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**The European Union–West Africa Economic
Partnership Agreement**

Small Impact and New Questions

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ABSTRACT

This article evaluates the economic effects of the West Africa Economic Partnership Agreement (EPA) in terms of trade, welfare, production, government revenue, and poverty. The study is based on a dynamic multicountry, multisector computable general equilibrium model (MIRAGRODEP), which includes the final details of the agreement and cutting-edge specifications to tackle important features of the reform: the existence of informal sectors in African economies, the importance of tariff revenues in total public revenues, and the implementation of a development program. A microsimulation completes the model and allows us to study the reform's poverty impact. This study shows that (1) while the reform slightly improves access to foreign markets for European producers, it does not improve market access for West Africa's least developed countries, and it does not deteriorate market access for other West African countries; (2) in our preferred scenario in terms of public closure, the implementation of an EPA between the European Union and West African countries is slightly positive for Burkina Faso and Côte d'Ivoire and negative for Benin, Ghana, Senegal, and Togo in terms of welfare; (3) the development package included in the reform does not have a significant economic impact; (4) a key element of the reform's impact is how West African countries react to the loss of public revenues implied by the implementation of free trade for imports coming from the European Union—this means that the trade agreement must be accompanied by fiscal reform in these countries.

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

JEL Classification: F11, F13, F15

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1. INTRODUCTION

Economic relations between the African, Caribbean, and Pacific (ACP) group of states and the European Union (EU) have significantly changed since the 2000 signing of the Cotonou Agreement, which launched the negotiation of the Economic Partnership Agreements (EPAs). These trade and development schemes are aimed at creating seven free trade areas between the EU and ACP countries.

Until these agreements, the EU had been criticized for establishing nonreciprocal and discriminating preferential trade agreements that were considered incompatible with the World Trade Organization (WTO) rules. According to WTO rules, preferential agreements may be granted only to either the whole group of developing countries or to the subset of least developed countries (LDCs). Implementing free trade areas was a way to both stop these criticisms and support trade and development in the ACP countries.

The EPAs were supposed to take effect in 2008, but the negotiations took much longer than expected, in part because of several elements of the reforms criticized by ACP governments, particularly those of West Africa

The first criticism was based on the observation that these trade regimes would not provide West African countries with significantly better access to foreign markets. Among these 16 countries,¹ 12 are considered LDCs² and, as such, are granted access to the EU through the Everything But Arms (EBA) initiative, which gives them duty-free, quota-free access to all goods except arms. WA's other countries (Cape Verde, Côte d'Ivoire, Ghana, and Nigeria) benefited from the Cotonou ACP preferences, but they would lose these benefits if they did not sign the EPA; in this case, their exports would fall under the Generalized System of Preferences (GSP) scheme, which is significantly less beneficial. The second criticism focused on the potential loss of public revenues associated with imports, free of any charge, of European products into West African 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 GTAP database, the EU represented 38.3 percent of Senegal's imports in 2015, 21.1 percent in the case of Benin, 33.5 percent for Burkina Faso, and 33.8 percent for Côte d'Ivoire. African countries are well known for having a restricted domestic fiscal base,³ so changes to public revenues due to the EPA could endanger the government's ability to provide public goods. In response to these fears, the EU has accepted several concessions. Concerning WA, the tariff agreement is now asymmetric: the EU implements free trade for WA's products, while West African countries only partially open their borders to European products. Moreover, the time granted to implement this reform is more gradual for African countries. Finally, the EU has promised to include a development package (DP). These concessions were successful, and the negotiations were concluded on February 6, 2014, in Brussels.

The objective of this article is to evaluate the economic effects of the WA EPA on Economic Community of West African States (ECOWAS) countries in terms of trade, welfare, production, government revenue, and poverty. This evaluation is based on the last version of the agreement, on disaggregated data on tariffs and a dynamic multicountry, multisector computable general equilibrium (CGE) model. The advantage of this methodology is its consistency; it accounts for interdependence and real income effects and is based on real data and econometric estimations of behavioral parameters. In addition, the EPA involves many countries and regions, so it is important to use a multicountry model. Since the reform is implemented gradually, we adopt a dynamic version of the model.

The CGE model used in this project is MIRAGRODEP. This is a recent version of the Modelling International Relations under Applied General Equilibrium (MIRAGE) model, developed for the AGRODEP initiative.⁴ For this study, MIRAGRODEP has been improved in three ways.

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

² Only Cape Verde, Ghana, Côte d'Ivoire, and Nigeria are not LDCs.

³ See, for example, Organisation de Coopération et de Développement Economique –OCDE– (2010) or Jacquemot (2005).

⁴ MIRAGE is a CGE model developed at the Centre d'Etudes Prospectives et d'Informations Internationales (CEPII)

1. *A dual-dual economy.* Most classical CGE studies in international trade work with simple sets of assumptions about the labor market; these assumptions are not appropriate for developing countries. Our new version of MIRAGRODEP 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 wages differentials are substantial, while trade policy reforms imply reallocation of productive factors between sectors. We adopt a model that is inspired by Stifel and Thorbecke (2003),⁵ but we design it to match the sector decomposition adopted in our CGE model.
2. *Fiscal revenues.* The topic of fiscal revenue is a key issue of these trade negotiations, in particular since West African governments are worried about losing an important source of public revenues. Consequently, a specific modeling effort has been undertaken to gauge the impact of the trade agreement on public revenues and particularly to account for existing fiscal inefficiency and to move from nominal duties to actual revenues. This research is based on MIRAGRODEP, which models a public agent separately from a private agent. Moreover, the approach prioritizes the “Consistent Aggregator Approach” for import tariffs,⁶ which allows us to capture the exclusion effects and the variance of tariffs at a detailed level. Finally, our modeling approach introduces inefficiencies in the collection of tariffs and taxes.
3. *The development program.* Finally, specific attention was paid to modeling the elements that address the Economic Partnership Agreement Development Program (EPADP), which is intended to boost African farmers’ and firms’ competitiveness.

The CGE approach is complemented by a top-down microsimulation to study the impact of this trade agreement on poverty. This analysis is based on a micro-macro distributional toolbox.⁷ The macromodel component (the CGE model) accounts for impacts of trade policies and external shocks on macrovariables and the labor market. However, this method alone is insufficient to account for impacts at the household level and to analyze the effects on income distribution. To address this gap, micromodels, which incorporate detailed information at the household level, are linked to the macromodel. This method captures most of the channels through which trade policies and external shocks affect the economy at the macrolevel and at the same time incorporates microdata that account for distributional impacts at the microlevel (household level).

To evaluate the poverty impact of the agreement, the microsimulation exercise is conducted for two countries: Nigeria (based on 2011 household surveys) and Ghana (based on 2005–2006 household surveys). Microsimulation exercises require household surveys that include an income module, as most of the impact of trade liberalization on poverty passes through the income channel.⁸

This study reaches several conclusions. Concerning border liberalization, the gains in terms of access to foreign markets are limited or nil for West African countries, especially West African LDCs. For non-LDCs, most of the gains in terms of 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, in our evaluation we implement the application of the GSP tariffs by the EU on products coming from West African countries in the baseline, while these tariffs are removed in the scenario describing the implementation of the EPA.

between 2001 and 2004 for trade policy analysis.

⁵ See also Bouët, Dienesch, and Fall (2013).

⁶ See Laborde, Martin, and van der Mensbrugge (2011).

⁷ See www.agrodep.org/model/micro-macro-distributional-analysis-toolbox.

⁸ See Winters (2002); Winters, McCulloch, and McKay (2004); and Bouët, Estrades, and Laborde (2013).

Concerning the economic impact of this reform, under our preferred scenario in terms of public closure (a lump-sum tax is implemented in compensation for variations in public revenues), the reform is positive only for Burkina Faso and Côte d'Ivoire in terms of welfare. This raises several new policy issues.

First, the effects of the EPA on West African countries are small; this reflects not only the small improvement in access to foreign markets obtained by West African countries under the agreement but also the lack of ambition of the EPADP.

A second issue is how West African countries react to the loss of public revenues implied by the implementation of free trade for imports coming from the EU. A sensitivity analysis conducted on the public closure of the model leads to different evaluations. Therefore, our analysis clearly illustrates the need for a fiscal reform in these countries.

This study is important for two reasons. First, it conducts a new evaluation of the EPA between the EU and West African countries based on the final details of the agreement.⁹ As stated previously, the EU recently gave some concessions to West African countries to get their approval of the deal; no study has incorporated these modifications.

Second, this evaluation is based on a dynamic multiregion, multisector CGE model with cutting-edge 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. These specifications are particularly adapted to West African countries and to the evaluation of a trade agreement that may lead to losses in public revenues. Moreover, trade reforms imply reallocation of production between sectors, and how such changes are distributed across formal, informal, rural, or urban sectors is an important implication. Therefore, it is important to design analytical instruments capable of tackling these mechanisms.

The background of this study is presented in section 2, while Section 3 explains the methodology. Section 4 presents the results, and Section 5 presents our sensitivity analysis. Section 6 concludes.

⁹ These details were provided by the European Commission–DG Trade.

2. BACKGROUND

The EPA between West Africa¹⁰ and the EU involves the EU and its member states, 16 West African countries, ECOWAS, and the West African Economic and Monetary Union (WAEMU). The EPA was launched on June 30, 2014, in Ouagadougou, Burkina Faso. It includes (1) free market access to the EU for all West African products as soon as the agreement enters into force; (2) a partial and gradual opening of the West African market; (3) protection of WA's sensitive agricultural products from European competition by keeping tariffs in place or, when necessary, by imposing safeguard measures; (4) no subsidization of any European agricultural exports to WA; (5) flexible rules of origin for West African companies; and (6) a development assistance package (EPADP) to complement market-opening efforts. The commercial relationship between the EU and ACP countries was previously based on the various Lomé conventions that began in the 1970s; under these agreements, the EU provided nonreciprocal trade preferences to ACP countries. However, the preferences granted to ACP countries were deemed discriminatory and not compatible with WTO rules as they were granted only to ACP countries and not to other developing-country WTO members. The EPAs, which form the trade component of the Cotonou Agreement between the EU and ACP countries, signed in June 2000, aim at addressing these issues and were supposed to replace the unilateral trade preferences by the end of 2007. The EPAs define a new framework based on the principle of reciprocity and are compatible with WTO rules (particularly the provisions of General Agreement on Tariffs and Trade Article XXIV about the Most-Favored-Nation treatment).

The Cotonou Agreement was set in place to cover a 20-year period (2000–2020) with a transitory period that ended in December 2007. As the preferences granted to ACP countries were not compatible with WTO provisions, the EU was granted a waiver in 1996, extended in 2001 to 2007, under the condition that the discriminatory regimes would be replaced by WTO-compatible rules such as free trade agreements and nondiscriminatory treatment under the GSP. During this transitory period, the EU negotiated with the six ACP regions¹¹ and came up with seven interim agreements establishing free trade areas that covered substantially “all the trade” between the EU and the concerned countries.¹² However, 41 of the 77 ACP countries did not sign an interim agreement, partly because of the principle of differentiation and conflicting interests between LDCs and non-LDCs (Hinckle and Schiff 2004).¹³ Among the nonsignatory group, 31 LDCs preferred to remain under the EBA initiative that provided them duty- and quota-free access to the EU market. The remaining countries that did not sign the agreement were eligible for the standard GSP.

The Caribbean region was the first group that in 2008 fully signed a comprehensive EPA with the EU; this agreement included investment and trade in services. On July 15, 2014, the EU concluded negotiations with the Southern African Development Community group composed of Botswana, Lesotho, Mozambique, Namibia, South Africa, and Swaziland. Negotiations with WA were closed on February 6, 2014, in Brussels. Other regions have either just concluded an agreement (East African Community) or are still negotiating (Eastern and Southern Africa, Central Africa, and the Pacific). However, some countries, such as Cameroon in Central Africa or Fiji in the Pacific region, are applying interim agreements even though the regions they belong to have not yet reached an agreement with the EU. Table 2.1 highlights the current status of the negotiations at the regional levels as of March 2015.

