MIRAGRODEP, an analytical model adapted to economic and trade reforms

Antoine Bouët, David Laborde and Valeria Piñeiro[140]

Introduction

The international community is facing considerable challenges today. To meet these challenges, governments, regional bodies, and international institutions must define and implement reforms that meet a triple requirement: inclusiveness, sustainability and resilience. Inclusiveness means the implementation of reforms that primarily benefit the most disadvantaged populations in terms of income, food security, and/or health status. Sustainability means the design of solutions that favor the fight against climate change and the respect of biodiversity. Resilience means finding out tools that enable economies and populations to resist external shocks (extreme climatic events, pandemics).

This triple requirement implies that decision-makers must have access to coherent tools in order to analyze ex-ante the impact of potential economic and trade reforms: carbon tax, environmental regulation, customs union or free trade area, and others. These tools must be coherent from an economic, environmental and nutritional point of view and integrate not only detailed information at the level of economic agents to respect the requirement of inclusiveness, but also a dynamic dimension to respond to the concern of resilience.

The objective of this chapter is to present a general overview of the MIRAGRODEP model, a model of the global economy. This model has the consistency of computable general equilibrium models and can include environmental considerations, while being based on detailed data that can represent not only many sectors of activity, but also many countries. It can also be linked to individual surveys to estimate the impact of shocks and reforms at the household level in terms of income, purchasing power, poverty, food security, and nutrition.

MIRAGRODEP has already been used to study issues related to international trade and trade policy: the impact of the Doha Development Agenda (Bouët and Laborde, 2010a)

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or the cost of a non-Doha (Bouët and Laborde, 2010b), the impact of the Economic Partnership Agreement between the European Union and the ECOWAS (Bouët, Laborde and Traoré, 2018), the impact of the African Continental Free Trade Area with modelling of non-tariff measures (Bouët, Laborde and Traoré, 2021) or the impact of WTO reform (Bouët and Laborde, 2019). It also served for an evaluation of export taxes (Bouët and Laborde, 2019) and export restrictions (Piñeiro et al, 2019), an estimation of the impact of non-cooperative policies in times of food crisis (Bouët and Laborde, 2012), and US tariff wars (Bouët and Laborde, 2018), of biofuels mandate (Bouët, Dimaranan and Valin, 2010; Laborde, 2011), the impact of the COVID-19 pandemic (Laborde, Martin and Vos, 2020) and agricultural subsidies and global greenhouse gas emissions (Laborde et al, 2020).

The rest of the chapter is organized as follows. Section 2 gives an overview of the MIRAGRODEP model. In section 3 we present data on which the model is based, including not only Social Accounting Matrixes, but also tariffs, export taxes, non-tariff measures and household surveys while section 4 gives an illustration of an estimation conducted with MIRAGRODEP. Section 5 concludes.

An overview of the model

Like MIRAGE (Bchir et al., 2002; Decreux and Valin, 2007) and the GTAP model (see Corong et al., 2017), MIRAGRODEP is a multi-region, multi-sector CGE model with perfect competition and constant returns to scale (see Bouët et al., 2021, for a complete documentation). It is usual to assume perfect competition in all sectors, which enables to have a detailed geographic and sector decomposition.

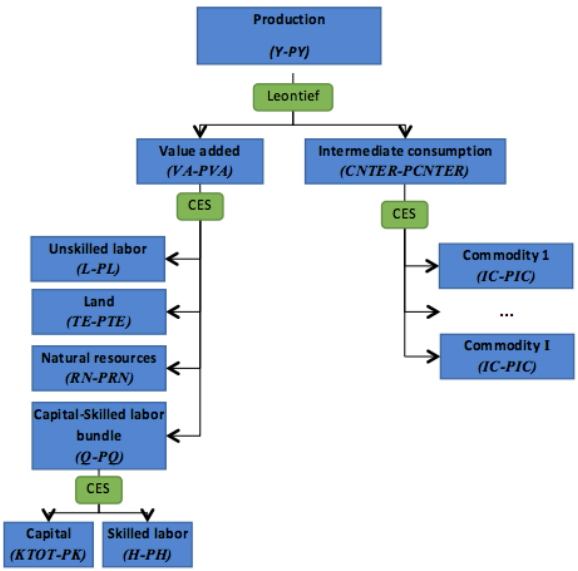
All these models (GTAP, MIRAGE, MIRAGRODEP) share common features: they are all based on an input–output framework and their theoretical structure is derived from optimizing behavior of economic agents, particularly households and firms. In all these models, Walras's law holds: if there is equilibrium in all but one of the markets, equilibrium also holds in the last market. Consequently, one price is held fixed and all other prices are evaluated relative to this numeraire. However, each of these models also has specificities: specific choices of functional forms for the final and intermediate demand functions, treatment of international transport margins or specific duties, representation of factor markets, nesting in the Armington representation of trade preferences, and others. When studying the same policy reform using the same data, these models do not show large differences (Bouët et al, 2020 and Maliszewska and Ruta, 2020).

