleum, coal products	ffl
pcr	Processed rice	rice
pdr	Paddy rice	rice
pfb	Plant-based fibers	pfb
ppp	Paper products, publishing	paper
rmk	Raw milk	cattle
sgr	Sugar	sug
tex	Textiles	tex
v_f	Vegetables, fruits, nuts	v_f
vol	Vegetable oils and fats	vol
wap	Wearing apparel	wap
wht	Wheat	cereals
wol	Wool, silkworm cocoons	otherAni

Table B.4 Continued

GTAP code	Label	MIRAGRODEP code
atp	Air transport	trans
cmn	Communication	privser
cns	Construction	cns
dwe	Dwellings	otherserv
ely	Electricity	utilities
gdt	Gas manufacture, distribution	utilities
isr	Insurance	privser
obs	Business services nec	privser
ofi	Financial services nec	privser
ome	Machinery and equipment nec	cgd
omf	Manufactures nec	omf
osg	Public administration/defense/health/education	pubserv
otp	Transport nec	trans
ros	Recreation and other services	otherserv
trd	Trade	trade
wtp	Sea transport	trans
wtr	Water	utilities

Source: Authors.
Note: GTAP = Global Trade Analysis Project; nec = not elsewhere classified.

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