¹⁰ What we call West Africa now consists of the set of 16 countries established in note 1.

¹¹ These include ECOWAS, the Communauté Économique et Monétaire des États de l'Afrique Centrale, the Common Market for Southern and Eastern Africa, the Southern African Development Community, the Caribbean Forum, and the Pacific group.

¹² ACP countries could negotiate either individually or as groups depending on their regional specificities in terms of integration.

¹³ Some custom unions, such as WAEMU, have both LDCs and non-LDCs.

Table 2.1 Overview of regional Economic Partnership Agreement (EPA) negotiations

Region	Status of the negotiations
West Africa	An agreement was concluded in June 2014, and the final document was endorsed by Economic Community of West African States heads of states in July 2014 for signature.
Southern African Development Community EPA Group	An agreement was concluded in July 2014.
East African Community	An agreement was concluded in October 2014 and is under scrutiny for signature in August 2015.
Eastern and Southern Africa	Negotiations are still ongoing. Mauritius, Seychelles, Zimbabwe, and Madagascar signed an interim agreement in 2009, which has been provisionally applied since 2012.
Central Africa	The negotiations are still ongoing. Cameroon was the only country in the region to sign an interim agreement in 2009 and to ratify it in 2014.
Pacific	Talks are still ongoing. Papua New Guinea signed an interim agreement in July, and Fiji signed in December 2009. Papua New Guinea ratified in May 2011, and Fiji has been provisionally applying the agreement since July 2014.
Caribbean	An EPA between the European Union and the Caribbean Forum of the African, Caribbean, and Pacific Countries (including trade in services) was signed in October 2008.

Source: European Union DG trade.

Negotiations with WA formally began in 2003 and were conducted at the regional level between the EU and ECOWAS plus Mauritania and WAEMU. In the meantime, Côte d'Ivoire and Ghana agreed to an interim EPA with the EU in 2007 to avoid the disruption of their exports at the end of the second waiver granted to the EU by the WTO; only Côte d'Ivoire signed the interim agreement in 2008. At the regional level, after a series of back and forth due to ECOWAS's internal issues related to the adoption of the CET, the three parties (EU, ECOWAS, and WAEMU) formally endorsed an agreement in July 2014 at the 45th session of the Conference of Heads of State and Government of ECOWAS held in Accra.¹⁴ It is worth noting that concluding an agreement before October 1, 2014 (the end of the EU Market Access Regulation), was of great importance as any non-LDC country that had not ratified the agreements concluded in 2007 or had not concluded a new regional agreement would fall automatically under the GSP that will remove trade preferences to middle-income countries in 2016.

In its current version, the agreement between the EU and WA is established on an asymmetric basis in terms of both products covered and timing. The EU has agreed to open its market to all West African products as soon as the agreement enters into force. In exchange, West African countries will gradually liberalize 75 percent of their trade with the EU during a 20-year period. These countries will also have more flexibility in terms of foreign components in their exports to Europe; they will be able to use materials sourced from other countries without losing the benefit of free access to the EU market. West African countries also maintain the ability to protect their markets for sensitive products by keeping current tariffs or by imposing safeguard measures when necessary; in addition, the agreement leaves room for future negotiations on services.

Unlike in the agreements with other ACP regions, the EU also has committed to support West African countries with a €6.5 billion development assistance package covering the period from 2015 to 2020.¹⁵ This EPADP, often referred to by its French acronym PAPED,¹⁶ aims to support West African

¹⁴ The Conference and the 46th ordinary summit held in Abuja explicitly called for the signing of the agreement and its ratification by all member states. The main concerns are being raised by Nigeria, Togo, Gambia, Sierra Leone, and Mauritania.

¹⁵ However, there are some opportunities for other regions throughout the 11th European Development Fund.

¹⁶ That is, Programme Accord de Partenariat Economique pour le Développement.

countries throughout the liberalization process so as to achieve the agreement's development goals. The main components of the program consist of removing supply-side constraints by increasing productive capacities, improving national and regional trade-related infrastructure, and strengthening subregional trade. These thematic areas are in concordance with WTO aid-for-trade categories. The EU also has committed to assisting its African partners in the fiscal transition process, as the loss of tariff revenues is a key challenge for these countries. Overall it is expected that the development program will help African countries take full advantage of the EPA while reducing its negative effects.

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 focusing on trade flows, fiscal revenues, welfare, economic growth, and regional integration. Table 2.2 provides a summary of the main studies that have addressed the topic.¹⁷

Table 2.2 Summary of the main studies

Authors	Region(s) covered	Methodology used
Ndlela and Tekere (2003)	SADC	PE modeling
Busse, Borrmann, and GroBmann (2004)	ECOWAS+	PE modeling
Milner, Morrissey, and McKay (2005)	EAC	PE modeling
Karingi et al. (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 the 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 as they use different methodologies, datasets, parameters, baselines, and country coverage. However, overall, these studies find that given the asymmetry between current protection rates and the discrepancies in terms of economic performance between the two groups of countries, 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 GroBmann 2004; Karingi et al. 2005; Perez 2006; Berisha-Krasniki, Bouët, and Mevel 2008; Fontagné, Laborde, and Mitaritonna 2011). EU exporters thus appear to be the main beneficiaries of the agreement.

These studies also highlight the trade diversion effects for 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 that 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 be limited mainly to a few agricultural products, which are currently protected by the EU (particularly dairy products, sugar, and meat).

¹⁷ 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.

Some simulations 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); however, on the other hand, further gains could arise from intraregion liberalization for most countries while the EPAs take place (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 to both the elimination of custom duties on imports from EU and 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 increasing the capacity of ACP countries to reorganize their fiscal base toward internal direct and indirect taxation.

Finally, some of the studies that use general equilibrium models (Perez 2006; Berisha-Krasniki, Bouët, and Mevel 2008; Keck and Piermartini 2008) also address 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 CGE approach is that it conducts a more thorough welfare analysis, while the PE models capture only trade creation and diversion effects.¹⁸ In this regard, most of the studies find either a negative or a positive but limited impact in terms of welfare for ACP countries.

¹⁸ Milner, Morrissey, and McKay (2005) is an exception, performing a thorough short-run welfare analysis using a partial equilibrium model.

3. THE MODEL

We now present the general features of the model on which this evaluation is based. Appendix A includes a complete technical presentation of the model.

MIRAGRODEP

MIRAGRODEP is a CGE model based on MIRAGE. It is a recursive dynamic multiregion, multisector model. MIRAGE was initially developed at CEPII and is devoted to trade policy analysis.

As opposed to a single-country CGE model, a multicountry CGE model allows for a detailed and consistent representation of economic and trade relations with the rest of the world. International economic linkages are captured through the international trade of goods. A dynamic version of the model is used by solving the model sequentially and moving the equilibrium from one year to another. In our study, we assume perfect competition in all sectors, which enables us to have a detailed geographic and sector decomposition.

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. The government is supposed to maximize a Cobb-Douglas utility function: government spending on each commodity is a fixed share, in value, of total public expenditure in goods and services. Government purchases are subject to taxes.

The Consistent Tariff Aggregator approach¹⁹ has been implemented in MIRAGRODEP. This is an important element of the model since the project will be conducted at a relatively low level of sector disaggregation (37 sectors); in terms of import tariffs, it is often stated that the devil is in the details. The Consistent Tariff Aggregator approach allows us to take into account the variance of tariffs at the tariff line level.

Social Accounting Matrix (SAM) and trade data in MIRAGRODEP are based on GTAP 8.1 (Narayanan and Walmsley 2008). The GTAP database is a fully documented global database that contains complete bilateral trade information, transport, and protection linkages among 130 regions for all 57 GTAP commodities for 2007.

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

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: either a model is neoclassical and assumes savings determines investment, or a model is Keynesian and assumes investment determines savings. The MIRAGRODEP model is neoclassical: 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 (the current account includes exports and imports of goods and services plus public and private transfers from or to the rest of the world). The current account balance could be affected by a trade agreement since this policy reform entails a variation of border tariffs and consequently a variation of imports and exports. One option is to suppose that the current account balance varies and the real exchange rate is unaffected by the reform. A second option is to suppose that the real exchange is affected by the reform in such a way that the current account balance is constant. The adjustment of the real exchange rate could take place through an adjustment of the nominal exchange rate (devaluation, depreciation) or through different evolutions of domestic prices in the different regions (that is, competitive disinflation).

¹⁹ See Laborde, Martin, and van der Mensbrugghe (2011).

The first option (rigidity of the real exchange rate and modification of the current account surplus or deficit) has two significant disadvantages. If a country's current account balance, which includes the trade balance, is modified by the reform, this means that the adjustments in the upper part of the balance of payments have to be compensated for by a modification of the capital and financial account balance. The problem is that MIRAGRODEP does not model financial markets,²⁰ so there is no explicit representation of how capital flows will be reallocated at the global level following the agreement or how the sovereign risks of the countries, and the propensity of investors to allocate resources to these countries, will evolve.

Second, assuming that a current account balance can vary without constraints means there is no limitation in the import increase. The country consumption, and welfare, is "subsidized" through transfers from the rest of the world; therefore, a welfare analysis is biased: increasing the external debt has no negative consequence on welfare, while the additional imported consumption increases welfare.

The second option (exogenous behavior for the current account surplus or deficit, by default) implies that the real exchange rate is adjusted in such a way that the current account balance is stable (in the model expressed as a percentage of global gross domestic product [GDP]). In a nutshell, when the first-order effect of the reform is increasing imports (higher tariff reduction on the import side than on the export side), the real exchange rate is depreciated such that the competitiveness of this country is improved to ensure that additional imports will be compensated for by additional exports in value, in the long term. Conversely, when the first-order effect of the reform is increasing exports, the real exchange rate is appreciated such that the competitiveness of this country is deteriorated. The key advantage of this assumption is that we can conduct a welfare analysis that is fully representative of how the reform has affected a country's real situation. It also provides a long-run assumption consistent with the CGE analysis.

The government or public account closure assumption concerns how the public balance is affected when taxes are changed by a reform. There are several options:

1. When taxes, for example, public revenues coming from import tariffs, are decreased, it is possible to not change anything in the public budget. With other tax rates constant and public expenditures (including investment) constant, this implies a growing public deficit and leads to more borrowing from the public sector; since the current account balance is stable, no external savings will finance this growing public deficit. Consequently, it is the private sector that will have to finance the public sector. Since domestic private savings are also assumed to remain stable (no change in people's propensity to save), there is less funding for private investment, which leads to less economic activity in the future. This is the "crowding-out effect" of raising public deficit.
2. Suppose that the public deficit/surplus is constant. In this case, when one source of revenue for the public agent is reduced, then there are two options: either there is another tax which is increased to compensate for lost public revenues on import tariffs or public expenditures are reduced in such a way that the government account balance is constant.

This last assumption may be interpreted as fewer public expenditures leading to fewer public goods; thus, private agents' welfare is reduced since the public sector provides either fewer health services or fewer education services, for example. In this study, we assume that each government maintains the public balance constant and that after a shock that reduces custom duties, a lump-sum tax (either negative or positive) is established to maintain real public expenses per capita constant while public sold is constant in percentage of GDP.

With this assumption, the level of public services in each country is constant, and there is no variation of public sold and no associated crowding-out effect on private investment. Of course, this policy option may not appear realistic since a lump-sum tax is regressive. However, this scenario is worth being studied since a lump-sum tax is efficient in the sense that it does not interfere with market

²⁰ Other multicountry CGEs face the same problem.