There is a comparative static and a recursive dynamic version of the model. The dynamic version is used by solving the model sequentially and moving the equilibrium from one year to another.

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

In the dynamic version, the only factor with a fixed supply over time is natural resources. Labor supply growth rates are fixed exogenously. Land supply is endogenous and depends on the real remuneration of land. Skilled labor is the only factor that is perfectly mobile. Installed capital and natural resources are sector-specific. New capital is allocated among sectors according to an investment function.

Figure 1 : Production side



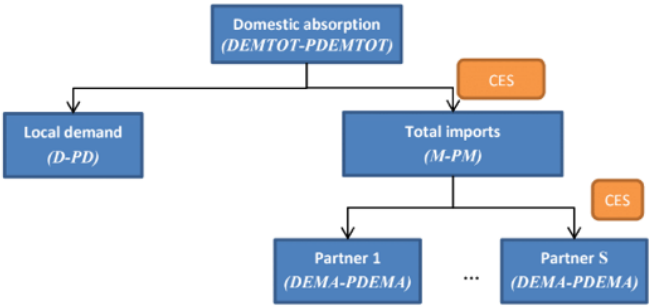
Unskilled labor is imperfectly mobile between agricultural and non-agricultural sectors, according to a constant elasticity of transformation (CET) function. Land is also imperfectly mobile between agricultural sectors.

Capital in a given region, whatever its origin (domestic or foreign), is assumed to be obtained by assembling intermediate inputs according to a specific combination. The capital good is the same regardless of the sector.

The demand side is modeled in each region through a representative agent that own all factors of production and whose propensity to save is constant. The rest of the national income is used to purchase final consumption. Preferences between goods are represented by a linear expenditure system–constant elasticity of substitution (LES-CES) function. This specific utility function allows the evolution of the demand structure of each region to be accounted for as its income level changes. Additionally, 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 (e.g. developing versus developed country).

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 market is imperfect and highly dependent on the choice of the CES trade elasticities and the initial share of trade. For the latest studies, Armington elasticities are drawn from the GTAP 11 database and are adjusted for each region based on sectoral composition. The import tree is specific to each market (importer*sector) to reflect the export similarities (HS4 level) of each exporter.

Figure 2: Demand side



In MIRAGRODEP, the government is explicitly modelled 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 govern-

ment 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 model includes four important assumptions: the external account closure, the private account closure, the government account closure and the factor market closure.

The private account closure assumption concerns the savings-investment closure. The MIRAGRODEP model is Neo-Classical: the marginal propensity to save is constant such that variation in income leads to variation in savings, which brings variations in investment.

The external account closure concerns the assumption on the current account. This account balance could be affected by a trade shock 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 (i.e., competitive disinflation).

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 shock, 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. However, MIRAGRODEP does not model financial markets[141] 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.

Secondly, if it is assumed that a current account balance can vary without constraints, it means that there is no limitation in the increase of import. In this case, the country's 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) is our preferred one and it 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 percent of global GDP). In a nutshell, when the first-order effect of the shock 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.

141. Other multi-country CGEs face the same problem.

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 which 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 shock or a reform. In many studies, we assume that after a shock that impacts custom duties, a consumption tax (VAT) is adjusted 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. The magnitude of the additional tax measures the cost imposed on the economy to maintain constant real public expenses per capita, and consequently constant provision of public goods. In a sensitivity analysis, it is possible to consider other closures which could include changes in public expenditure and the introduction of a lump-sum tax.

An overview of data

The first source of data for MIRAGRODEP is GTAP11 database (see Aguiar et al., 2019 for full documentation), which provides world macroeconomic accounts and trade flows for four reference years 2004, 2007, 2011, 2014 and 2017. The database describes values of production, and intermediate and final consumption of commodities and services for 141 countries or regions and 65 sectors, but also global bilateral trade patterns, international transport margins and protection matrices that link individual countries/regions.