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.

This assumption may be criticized since a lump-sum tax may be considered politically unrealistic and may be more damaging for the poorest households. This is why we conduct a sensitivity analysis that includes other 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. We also consider a case in which public expenses adjust such that the public sold is constant.

Specific Model Features for This Study

To better tackle the specific features of the topic of this study, three innovations are implemented in MIRAGRODEP. In this section, we present these innovations before presenting the poverty analysis and the data used in the model.

The Dual-Dual Hypothesis

To better model West African economies, the CGE model framework was modified in the representation of the labor market to reflect a “dual-dual economy.” This expression is borrowed from Stifel and Thorbecke (2003) and refers to the double dichotomy between urban and rural areas and formal and informal sectors. Many of the classical CGE studies in international trade use simple sets of assumptions about the labor market that are not appropriate for developing countries, assuming especially fixed or uniform labor supplies. To address this, our CGE model presents a mechanism that endogenizes labor supply and a labor-market segmentation that is based on a distinction between both unskilled and skilled workers and rural and urban activities. As highlighted by Stifel and Thorbecke, 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, while urban sectors are divided into formal (mainly manufacturing) or informal (services). The MIRAGRODEP model also will be run with traditional assumptions concerning labor markets to evaluate how these new assumptions change our understanding of the impact of trade liberalization.

In countries with dual-dual modeling (that is, West African countries), skilled workers are employed only in formal sectors; however, amid these formal sectors, they may decide to migrate between urban and rural sectors. Skilled workers get better salaries in urban areas, and the salary gap is constant. There may be different explanations for this prevailing 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 utility, which depends on the number of the union’s members and the level of salary given to its members. This 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:

$$WHu_{r,t} = WHr_{r,t}(1 + gap_{hr}) \quad (1)$$

$$Hu_{r,t} + Hr_{r,t} = \bar{H}_{r,t} \quad (2)$$

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

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

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 , a constant positive parameter; $Hu_{r,t}$ the total demand for skilled labor in urban sectors in country r at time t ; $Hr_{r,t}$ the total demand for skilled labor in rural sectors in country r at time t ; and $\bar{H}_{r,t}$ the total supply of skilled labor in country r at time t .

Concerning unskilled workers, wages are lower in informal sectors than in formal sectors. There are potentially different explanations for this gap: 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 modelling:

$$WLR_{formal_{r,t}} = Prob_{Lu_{formal_{r,t}}} WLu_{formal_{r,t}} + [1 - Prob_{Lu_{formal_{r,t}}}] WLu_{informal_{r,t}} \quad (5)$$

$$Prob_{Lu_{formal_{r,t}}} = cp_r \frac{Lu_{formal_{r,t}}}{Lu_{informal_{r,t}} + Lu_{formal_{r,t}}} \quad (6)$$

$$Lu_{r,t} + Lr_{r,t} = \bar{L}_{r,t} \quad (7)$$

$$Lu_{formal_{r,t}} + Lu_{informal_{r,t}} = Lu_{r,t} \quad (8)$$

$$Lr_{formal_{r,t}} + Lr_{informal_{r,t}} = Lr_{r,t} \quad (9)$$

$$Lu_{formal_{r,t}} = \sum_{formal(i,r)} Lu_{i,r,t} \quad (10)$$

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

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

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

$$WLu_{formal_{r,t}} = WLu_{informal_{r,t}}(1 + \delta u_r) \quad (14)$$

$$WLR_{formal_{r,t}} = WLR_{informal_{r,t}}(1 + \delta r_r) \quad (15)$$

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 ; $WLR_{informal_{r,t}}$: the remuneration of unskilled labor in rural informal sectors in country r at time t ; δu_r : a positive constant; δr_r : a positive constant.

Tariff Aggregation and Tariff Revenues

Our model adopts two specific procedures to aggregate tariffs and calculate tariff revenues. First we apply the optimal aggregator method developed by Laborde et al. (2011), which was designed for CGE models with a few sectors and partners rather than the real-world scenario of many countries and many commodities. This method is based on the availability of detailed information about trade and tariffs and reflects the fact that different aggregators are needed for expenditures on imported goods and for tariff revenues (for a detailed explanation, see Laborde et al. 2011).

The second procedure allows us to properly capture the fiscal costs for West African countries by introducing an explicit set of parameters to represent the efficiency of the tax collection system. Most African economies have a relatively low rate of effective tax collection; thus, considering the tariff revenue to be equal to the product of nominal tariff and trade flows is a huge overestimation. When available, we use a country-sector-specific efficiency ratio; otherwise, we use a country-level efficiency ratio and aim to duplicate effective tariff revenues as indicated in International Monetary Fund financial reports.

The Development Package

In addition to having a market access component, the EPA between WA and the EU includes a DP known as EPADP. This 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 (for example, productivity increase and reduction of trade costs) of the model. We propose the following approach to represent this program: a DP is included in both the baseline and the scenario since the European Commission intends to adopt a DP regardless of the result of the negotiations. The DP is more education oriented in the baseline and is more trade oriented in the scenario—see section 3 for more details.

The Poverty Analysis

We also implement a poverty analysis using a top-down microsimulation approach that feeds the inputs from the macromodel (changes in prices and returns to factors) into a micromodule. This approach gives the first-round effects of the exogenous policy change at the household level. The advantage of a top-down microsimulation is that there is no need to reconcile data from the macromodel with data from the household survey. The micro-macro distributional toolbox developed at the International Food Policy Research Institute²¹ was used for this purpose.

As 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. The counterfactual changes for labor market parameters (participation rate, unemployment, employment composition by sector, wage structure) are then imposed on the data using a sequential random procedure consistent with the macromodel. It is assumed that individuals comply with the following sequence: the individual first decides whether to participate in the labor market; then the market decides whether that individual will be employed. In the third stage, the person decides in which sector to work, and this determines a certain wage level.

Since 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

²¹ See Estrades (2013).

inequality indicators. The main difference between the nonparametric and the microaccounting approach, which drives the results, is changes in employment status.

Data

The MIRAGRODEP model is mainly built on the GTAP database. We first rely on the GTAP 8.1 database, which is the latest version available. This database contains the social accounting matrixes for eight West African countries (Benin, Burkina Faso, Ghana, Côte d'Ivoire, Niger, Nigeria, Senegal, and Togo).

The model is based on a geographical and sectoral disaggregation that includes 17 regions and 37 sectors. Lists of these regions and sectors are presented in Appendix B, with correspondences to GTAP regions and sectors. Among the 37 sectors, there are 14 agricultural and food sectors and four primary nonagricultural sectors. Among the 17 regions, there are eight countries or regions from ECOWAS and two regions from Africa but not from ECOWAS.

In the developing countries on which this study focuses, that is, Benin, Burkina Faso, Côte d'Ivoire, Ghana, Nigeria, Senegal, and Togo as well as the Rest of ECOWAS region, informal sectors have been selected after a review of the literature²² 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 these countries of interest, formal sectors are the “other” sectors, while in all other countries, all sectors are formal.

Poverty analysis requires two elements. First, the household surveys must be relatively recent and publicly available. Second, they should include an income module to run the microsimulation model. Unfortunately, most household surveys focus only on expenditures (consumption) and seldom include the income component. Taking into account all these constraints, two countries were selected for a microsimulation exercise:

- Nigeria: the microsimulation is conducted using the General Household Survey carried out in 2010–2011
- Ghana: the microsimulation is conducted 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).

Baseline and Scenario

A baseline is designed in terms of market access. Starting from a 2007 database, this baseline involves the EU GSP reform starting in January 2014, the ECOWAS Common External Tariff (CET), and some transitory measures as defined in the new ECOWAS regulation. It also includes the other EPA signed with third countries (ACP) and specific preferences granted by the EU to Central American countries. This new 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. In the baseline, GSP prevails for Ghana, Côte d'Ivoire, Cape Verde (after the phasing out of the LDC status), and Nigeria. Other countries benefit from the EBA preference.

We implement all the changes at the eight-digit basis using a new tariff database based on TARIC for the EU (with information about both the partner and the regime). We consider that either the ACP regime or the intermediate EPA regime is removed; the second-best option in terms of tariff level is kept.

²² See Benjamin and Mbaye (2012) and de Vreyer and Roubaud (2013).

EPADP consists of an “envelope” of €1.3 billion per year from 2015 to 2035 given by the European Commission. This envelope is given to ECOWAS countries both in the baseline and in the scenario; however, while in the baseline it is allocated 50 percent to trade infrastructure and 50 percent to general assistance (education, health, economic reform, and so forth), it is allocated 100 percent to trade infrastructure in the scenario.²³

We expect this package to have two impacts. First, in terms of demand, the package represents new expenditures financing demand to 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 skilled labor force and unskilled labor force concerning the general assistance program (this augments the skilled labor and decreases the unskilled labor force), while they reduce trade costs when allocated to trade infrastructure.

The magnitude of these impacts also has to be selected: by how much will one Euro 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 2000; Hansen and Tarp 2001; Rajan and Subramanian 2005),²⁴ we base our approach on our preferred reference (Hansen and Tarp 2001) and calibrate these effects such that a 1 percent increase in the ratio of aid to GDP augments the GDP by 0.15 percent.

We do not expect the EPADP to have much impact for two reasons:

1. The annual envelope (€1.3 billion) represents, in 2013, 0.2 percent of the total GDP of the ECOWAS region (\$755.6 billion,²⁵ according to the World Development Indicators).
2. This envelope is given in both the baseline and the scenario. Since we estimate the impact of this agreement using a comparison between the scenario and the baseline, the results will tackle the reallocation of only half of these funds from general assistance to trade infrastructure.

Section 4 presents the results of our simulation, including tariff reform and the DP, under the following assumptions: dual-dual modeling and public closure where a lump-sum tax is implemented such that real public expenses per capita are constant and public deficit is constant in percentage of GDP.

Since we adopt a new model consisting of a representation of rural-urban mobility and of labor reallocation between formal and informal sectors (dual-dual model), in section 5 we conduct a sensitivity analysis of the same policy scenarios without the dual-dual assumptions to see if this significantly modifies the results. We also check the importance of the DP by simulating the same exercise without the DP, and we conduct another sensitivity analysis concerning the public closure.

²³ This information was obtained from the EU Commission–DG Trade.

²⁴ It should be noted that this literature does not provide a consensus. For example, Burnside and Dollar (2000) conclude that aid has a conditional positive impact, while Easterly, Levine, and Roodman (2003) do not find any significant impact.

²⁵ All dollars are US dollars.

4. RESULTS

We first present how the implementation of the EPA modifies protection at the border; we then evaluate how these changes in protection affect the main countries' exports, imports, and public revenues. Then we turn to production at the sector level and the remuneration of productive factors, and we evaluate how this reform changes the allocation of labor in ECOWAS countries between rural and urban sectors and between formal and informal sectors. Finally we provide estimations concerning macroeconomic variables like GDP and welfare of the representative agent as well as concerning poverty results from the microsimulation exercise.

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 4.1 and 4.2. 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, the 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 4.1 Protection applied on all imports from all origins, baseline and scenario, 2012 and 2035 (in percentages)

Country/Region	2015			2035		
	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: B = baseline; S = scenario; ECOWAS = Economic Community of West African States.

Table 4.2 Protection faced by all exports, baseline and scenario, 2012 and 2035 (in percentages)

Country/Region	2015			2035		
	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: B = baseline; S = scenario; ECOWAS = Economic Community of West African States.

We do not adopt bilateral imports as weights to calculate an average duty applied on imports or an average duty faced by exports since these are endogenous weights; bilateral imports depend directly on tariffs, and thus, the higher the tariff, the lower are the imports. When a tariff is so high that it prohibits imports, the weight would be zero. 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 (0.6 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. Concerning non-LDCs from ECOWAS, import duties conceded to these countries by the EU were relatively low under the Cotonou 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 products coming from the EU on a limited range of goods, 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 region. 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 by Table 4.2. 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 region (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; as far as the EU is concerned, this decrease is delayed.

Consequently, this trade agreement entails an asymmetric opening of trade borders. West African countries open their borders to European products more than the EU opens its borders to West African countries. Concerning LDCs from ECOWAS (Benin, Burkina Faso, Senegal, and Togo), the trade agreement does not imply any improvement of access to foreign markets since 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. Concerning non-LDC ECOWAS countries (Côte d'Ivoire, Ghana, and Nigeria), the EPA results in more West African openness to European products than EU openness to West African products. The reduction of the EU's protection on imports is close to zero, while the EU gets a small but significant improvement in access to foreign markets at 3 bp.

Table 4.3 indicates the protection applied on goods by the country in each column on products originating in the country in each row. This is 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, while it is 8.5 percent in the scenario.

The EPA is essentially a free trade area. In a classical and influential study, Viner (1950) points out two effects from 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. This 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 4.3), we see that trade creation may be insignificant since tariff barriers on the EU's side are low. On the West African side, initial tariff barriers on EU products are significant, but their elimination may either create trade or divert trade since barriers remain at the same level on products originating from partners other than the EU and WA.

Table 4.3 Protection on goods imposed by country (in columns) on imports coming from country (in rows), baseline and scenario, 2035 (in percentages)

Variable	Asia		Benin		Burkina Faso		CARICOM		Community of Independent States		Côte d'Ivoire		European Union		Ghana		Latin America	
	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
European Union	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 America	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
MENA	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
Rest of the world	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 4.3 Continued

Variable	Middle East and North Africa		NAFTA		Nigeria		Rest of Africa		Rest of ECOWAS		Rest of the world		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
European Union	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 America	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
MENA	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
Rest of the world	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: B = baseline; CARICOM = Caribbean Community; Com. of Indep. States = 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; S = scenario. Weight is world imports.

Products exported by the EU to West African 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 region by 27 bp.

This confirms that the trade agreement entails an asymmetric opening of trade borders, to the disadvantage of West African countries.

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

Table 4.4 indicates the variation of protection implied by the EPA in 2035 on the EU's exports to West African countries. The sectors in which Europe benefits most from improvements in access to West African markets are fisheries (particularly in Benin, Burkina Faso, and 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 4.4 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 mineral	-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
Textile	-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: ECOWAS = Economic Community of West African States. Exporter is European Union.

Concerning the protection applied by Europe on products from West African countries by sector (Table 4.5), the sectors in which West African 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 4.5 Variation in protection by sector, scenario/baseline, 2035 (in percentages)

Sector	Burkina		Côte d'Ivoire	Ghana	Nigeria	Rest of		Togo
	Benin	Faso				ECOWAS	Senegal	
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: ECOWAS = Economic Community of West African States. Importer = European Union.

Impact of the Reform on Tariff Revenues and Trade

A cut in import tariffs has a direct effect on trade and tariff revenues. Table 4.6 indicates the impact of the reform on exports and imports by country (or region) in 2035 and in volume. This table gives an estimation of the trade impact of the reform on the seven countries included in the Rest of ECOWAS region (Gambia, Guinea, Guinea Bissau, Liberia, Mali, Niger, and Sierra Leone). As discussed in sections 2 and 3, the model nomenclature includes seven individual countries and a Rest of ECOWAS aggregate. This choice was driven by the lack of reliable SAMs for the remaining countries; if some of these countries have available SAMs, these data are in reality based on old input-output structures (for example, 1990 for Gambia) or highly aggregated data (for example, four sectors). In both cases, the data do not guarantee the degree of relevance and reliability we want to have to build a high-quality CGE analysis at the country level.

Table 4.6 Impact of the reform on total trade by country, all sectors, constant US dollars, 2035 (in percentages)

Region	Exports	Imports
Rest of the world	0.0	0.0
Asia	0.0	0.0
NAFTA	0.0	0.0
Latin America	0.0	0.0
CARICOM	-0.1	-0.2
European Union	0.1	0.1
Community of Independent States	0.0	0.0
Middle East and North Africa	0.0	0.0
Nigeria	1.3	1.1
Senegal	3.7	1.5
Benin	2.5	0.7
Burkina Faso	2.6	3.2
Côte d'Ivoire	2.5	3.3
Ghana	2.9	1.6
Rest of ECOWAS	1.5	0.6
Togo	1.3	0.4
Rest of Africa	0.0	0.0
Guinea	1.1	6.6
Gambia	5.7	-2.1
Guinea-Bissau	2.1	-3.3
Liberia	1.5	10.6
Mali	2.5	-5.3
Niger	1	-4.6
Sierra Leone	0.6	1.2

Source: Authors' calculation.

Note: CARICOM = Caribbean Community; ECOWAS = Economic Community of West African States; NAFTA = North American Free Trade Agreement.

Having average results for this group of countries provides a good compromise between relevant results and data constraints. Two sources of data are especially reliable for the countries included in this group: trade flows, especially due to the use of mirror trade flows (for example, using COMEXT²⁶ for monitoring bilateral trade between Sierra Leone and the European Commission), and tariffs (existing trade policy review of the WTO, existing regional CET for the WAEMU countries, datasets provided by the EU DG Trade). Therefore, it is possible to use a top-down approach based on this information to disaggregate some indicators of the CGE results. In addition, this approach is not limited to a proportional allocation based on initial shares, as it is commonly done in the literature. Using the consistent policy aggregator gives us the explicit shift in shares, in terms of both trade and tariff revenue, occurring at the country and product levels. So it is possible to accurately and consistently see how the respective shares for each individual country evolve within the aggregate both in the baseline and in the different scenarios compared to the base year. These shares are used to disaggregate both trade and tariff revenue of the model.

²⁶ COMEXT is a database on international trade designed by Eurostat.

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 obtain a significant variation in exports and imports (Table 4.6). Liberia's imports are augmented by 10.6 percent, Gambia's exports by 5.7 percent, Senegal's exports by 3.7 percent, and Burkina Faso's imports by 3.2 percent in 2035, while the EU's exports and imports are raised by only 0.1 percent. This is related to asymmetry in country size.

It has been stated frequently that the exports and imports of some African countries are too concentrated from a geographic point of view, 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 West African countries, however. For example, for Burkina Faso, this share is only 5.6 percent.

Whatever this share, the EPA leads WA's countries to concentrate their exports toward the EU (Table 4.7). Concerning 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. Other destinations are not presented in Table 4.7 since in their case, the variation is close to 0. The conclusion is similar concerning imports.

Table 4.7 Impact of the reform on bilateral trade in value, FOB (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	22.5	18.8	20.2	29.2	18.4	29.9	34.1	21.7
Nigeria	2.4		-10.5	-0.4	-5.5	-2	-23.1	-0.5	-0.1
Senegal	3.1	0		-0.7	1.2	0.9	0.2	-1	-0.7
Benin	3.2	-0.4	-4.1		-1.8	-0.9	0	-2.1	-1.2
Burkina Faso	2.1	-1.5	-10.7	-2.5		-7.3	-0.8	-1.3	-2.1
Côte d'Ivoire	11	-4.1	-5.1	-2.8	-7.6		-5.1	-3.2	-2.6
Ghana	7.3	-1.5	-4.7	0	-2.4	-3.2		-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	

Source: Authors' calculation.

Note: ECOWAS = Economic Community of West African States. Exporters are in rows and importers in columns.

However, the EPA has a different impact on ECOWAS countries depending on whether they are LDCs. In the case of a non-LDC country like Côte d'Ivoire, for example, the EPA implies a decrease of European protection on products exported (from 3.1 percent to 0 percent in 2035; Table 4.3) while trade barriers on Côte d'Ivoire's products remain at the same level in other places (Table 4.3). 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 the North American Free Trade Agreement by 0.3 percent; these figures are not presented in Table 4.3).

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 increases Senegal's imports and could deteriorate the current account balance. Since the model assumes that Senegal's current account balance remains constant, this implies 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 the North American Free Trade Agreement by 2.9 percent; these figures are not presented in Table 4.7.

On a large-sector level (agrofood, industry, services), Table 4.8 shows how trade is affected for the main countries/regions of concern. Any rate of variation may be misleading since it can correspond to

a small initial value: for example, Nigerian exports in the agrofood sector augment by 7.2 percent in 2035 due to the implementation of EPA, but in the baseline in 2035, agrofood exports represent only 0.5 percent of total Nigerian exports of goods and services.

Table 4.8 Impact of the reform on exports and imports in value by country and large sectors, scenario and baseline, 2035 (in percentages)

Country/Region	Exports			Imports		
	Agrofood	Industry	Services	Agrofood	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: ECOWAS = Economic Community of West African States.

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

Table 4.9 shows how exports by sector in the main study countries vary, first by a rate of variation (in value, in percentages, and in 2035) and second in variation in US\$ millions.

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, since this country's protection on European products decreases by 708 bp (see Table 4.4), and Ghana, since its protection on European products decreases by 709 bp. European exports of capital goods are substantially raised for Nigeria, the Rest of ECOWAS region, 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, augmentation of exports in terms of value is limited; this is especially true in the cases of Senegal and Togo. The greatest augmentations of Senegal's and Togo's exports in terms of value are in the metals sector and are worth \$89 Mios and \$23 Mios, respectively. In the cases of Nigeria and Côte d'Ivoire, both of which will fall under the GSP program if they do not sign the EPA, the augmentation of exports in terms of value is more substantial, with \$2.2 billion in the fossil fuel sector for Nigeria and \$758 Mios 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 4.9 Impact of the reform on exports in value by country and by sector, 2035

Sectors	Rate of variation: scenario/baseline (%)								
	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
Textile	-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 product	-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	-1.4
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	-0.7	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 animal	-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	-0.1	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
Beverage 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 mineral	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 4.9 Continued

Sectors	Variation: scenario-baseline (US\$ Mios)								
	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	-14.2	0.40	7.80	1.80
Other crops	1715.80	14.70	0.10	0.10	0.00	-68	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
Textile	-118.5	9.70	2.10	0.10	1.00	-4	1.60	10.10	-0.20
Wearing apparel	-84.20	1.20	2.40	0.00	0.30	2.20	5.80	27.10	-0.5
Leather product	-42.5	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	-1.2	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 animal	-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	5512.80	2173.30	31.90	-0.10	17.10	-69.50	132.50	25.30	-0.1
Red meat	-32	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
Beverage 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 mineral	552.20	-2.00	-36.60	0.30	-0.10	-3.90	-2.20	-7.90	-15.40
Metals	1531.90	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	-5.5	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: ECOWAS = Economic Community of West African States.

Table 4.10 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 in variation in \$ Mios.

Table 4.10 Impact of the reform on imports in value by country and by sector, 2035

Sectors	Rate of variation: scenario/baseline (%)								
	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	0.7	0.2
Oilseeds	0	-1.7	2.7	-0.2	0.7	3	0.2	0	-0.6
Plant fibers	0.1	6.7	-1.5	11.9	-1	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
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	0.9	-1.1
Textile	0.1	-1.2	-1.1	-0.7	-1	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
Leather product	0.1	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	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	8.3	0.2	1	1
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
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	-0.4	3.7	3	1.4	1.8	-0.9
Other animal	0	3.4	2.7	4.6	5.9	8.6	2.8	2.7	5
Other natural resources	0.1	8.8	0.4	10	5	3	0.5	4.1	2
Fisheries	0	1.7	2.6	5	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
Beverage and tobacco	0.1	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	8.7	1.5	2.9	1
Paper products	0.1	2.2	3.7	1.2	1.3	7.5	0.7	1.4	-0.6
Other mineral	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
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	-1.2	-1.2	0.6	-1.1	-0.4	-1.1
Other services	0.1	-2	-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 4.10 Continued

Sectors	Variation: scenario-baseline (US\$ Mios)								
	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	-0.8	1.3	-0.1	2	0.1
Oilseeds	8.1	-1.2	0.4	0	0.1	0	0	0	0
Plant fibers	1.9	1.5	-2.2	0	0	0.3	-0.1	0	0
Other crops	391.1	926.4	2.7	0.5	7.6	6.5	1.1	0.9	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
Textile	160.2	-59.1	-7.4	-23.1	-0.7	5	-11.8	-1.2	-8
Wearing apparel	288.9	-10.8	-0.9	-1	2	1.3	-1.1	1	-1.7
Leather product	118	0.7	-0.4	-2.5	0.6	2.4	-2.7	0.8	-1.2
Chemicals	1006.9	92.3	32.8	6	-1.8	98.1	27.9	56	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	25.5	78	46.2	10.2
Other industries	367	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	0.3	0	-1.4	-0.1
Rice	3.3	-394	-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	-7.9	-1	-1.6	2.8	-0.7	-2.1	-2.1
Cattle	3.7	0.5	0.2	0	0	0	0	0.1	0
Other animal	7.9	1.8	1.4	0.5	0.1	1	1.6	1.5	0
Other natural resources	115.4	149.1	1.2	9	3.1	3.9	0.4	24.9	0.6
Fisheries	7.4	0.4	0.1	0	0	0.4	0.1	0.1	0
Fossil fuel	2942.4	2450.4	107.8	124.1	28.3	-9.2	378.6	64.3	41.2
Red meat	32	-25.7	-1.2	0	-0.1	0.4	-1	-0.1	0
White meat	39.8	-44.1	0	-2.1	0	-0.3	2.4	0	-0.1
Dairy products	43.6	11.9	2.8	-0.1	1.5	5.5	12.7	3.7	-0.4
Beverage and tobacco	45.8	-0.5	0.2	0.4	-0.7	10.9	-3.2	-3	-0.7
Wood products	142.2	52.1	1.6	0.2	0.3	5	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 mineral	131.6	62.4	13.2	4.9	13.8	44.6	13.2	20	-4.5
Metals	1130.4	157.7	41.5	13.2	21.4	73.1	17.6	111.5	6.1
Capital goods	2039.6	586.3	56.3	22.2	91	115.3	268.6	112.6	5.8
Utilities	83.8	-3.7	-0.4	-3.3	-1.7	0.2	-14	-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	-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	-3.4	-0.4	-0.8	-1.9	-4.2	-19.3	-0.1

Source: Authors' calculation.

Note: 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.

It has been often highlighted that custom duties make up an essential element of public revenues in Africa, as the collection of domestic indirect or direct taxes is often not efficient in this region. Thus, one worrying element for African countries concerning the EPA is a potential loss of custom duties. As shown in Table 4.11, 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 this trade agreement since it can potentially affect the ability of Africa's public sectors to finance public services.

Table 4.11 Impact of the reform on collection of import duties, scenario/baseline, 2035 (in percentages)

Country/region	Public revenue
European Union	-0.3
Nigeria	-13.1
Senegal	-22.3
Benin	-7.5
Burkina Faso	-25.8
Côte d'Ivoire	-17.0
Ghana	-14.1
Rest of ECOWAS	-10.4
Togo	-10.9
Rest of Africa	0.0

Source: Authors' calculation.

Note: ECOWAS = Economic Community of West African States

Let us remember that in this central scenario, we do assume that the public sold is constant in proportion of GDP and that a lump-sum tax is implemented to offset the loss of custom duties, such that when public revenues are cut, real public expenses per capita remain constant. This lump-sum tax is in a range of \$2.41 (Burkina Faso) to \$17.51 (Ghana); it is \$5.02 in Nigeria, \$14.7 in Senegal, \$11.79 in Benin, \$4.95 in Côte d'Ivoire, \$6.02 in the Rest of ECOWAS region, and \$12.37 in Togo.

Impact of the Reform on 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 productive factors markets, 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 DP that involves a demand effect and a supply effect on activity.

Table 4.12 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 4.12 Impact of the reform on production, by country and sector, constant US dollars, 2035 (in percentages)

Sectors	Rate of variation (%) - scenario/baseline								
	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
Textile	-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 product	-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 animal	-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
Dairy products	0.0	-1.2	-0.9	-0.5	-1.2	-1.9	-1.8	-0.5	-1.4
Beverage 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 mineral	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
Agrofood	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

Table 4.13 Continued

Sectors	Share in total production (%) - baseline								
	European Union	Nigeria	Senegal	Benin	Burkina Faso	Côte d'Ivoire	Ghana	Rest of ECOWAS	Togo
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
Textile	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 product	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 animal	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
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
Beverage 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 mineral	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

Table 4.13 Continued

Sectors	Share in total production (%) - baseline								
	European Union	Nigeria	Senegal	Benin	Burkina Faso	Côte d'Ivoire	Ghana	Rest of ECOWAS	Togo
Agrofood	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: ECOWAS = Economic Community of West African States.

On the European side, the impact on sectoral production is close to zero, with only a significant effect on production 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 DP. 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.

Impact of the Reform on Factor Markets

Table 4.13 highlights the impact of the EPA reform on factors' real remuneration. Concerning the EU, the impact is close to being nil. Concerning West African 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 productive factors. An augmentation of the remuneration of unskilled labor is important for the potential impact on poverty.

Table 4.13 Rate of variation in factors' real remuneration, scenario/baseline, 2035 (in percentages)

Contry/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
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
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
Rest of ECOWAS	0.6	0.4	0.3	0.5	0.1	-0.4
Togo	0.9	0.5	0.6	0.8	0.4	-0.6
Rest of Africa	0.0	0.0	0.0	0.0	0.0	0.0

Source: Authors' calculation.

Note: ECOWAS = Economic Community of West African States.

The last column of Table 4.13 indicates the change in the consumption price index implied by the reform. The implementation of the EPA leads to a reduction of border protection that directly reduces consumption prices of imported goods and indirectly reduces the consumption prices of domestic goods due to a competition effect. This 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; of course, local prices are also down 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 (see above).

We focus on unskilled labor since this 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 is due to a reduction in the production of the other crops sector (Table 4.12) by 4.5 percent, 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. Any increase in the real remuneration of unskilled labor stems from an increase in demand for unskilled labor from the vegetables and fruits and 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 4.14 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.

Table 4.14 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	
	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: 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 formal and urban sectors. In Côte d'Ivoire, the vegetables and fruit sector and plant-based fibers sector (both informal and rural sectors) expand with the reform. In Senegal, there are three sectors that 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 4.12). Concerning 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 how the share of formal sectors (or urban sectors) in total production in value by country is affected by this policy reform, 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.

Impact of the Reform on Macroeconomic Variables

Table 4.15 presents the macroeconomic results, particularly how GDP and welfare (equivalent variation) are affected by the reform. For all countries outside WA, the reform has almost no impact on GDP and welfare.²⁷

Table 4.15 Rate of variation of gross domestic product (GDP) and real income, scenario and baseline, 2035 (in percentages)

Country/Region	GDP	Welfare
Rest of the world	0.0	0.0
Asia	0.0	0.0
NAFTA	0.0	0.0
Latin America	0.0	0.0
CARICOM	0.0	0.0
European Union	0.0	0.0
Community of Independent States	0.0	0.0
Middle East and North Africa	0.0	0.0
Nigeria	0.0	-0.1
Senegal	0.4	-0.2
Benin	-0.2	-0.4
Burkina Faso	0.2	0.1
Côte d'Ivoire	0.3	0.3
Ghana	0.0	-0.2
Rest of ECOWAS	-0.1	-0.3
Togo	-0.2	-0.5
Rest of Africa	0.0	0.0

Source: Authors' calculation.

Note: CARICOM = Caribbean Community; ECOWAS = Economic Community of West African States; NAFTA = North American Free Trade Agreement.

The results concerning welfare are negative for Nigeria, Senegal, Benin, the Rest of ECOWAS region, and Togo and positive for Burkina Faso and Côte d'Ivoire. In all West African countries, households are positively affected by a decreasing consumption price index (see Table 4.13) but negatively affected by a lump-sum tax needed to maintain public expenses and public sold constant. In all countries, the net change in welfare is small.

Table 4.15 indicates an increase of GDP in Senegal, Burkina Faso, and Côte d'Ivoire and a decrease in Benin, the Rest of ECOWAS region, and Togo. This again reflects contrasting forces. If local production is 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 also may have several positive impacts on local production, as 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 due to the 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 consumers may increase their consumption and demand for local products. In all West African countries, however, this effect is small.

²⁷ 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.

Impact of the Reform on Poverty

Table 4.16 presents the impact of the EPA reform on the poverty headcount in Nigeria and Ghana. Poverty headcount at \$x a day is the percentage of the population living on less than \$x a day at 2005 international prices (x is either 1.00 or 1.25). The base year refers to the year in which the household surveys were conducted, that is, 2010–2011 for Nigeria and 2006–2007 for Ghana. All other figures are for 2035.

Table 4.16 Impact of trade reform on poverty headcount, scenario and baseline, 2035 (in percentages)

US \$ per day	Nigeria		Ghana			
	Base year	Reference Scenario	Base year	Reference Scenario	Scenario	
1.00	51.57	44.37	44.41	29.99	21.65	21.75
1.25	55.61	47.45	47.52	31.66	23.64	23.59

Source: Authors' calculation.

It is worth noting that changes in the poverty headcounts due to the reform are marginal. As already noticed, this trade reform does not have a substantial impact on the economy of West African countries, particularly when it comes to factors remuneration or the consumer price index used to update the poverty line between the baseline and the scenario. For example, in Nigeria the impact of the trade reform is an augmentation of poverty headcount at \$1.00 a day or \$1.25 a 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 headcount at \$1.25 will decrease from 55.61 percent in 2010–2011 to 47.45 percent in 2035, while in Ghana the poverty headcount at \$1.25 will decrease from 31.66 percent in 2006–2007 to 23.64 percent in 2035.

The next section presents our sensitivity analysis.

5. OTHER SCENARIOS AND POLICY DISCUSSION

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

The Role of the Dual-dual Hypothesis and the DP

We conduct three sensitivity analyses: the same scenario without the dual-dual modeling (scenario called NoDD_DP), the same scenario without the DP (scenario called DD_NoDP), and the same scenario without the dual-dual modeling or the DP (scenario called NoDD_NoDP). We compare these three scenarios to the central scenario, called in this section DD_DP.

As 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.²⁸

This sensitivity analysis shows that the results obtained with the dual-dual modeling and the DP are not significantly dependent on these two assumptions. In Table 5.1, we show 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 DP); we then indicate the results obtained under the three alternative assumptions. Table 5.1 clearly demonstrates that neither assumption has a significant impact on how trade is affected by the reform.

Table 5.1 Impact of reform on trade, sensitivity analysis, 2035 (in percentages)

Country/Region	Total exports volume				Total imports volume			
	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	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	-0.1	-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	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: CARICOM = Caribbean Community; DD_DP = central scenario; DD_NoDP = scenario without the development package; ECOWAS = Economic Community of West African States; NAFTA = North American Free Trade Agreement; NoDD_DP = scenario without the dual-dual modeling; NoDD_NoDP = scenario without the dual-dual modeling or the development package.

²⁸ Other comparisons may be requested from the authors.

In Table 5.2 and Table 5.3, 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 the assumption concerning the dual-dual modeling, the inclusion of the EPADP, or both are removed from this modeling exercise.

Table 5.2 Impact of reform on gross domestic product (GDP) 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	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: CARICOM = Carribean Community; DD_DP = central scenario; DD_NoDP = scenario without the development package; ECOWAS = Economic Community of West African States; NAFTA = North American Free Trade Agreement; NoDD_DP = scenario without the dual-dual modeling; NoDD_NoDP = scenario without the dual-dual modeling or the development package.

Table 5.3 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	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: CARICOM = Caribbean Community; DD_DP = central scenario; DD_NoDP = scenario without the development package; ECOWAS = Economic Community of West African States; NAFTA = North American Free Trade Agreement; NoDD_DP = scenario without the dual-dual modeling; NoDD_NoDP = scenario without the dual-dual modeling or the development package.

Table 5.4 Level of additional taxes to offset the loss of custom 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: ECOWAS = Economic Community of West African States.

Concerning the EPADP, this is not a surprising result: as demonstrated earlier, not only is the total envelope implied in this package small; 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 that states the impact of aid on local GDP is positive but small. Consequently, it was largely expected that the noninclusion of the DP would not significantly affect the results.

Identically, concerning the dual-dual modeling, the results, in terms of both impact on trade and impact on GDP, welfare, and collection of import duties, are not significantly affected by this hypothesis. This new modeling introduces mechanisms of reallocation of labor, both skilled and unskilled, between formal and informal activities and between urban and rural sectors. As shown in Table 4.14, 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 West African 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, which concern the following:

- The implementation of an income tax, in percentage and added to the income tax already imposed, such that the public sold in proportion of GDP is constant. This scenario is called INC.
- The implementation of a consumption tax, in percentage and added to the consumption tax already imposed, such that the public sold in proportion of GDP is constant. 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 since this is not a realistic policy option. This scenario is called CONS.
- No implementation of any tax in compensation for the loss of custom duties. Public expenses adjust to this variation in public revenues such that public sold is 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 since when public revenues are decreased, public expenses also decrease, and the provision of public good is necessarily affected.

Before comparing these three scenarios to the central scenario (called Central in this section), we first provide estimations of the magnitude of these additional taxes (Table 5.4). As an illustration, if Senegal's government decides to offset the loss of custom duties by a lump-sum tax, this tax will be \$14.70 per person in 2035. If the government chooses to instead tax individual income, this additional income tax will be 0.9 percent.²⁹ If the government chooses to tax consumption, the additional consumption tax will be 0.7 percent.

²⁹The 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.

Table 5.5 Impact of reform on trade, sensitivity analysis, 2035 (in percentages)

Country/Region	Total exports volume				Total imports volume			
	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: CONS, EXP, INC and LS are scenarios presented in the body of the text; ECOWAS = Economic Community of West African States.

Let us now compare these three robustness tests to 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 custom duties is called LS.

Table 5.6 shows the impact of the central scenario and of the three alternative fiscal closure scenarios on trade. Variations in total export volume and import volume are slightly different from those obtained in the Central scenario (LS).

Table 5.6 Impact of reform on gross domestic product (GDP) and welfare, sensitivity analysis, 2035 (in percentages)

Country/Region	EXP		LS		INC		CONS	
	Section 1		GDP	Welfare	GDP	Welfare	GDP	Welfare
	DP	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 ECOWAS	0.1	0.4	-0.1	-0.3	-0.1	-0.3	1.1	-0.4
Togo	0.0	0.5	-0.2	-0.5	-0.2	-0.5	1.6	-0.4

Source: Authors' calculation.

Note: CONS, EXP, INC and LS are scenarios presented in the body of the text; ECOWAS = Economic Community of West African States.

The augmentation of imports is generally more important when there is no compensation for the loss of custom duties through the increase of 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 considering an alternative fiscal closure; this is particularly true of the impact on welfare (Table 5.7).

Table 5.7 Impact of reform on poverty, sensitivity analysis, 2035 (in percentages)

Nigeria	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	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, INC and LS are scenarios presented in the body of the text; all dollars are US dollars.

In the EXP scenario, all welfare variations are positive; in all alternative scenarios, they are all negative except for in Burkina Faso and Côte d'Ivoire. In the EXP scenario, public expenses are decreased (by 8.5 percent in Senegal and Togo in 2035 and by 4.5 percent in Benin in 2035) to maintain the public deficit in proportion of GDP constant after the loss of custom duties. This scenario does not affect the representative household's welfare since 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 good in all West African countries.

In other scenarios, we impose a new tax in the model that is levied to maintain real public 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 good to be maintained. This tax decreases individual private available income such that in six of eight countries/regions, welfare is reduced. Compensating for the loss of custom 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 a new tax. This solution is interesting in terms of its impact on GDP. Not only are public expenses an important portion of total demand, 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 5.7 illustrates the impact of the EPA on poverty under two alternative fiscal scenarios. We did not implement a microsimulation in the case of the additional consumption tax (CONS scenario) since the microsimulation is operated on the revenue side of the household survey.

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

6. CONCLUDING REMARKS

The objective of this research is to evaluate the economic, trade, and poverty impact of the EPA between the EU and the ECOWAS countries. This agreement consists of the implementation of a free trade area between the signatory countries, complemented by a DP. 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; while 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 custom duties requires the implementation of a new tax, which necessarily 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 DP 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 of domestic prices. This internal devaluation helps restore these countries' competitiveness and positively affects their exports. Thus, these are very different economic mechanisms that lead to the same result: increased exports leading to increased trade activity.

Third, the EPA agreement raises the issue of a fiscal adjustment. Custom tariffs represent an important part of public revenues in ECOWAS countries. However, the EPA entails a significant reduction of custom duties, since 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.

In this research, we adopt 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 raised to maintain the public expenses per capita constant. This illustrates that the EPA could affect households' income and welfare by affecting the public revenues of these countries. The fiscal closure rule, in which no alternative tax is raised to offset the loss of custom duties and public expenses adjust to maintain the public sold constant in percentage of GDP, implies that the provision of public services is altered; as such the measurement of welfare is uncertain.

In conclusion, the benefits of the EPA between the EU and WA's countries appear small, if not negative. West African 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. 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 Modelling International Relations under Applied General Equilibrium (MIRAGE). It is a multiregion, multisector, dynamically recursive³⁰ computable general equilibrium model. MIRAGE was initially developed at 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 have been added for this project.

Social Accounting Matrix and trade data in MIRAGRODEP are based on GTAP 8 (Narayanan and Walmsley 2008). The GTAP database is a fully documented global database that contains complete bilateral trade information as well as transport and protection linkages among 113 regions for all 57 GTAP commodities for 2004. For MIRAGRODEP, the base year is 2007, and the outlook period is from 2008 to 2025. Trade policy data come from MAcMAP-HS6.

Model Structure

Dimensions and Sets

The MIRAGRODEP model distinguishes multiple sectors (or activities, industries), each of them producing one single commodity (or good, product). Sectors and commodities are referred to using indices i or j , both representing the exact same elements. The subset *Transport* refers to the 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 ($NatRes$), capital ($Capital$), and land ($Land$). As will be 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 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, while informal (i,r) is its complement and includes all informal sectors. In the developing countries on which this study focuses, that is, Benin, Burkina Faso, Côte d'Ivoire, Ghana, Nigeria, Senegal, Togo, and the Rest of ECOWAS region,³¹ informal sectors have been selected after a review of literature³² and after consideration of the importance of capital and skilled labor in all sectors since informal sectors are not supposed to hire skilled labor and are supposed to be relatively not capitalistic. In those countries of interest, formal sectors are the other sectors, while in all other countries all sectors are formal. Table A.1 indicates the sector breakdown into formal and informal sectors in West African countries.

³⁰ Dynamically recursive models do not include expectation of value of variables in future periods in the model. Plus, value of variable X at the end of period t is the initial value of variable X at the beginning of period $t+1$.

³¹ These eight countries/regions are all the elements of a subset of r , the set of countries, and this subset is called $r_dual(r)$.

³² See Benjamin and Mbaye (2012) and de Vreyer and Roubaud (2013).

Table A.1 Formal versus informal sectors

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

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 of the modeling of the rural-urban migration. Table A.2 indicates the sector decomposition between rural and urban sectors.

Table A.2 Rural versus urban sectors

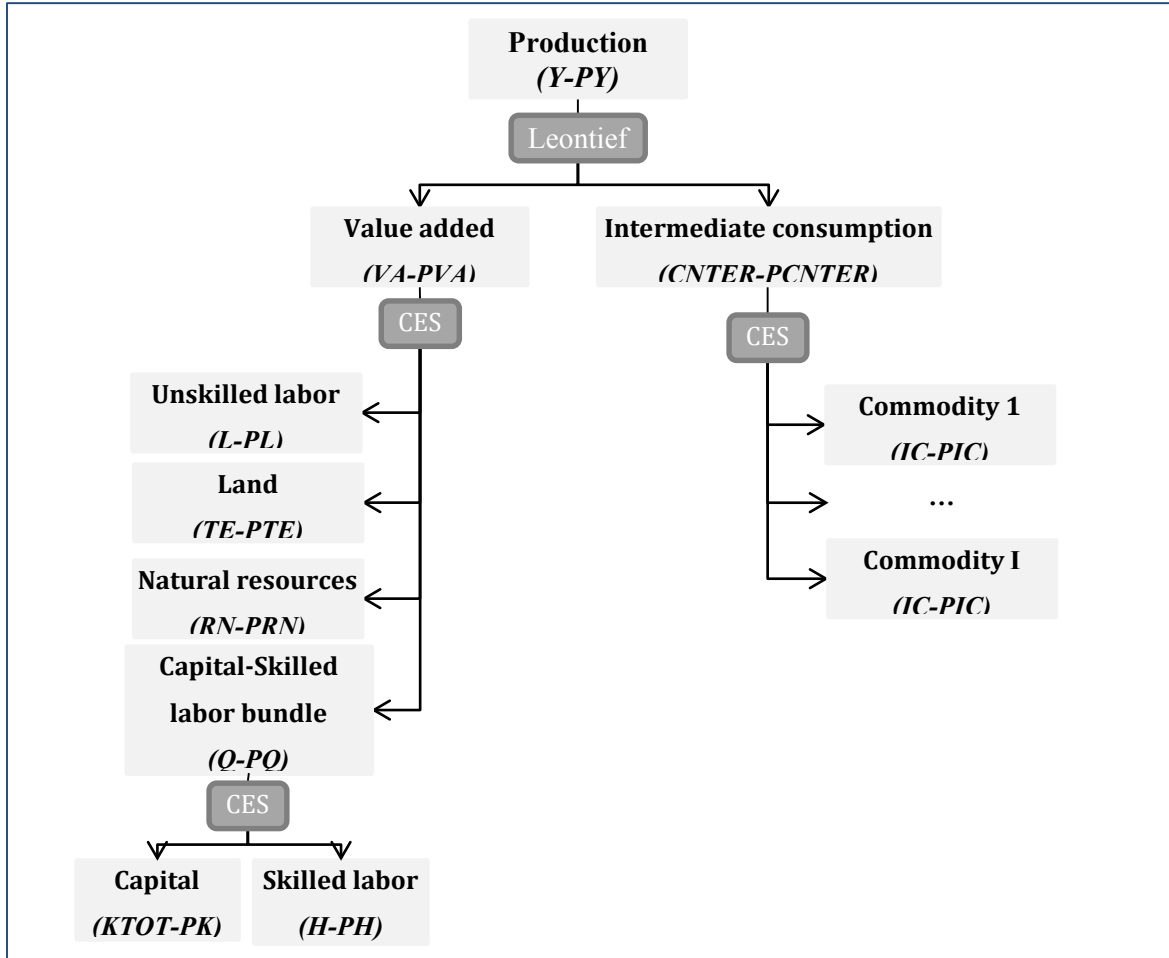
Rural sector	Urban sector	Urban sector
Vegetables and fruits	Vegetable oil	White meat
Oilseeds	Other food	Dairy products
Plant fibers	Textile	Beverages and tobacco
Other crops	Wearing apparel	Wood products
Rice	Leather products	Paper products
Cereals	Chemicals	Other minerals
Sugar	Motor vehicles	Metals
Cattle	Electronics	Capital goods
Other animals	Other industries	Utilities
	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 $Y_{j,r,t}$ is a Leontief of total value added, $VA_{j,r,t}$, and of total intermediate consumption, $CNTER_{j,r,t}$. 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: The acronyms for the volume followed by their corresponding prices appear in brackets.

Mathematically,

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

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

with

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

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

Hence, the producer price of output, $PY_{j,r,t}$ is a weighted sum of the price of value added, $PVA_{j,r,t}$, and of that of total intermediate consumption, $PCNTER_{j,r,t}$.

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

At the second level, on the value-added side, total value added is a combination of unskilled labor, $L_{j,r,t}$, land, $TE_{j,r,t}$, natural resources, $RN_{j,r,t}$, and capital-skilled labor bundle, $Q_{j,r,t}$.³³ 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.³⁴ The representative firm minimizes its costs subject to the CES aggregator, which yield the following first-order conditions:

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

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

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

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

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

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

³³ It is noteworthy that in informal sectors there is no skilled labor and this bundle is only capital.

³⁴ It might be worth noting that some parameters are solely indexed in j . It is the case, for example, for the elasticity used in

the value added functions (). This specification implies that the same parameter is used for all regions, but that it differs from one sector to the other.

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, $PRN_{j,r,t}$, and the aggregated price of capital and skilled workers, $PQ_{j,r,t}$ (the price of capital in informal sectors).

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

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

$$PL_{j,r,t} = WLt_{Ltype,r,t} (1 + taxf_{UnSkLab,j,r,t}^{VAL}) + PIndC_{r,t} taxf_{UnSkLab,j,r,t}^{VOL}$$

$$PTE_{j,r,t} = WTE_{j,r,t} (1 + taxf_{Land,j,r,t}^{VAL}) + PIndC_{r,t} taxf_{Land,j,r,t}^{VOL}$$

$$PRN_{j,r,t} = WRN_{j,r,t} (1 + taxf_{NatlRes,j,r,t}^{VAL}) + PIndC_{r,t} taxf_{NatlRes,j,r,t}^{VOL}$$

with:

$WLt_{Ltype,r,t}$ Rate of return to unskilled labor (net of taxes)

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

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

$PIndC_{r,t}$ Consumer price index

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

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

In countries r_dual with dual-dual modelling, 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 to unskilled labor (net of taxes):

$WLurbaninf_{r_dual,t}$ Rate of return to unskilled labor in urban informal sectors (net of taxes)

$WLRuralinf_{r_dual,t}$ Rate of return to unskilled labor in rural informal sectors (net of taxes)

$WLurbanfor_{r_dual,t}$ Rate of return to unskilled labor in urban formal sectors (net of taxes)

$WLRuralfor_{r_dual,t}$ Rate of return to unskilled labor in rural formal sectors (net of taxes).

At the bottom level, for formal sectors on the value-added side, capital, $KTOT_{j,r,t}$, and skilled labor, $H_{j,r,t}$, 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:

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

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

with

$a_{j,r}^H$ Skilled labor coefficient

$a_{j,r}^K$ Capital coefficient

σ_j^{CAP} Capital-skilled labor elasticity.

The price of the capital–skilled labor bundle is thus a weighted sum of the rental rate of capital, $PK_{j,r,t}$, and of the price of skilled labor, $PH_{j,r,t}$.

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

Again, the prices paid for the factors of production differ from the ones received by households as there are taxes levied on each of them.

$$PH_{j,r,t} = WH_{r,t} (1 + \text{tax}f_{SkLab,j,r,t}^{VAL}) + PIndC_{r,t} \text{tax}f_{SkLab,j,r,t}^{VOL}$$

$$PK_{j,r,t} = WK_{j,r,t} (1 + \text{tax}f_{Capital,j,r,t}^{VAL}) + PIndC_{r,t} \text{tax}f_{Capital,j,r,t}^{VOL}$$

with

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

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

Concerning informal sectors we get: $\forall (i, r) \in \text{informal}(i, r), KTOT_{i,r,t} = Q_{i,r,t}$ 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, an CES function is used to represent this imperfect substitutability, and cost minimization yields the demand for each input, $IC_{i,j,r,t}$:

$$IC_{i,j,r,t} = a_{i,j,r}^{IC} CINTER_{j,r,t} \left(\frac{PCINTER_{j,r,t}}{PIC_{i,j,r,t}} \right)^{\sigma^{IC}}$$

with

$a_{i,j,r}^{IC}$ Intermediate consumption scale coefficient

σ^{IC} Intermediate consumption elasticity.

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

$$PCINTER_{j,r,t} CINTER_{j,r,t} = \sum_i PIC_{i,j,r,t} IC_{i,j,r,t}$$

The price of each input is subject to taxes, $\text{tax}ic_{i,j,r,t}$, and thus differ from the price received by producers $PDEMTOT_{i,r,t}$.

$$PIC_{i,j,r,t} = PDEMTOT_{i,r,t} (1 + \text{tax}ic_{i,j,r,t}).$$

Income and Savings

Households

Households are assumed to be homogeneous, and they own all factors of production. They hence receive all the payments made to 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.

$$\begin{aligned}
 & REVH_{r,t} \\
 &= \sum_j \left\{ WRN_{j,r,t} RN_{j,r,t} + WTE_{j,r,t} TE_{j,r,t} + WH_{r,t} H_{j,r,t} \right. \\
 & \left. + \sum_{Ltype} WL_{Ltype,r,t} L_{j,r,t} + \sum_s WK_{j,s,t} K_{j,r,s,t} \right\} + Pop_{totpop,r,t}^{ag} TRH_{r,t} PIndC_{r,t}
 \end{aligned}$$

with

$REVH_{r,t}$ Households' income

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

$Pop_{totpop,r,t}^{ag}$ Population

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

$$SAVH_{r,t} = epar_r (REVH_{r,t} - RECDIR_{r,t})$$

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

Government

The income of the government, $REVGr,t$, 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 households' income, $RECDIR_{r,t}$.

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

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

Receipt from taxes on factors of production is the sum of volume and value taxes on each factor.

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

Exports may be subject to three taxes: taxes on production, $taxPi_{i,r,t}$, regular taxes on exports, $taxEXP_{i,r,s,t}$, and export tax equivalent of multifiber arrangement quota premium, $taxAMFi_{i,r,s,t}$.

$$RECEXP_{i,r,t} = PY_{i,r,t} (1 + taxPi_{i,r,t}) \sum_s (taxEXP_{i,r,s,t} + taxAMFi_{i,r,s,t}) TRADE_{i,r,s,t}$$

with

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

Duties, $DDi_{i,s,r,t}$, are collected on imports evaluated at the CIF price, $PCIFi_{i,s,r,t}$.

$$RECDD_{i,r,t} = \sum_s DDi_{i,s,r,t} PCIFi_{i,s,r,t} TRADE_{i,s,r,t}$$

Taxes are levied on households' consumption, $CHi_{i,r,t}$, government current expenditure on goods and services, $CGi_{i,r,t}$, on commodities sold for investment purposes, $KGi_{i,r,t}$, and on intermediate consumption, $ICi_{i,j,r,t}$. Each buyer faces a specific tax rate, respectively, $taxcci_{i,r,t}$, $taxgci_{i,r,t}$, $taxkgci_{i,r,t}$, and $taxicci_{i,j,r,t}$.

$$\begin{aligned}
& RECCONS_{i,r,t} \\
& = PDEMTOT_{i,r,t} \left\{ taxcci_{i,r,t} CHi_{i,r,t} + taxgci_{i,r,t} CGi_{i,r,t} + taxkgci_{i,r,t} KGi_{i,r,t} \right. \\
& \left. + \sum_j taxicci_{i,j,r,t} ICi_{i,j,r,t} \right\}
\end{aligned}$$

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

$$RECDir_{r,t} = taxdir_{r,t} REVH_{r,t}$$

Government savings, $SAVGr,t$, are assumed to be a fixed proportion, $PUBSOLD_r$, of gross domestic product (GDP) at market prices, $GDPMP_{r,t}$. Finally, the budget allocated to public current expenditure on goods and services, $BUDGr,t$, is determined residually.

$$SAVGr_{r,t} = PUBSOLD_r GDPMP_{r,t}$$

$$BUDGr_{r,t} = REVGr_{r,t} - SAVGr_{r,t} - Pop_{totpop,r,t}^{ag} TRH_{r,t} PIndC_{r,t}$$

Demand

Domestic absorption of each commodity, $DEMTOT_{i,r,t}$, is the sum of consumer demand, $CH_{i,r,t}$, demand from public administrations, $CG_{i,r,t}$, intermediate demand, $IC_{i,j,r,t}$, and demand for investment purposes, $KG_{i,r,t}$.

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

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 region (for example, developing versus developed country).

$$CH_{i,r,t} = Pop_{totpop,r,t}^{ag} \left(cmin_{i,r} + a_{i,r}^C AUX_{r,t} \left(\frac{P_{r,t}}{PC_{i,r,t}} \right)^{\sigma_r^C} \right)$$

with

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

$a_{i,r}^C$ Household consumption coefficient

$AUX_{r,t}$ Utility

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

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

σ_r^C Households' consumption elasticity of substitution.

Households maximize their utility subject to their consumption budget, $BUDH_{r,t}$, from which one can derive the shadow price of utility, $P_{r,t}$.

$$BUDH_{r,t} = \sum_i PC_{i,r,t} CH_{i,r,t}$$

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

The price paid by household for each commodity, $PC_{i,r,t}$, differs from the one received by the suppliers, $PDEMTOT_{i,r,t}$, by the amount of taxes collected, $taxcci_{r,t}$.

$$PC_{i,r,t} = PDEMTOT_{i,r,t} (1 + taxcci_{r,t}).$$

Finally, the consumer price index, $PIndCr,t$, is a Fisher index.

$$PindCr,t = \sqrt{\left[\frac{\sum_i PC_{i,r,t} CH_{i,r}^0}{\sum_i PC_{i,r}^0 CH_{i,r}^0} \right] \left[\frac{\sum_i PC_{i,r,t} CH_{i,r,t}}{\sum_i PC_{i,r}^0 CH_{i,r,t}} \right]}$$

with

$CH_{i,r}^0$ Benchmark value of households' consumption

$PC_{i,r}^0$ Benchmark value of final private consumption.

Public Demand

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

$$PCG_{i,r,t} CG_{i,r,t} = \alpha_{i,r}^G BUDGr,t$$

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

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:

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

with

$a_{i,r}^{KG}$ Capital good scale coefficient

$INVTOT_{r,t}$ Total investment

$PINVTOT_{r,t}$ Price of investment

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

σ^{KG} Capital good elasticity.

The aggregated price of capital, $PINVTOT_{r,t}$, is thus a weighted sum of the price paid for each commodity, $PKGi,r,t$.

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

Again, the price paid by the purchaser differs from the one received by the seller, as 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:

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

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

with

$a_{i,r}^D$ Local demand scale coefficient

$a_{i,r}^M$ Total import demand scale coefficient

σ_i^{ARM} Armington elasticity

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

$PM_{i,r,t}$ 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 of the price of the domestically produced commodity, $PD_{i,r,t}$, which differs from the amount received by the producer, $PY_{i,r,t}$, since taxes, $taxP_{i,r,t}$, apply.

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

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

At the second level (see Figure A.2), total imports, $M_{i,r,t}$, are 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:

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

with

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

σ_i^{IMP} Import elasticity

$PDEMA_{i,s,r,t}$ 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 as import duties, $DD_{i,s,r,t}^A$, apply.

$$PM_{i,r,t} M_{i,r,t} = \sum_s PDEMA_{i,s,r,t} DEM_{i,s,r,t}$$

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

And the CIF price is determined by the production costs, on which taxes apply, plus the transportation costs.

$$PCIF_{i,s,r,t} = PY_{i,s,t} (1 + taxEXP_{i,s,r,t} + taxAMF_{i,s,r,t}) (1 + taxP_{i,s,t}) + MUO_{i,s,r} Ptr_{i,s,r,t}$$

with

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

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

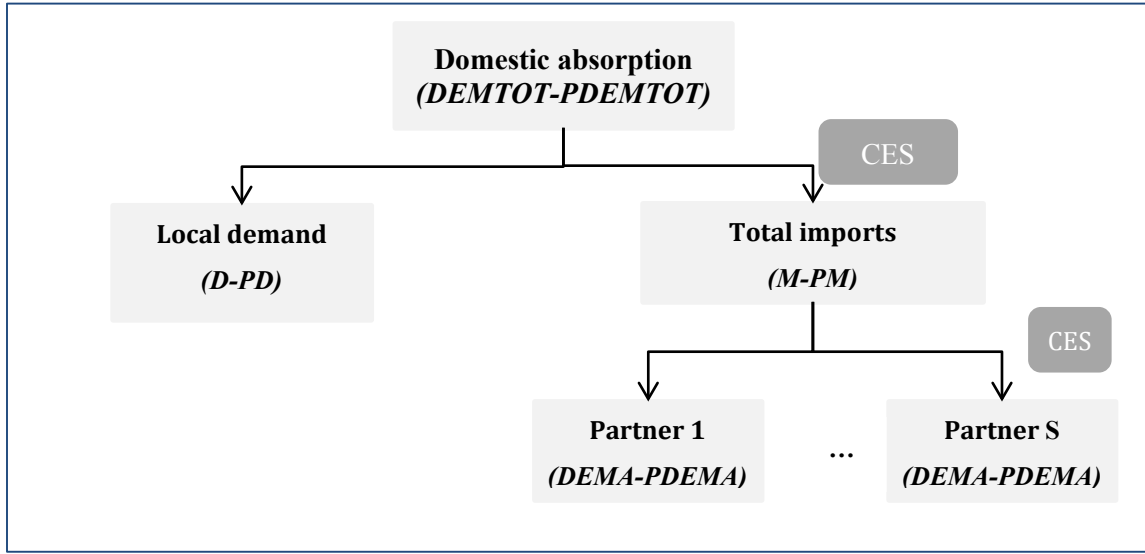
Following the consistent aggregator methodology as defined in Laborde, Martin, and van der Mensbrugge (2011), aggregation of volumes differ whether they are estimated at world prices or at domestic prices. Hence, the shadow price of bilateral trade, $PDEMi,s,r,t$, is evaluated as follows:

$$PDEMi,s,r,t = PCIF_{i,s,r,t} (1 + DD_{i,s,r,t})$$

which leads to the definition of the aggregator $TRADE_{i,s,r,t}$:

$$DEMA_{i,s,r,t} PDEMA_{i,s,r,t} = PDEMi,s,r,t TRADE_{i,s,r,t}$$

Figure A.2 Demand by geographic origin



Source: Authors

Note: The acronyms for the volume followed by their corresponding prices appear in brackets.

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 $a_{Transport,i,s,r}^{Tr}$ of total transportation demand. Implicitly, thus, total demand for transportation is a Cobb-Douglas type of function. Hence, the exact price formulation for the aggregated price of transportation, $PTr_{i,s,r,t}$, is the dual form of a Cobb-Douglas.

$$PTrMode_{Transport,t} TrMode_{Transport,i,s,r,t} = a_{Transport,i,s,r}^{Tr} Tr_{i,s,r,t} PTr_{i,s,r,t}$$

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

with

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

$PTr_{i,s,r,t}$ Price of transportation by commodity and partners

Supply and Market Clearing

Transportation Market

The world supply of transportation services per mode, $WorldTr_{Transport,t}$, follows a Cobb-Douglas specification. It follows that the supply from each region, $TrSupply_{Transport,r,t}$, is a constant share of the world value of transportation.

$$WorldTr_{Transport,t} = c_{Transport}^T \prod_r TrSupply_{Transport,r,t}^{a_{Transport,r}^{TrSupply}}$$

$$PY_{Transport,r,t} (1 + tax_{Transport,r,t}) TrSupply_{Transport,r,t} = a_{Transport,r}^{TrSupply} PTrMode_{Transport,t} WorldTr_{Transport,t}$$

with

$$c_{Transport}^T \text{ Scale coefficient}$$

$$a_{Transport,r}^{TrSupply} \text{ Share of each region in the world transport production}$$

Market for transportation clears since demand for transportation is equal to supply. Equilibrium on the transportation market determines the world prices of transportation per mode, $PTrMode_{Transport,t}$.

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

Commodity Market

In each region, supply of each commodity is equal to demand. Market clearing determines the price of each commodity, $PY_{i,r,t}$.

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

Factors of Production Market

Labor Market

Total supply of skilled workers, $\bar{H}_{r,t}$, 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.

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

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 sectors.

Skilled workers get better salaries in urban areas. There may be different explanations for this prevailing gap. One is that everything else being equal, there is a preference for living in rural areas. Another one is the existence of a monopolistic union that determines urban wages of skilled workers in formal urban sectors by maximization of its utility, which depends on the number of the union's members

and the level of salary given to its members: this 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

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

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

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

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

with $WHu_{r,t}$ 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 in country r at time t ;

$Hr_{r,t}$ The total demand for skilled labor in rural sectors in country r at time t ;

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

Regarding unskilled workers ($\bar{L}_{r,t}$), 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:

$$Lt_{Ltype,r,t} = b_{Ltype,r}^{L_t} \bar{L}_{r,t} \left(\frac{WL_{tLtype,r,t}}{\bar{WL}_{r,t}} \right)^{\sigma^L}$$

with

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

$b_{Ltype,r}^{L_t}$ Labor scale coefficient

$\bar{WL}_{r,t}$ Aggregated wage for unskilled workers

σ^L Labor elasticity

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

$$\overline{WL}_{r,t} \bar{L}_{r,t} = \sum_{Ltype} WL_{Ltype,r,t} L_{Ltype,r,t}$$

which is determined by the equilibrium between supply and demand.

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

In countries with dual-dual modeling, for unskilled workers, wages are lower in informal sectors than in formal sectors.

There are potentially different explanations of this gap: minimum wages, transaction costs, higher productivity in formal sectors due to a capital-intensive process of production. According to which these are urban or rural sectors, 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 urban formal sector (probability $Prob_Lu_formal_{r,t}$) and gets a salary of $WLu_formal_{r,t}$ or he works in a 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:

$$WLr_formal_{r,t} = Prob_Lu_formal_{r,t} WLu_formal_{r,t} + [1 - Prob_Lu_formal_{r,t}] WLu_informal_{r,t}$$

$$Prob_Lu_formal_{r,t} = cp_r \frac{Lu_formal_{r,t}}{Lu_informal_{r,t} + Lu_formal_{r,t}}$$

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

$$Lu_formal_{r,t} + Lu_informal_{r,t} = Lu_{r,t}$$

$$Lr_formal_{r,t} + Lr_informal_{r,t} = Lr_{r,t}$$

$$Lu_formal_{r,t} = \sum_{formal(i,r)} Lu_{i,r,t}$$

$$Lu_informal_{r,t} = \sum_{informal(i,r)} Lu_{i,r,t}$$

$$Lr_formal_{r,t} = \sum_{formal(i,r)} Lr_{i,r,t}$$

$$Lr_informal_{r,t} = \sum_{informal(i,r)} Lr_{i,r,t}$$

$$WLu_formal_{r,t} = WLu_informal_{r,t} (1 + \delta u_r)$$

$$WLr_formal_{r,t} = WLr_informal_{r,t} (1 + \delta r_r)$$

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;

$Wlr_informal_{r,t}$: the remuneration of unskilled labor in rural informal sectors in country r at time t;

δu_r : a positive constant;

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 to land (Lee and Van Der Mensbrugge 2001)). This implies that the greater the real overall return to land, the greater will be the overall supply of land.

$$\overline{TE}_{r,t} = \overline{TE}_r^0 \left(\frac{\overline{WTE}_{r,t}}{P_{r,t}} \right)^{\sigma_r^{TE}}$$

with

\overline{TE}_r^0 Benchmark value of total land supply

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

σ_r^{TE} Total land supply elasticity

To represent the imperfect mobility of land, supply to each activity, $TE_{j,r,t}$, 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

σ^{TE} Land elasticity

It follows that the aggregated price of land is the weighted sum of the price 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 , $K_{j,s,r,t}$, is given by the depreciated stock of capital inherited from the preceding period plus new investment $INV_{j,s,r,t}$

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

with

δ_r Depreciation rate,

where the investment per activity and region of destination depends on the rate of return to capital, the aggregated price of new capital, and capital stock.³⁵

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

with

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

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

α Elasticity of investment to return on capital

Total investment made in region r , $INVTOT_{r,t}$, is simply the sum of investment made in each sector of each region:

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

In each sector, total supply of capital equals demand, which determines the rate of return to capital specific to this sector ($WK_{i,r,t}$).

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

³⁵ For a complete discussion about the investment behaviour, see Decreux and Valin (2007).

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 $CAB_{r,t}$ represents the current account balance, which is a constant share $SOLD_{r,t}$ of world GDP, $PIBMVAL_t$.

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

World GDP is simply the sum of regional GDPs, $GDPMR_{r,t}$:

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

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

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

Finally, real GDP, $GDPVOL_{r,t}$, 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 Closures

In MIRAGRODEP, every economic agent balances income and expenditures: income of households equals spending of households (consumption, savings and transfers), and firms' spending (including payment to capital) equals firms' revenue. At a global level, savings must be equal to investment. At the country level, a gap between the two variables can occur due to international capital movements. 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 factors in the economy.

APPENDIX B: GEOGRAPHICAL DISAGGREGATION AND CORRESPONDENCE WITH GTAP REGIONS

Table B.1 Geographical disaggregation

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

Source: Authors.

Table B.2 Correspondence with GTAP regions

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

Table B.2 Continued

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

Table B.2 Continued

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

Table B.2 Continued

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

Source: Authors.

Table B.3 Sectoral disaggregation

MIRAGRODEP code	Section 2 Label
v_f	Vegetables and fruits
osd	Oilseeds
pfb	Plant fibers
ocr	Other crops
vol	Vegetable oil
ofd	Other food
tex	Textiles
wap	Wearing apparel
lea	Leather products
crp	Chemicals
mvh	Motor vehicles
ele	Electronics
omf	Other industries
cns	Construction
rice	Rice
cereals	Cereals
sug	Sugar
cattle	Cattle
otherAni	Other animal products
onr	Other natural resources
fish	Fisheries
ffl	Fossil fuels
meatc	Red meat
meato	White meat
dairy	Dairy products
bevto	Beverages and tobacco
woodp	Wood products
paper	Paper products
mat	Other minerals
metals	Metals
cgd	Capital goods
utilities	Utilities
trade	Trade
trans	Transportation
privser	Business services
otherserv	Other services
pubserv	Public services

Source: Authors.

Table B.4 Correspondence with GTAP sectors

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

Table B.4 Continued

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

Source: Authors.

Note : nec: not elsewhere classified.

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