The market access data come from the MacMap-HS6 version 2.1 database (Bouët et al., 2008; Guimbard et al., 2012), which measures protection in 2004, 2007, 2010, 2013, and 2016 and includes all regional agreements and trade preferences existing to these dates. Therefore, protection is measured at the bilateral level for each HS6 line. One important feature of the model is the Consistent Tariff Aggregator approach[142] which has been implemented for MIRAGRODEP. This is an important element of the model when it comes to trade shocks scenarios since the simulations are often conducted at a relatively low level of sector disaggregation (25 sectors) whereas protection is measured at a very detailed level. The Consistent Tariff Aggregator approach captures the exclusion effects and the variance of tariffs at a detailed (tariff line) level. Not considering this approach would yield inconsistent welfare effects since simple trade weights are endogenous and the welfare changes induced by a tariff is a function of it powers, not its level per se.

142. See Laborde, Martin, and van der Mensbrugghe (2016) for the importance of tariff aggregation in studying trade liberalization scenarios and a presentation of the Consistent Tariff Aggregator approach.

It is usual that MIRAGRODEP includes other data: (i) specific Social Accounting Matrix when MIRAGRODEP is used in collaboration with a specific government (Bouët, Laborde, and Traoré, 2021, for Morocco); (ii) data collected on export taxes for a specific project (Bouët and Laborde, 2013); (iii) evaluation of Ad Valorem Equivalent of Non-Tariff Measures (Bouët, Laborde, and Traoré, 2021).

Last, not least, MIRAGRODEP can be connected to households' surveys: Laborde, Martin, and Vos (2020) conduct two simulations of the economic consequences of COVID-19; to estimate the poverty impact of the shock, MIRAGRODEP is connected to the POVANA household dataset and model, which includes data on the full income distribution for over 300,000 representative households globally. The model and the dataset are linked in top-down fashion.

TRADE TENSIONS IN LAC: MODELING OUTCOMES[143]

Trade tensions between the major world economies increased in 2018, and US tariff increases triggered reprisals and counter-reprisals. In Latin America and the Caribbean (LAC), trade tensions between the US and China and other US trade partners were expected to generate a mix of opportunities and threats for exporters of food products.

To better understand the likely impacts of global trade tensions for LAC, we modeled a set of four scenarios using the MIRAGRODEP model . We looked at impacts on exports, imports, production, GDP, household consumption, and adjustment costs through changes in labor markets up to 2030.

Impacts will differ across the region's highly heterogeneous countries, but some broad trends are evident.

In the short-term…

LAC countries enjoy an advantage as the trade war allows them to replace either US or Chinese exports on their reciprocal markets.

• The ripple effect from the escalation of tariffs and reduction of US food exports to China could open new export opportunities.

In the long-term…

A prolonged period of moderate trade expansion would slow increases in productivity and longer-term growth prospects, reflecting (1) investment decisions that could increase global distortions and (2) a risk of increased competition (and potential dumping) as US exporters displace producers within LAC and commodity prices drop.

• An economic slowdown in China and/or the United States could reduce demand for commodities.

What should be the region's strategy?

The impact in Latin America of the US–China trade dispute and the resulting reordering of the world economy forces us to think about new strategies. While the level of intra-LAC heterogeneity could be a major challenge to defining a collective action agenda, it could also be a great asset. Our modeling exercise shows that a LAC mitigation strategy focused on intraregional trade could help the region avoid the negative impacts of current trade tensions.

For more details of this study, see D. Laborde and V. Piñeiro, "Trade Tensions: Implications for Latin America and the Caribbean," IICA and IFPRI, 2019.

143. This section is based on Laborde Debucquet, David; and Piñeiro, Valeria. 2019. Trade tensions in LAC: Modeling outcomes. Washington, DC: International Food Policy Research Institute (IFPRI). http://ebrary.ifpri.org/cdm/ref/collection/p15738coll2/id/133561

IMPACTS OF GLOBAL TRADE TENSIONS: FOUR SCENARIOS

1 US vs. China: Status quo

Tariffs proposed and/or implemented by the US and Chinese governments up to December 2018, including agricultural and non-agricultural products.

LAC benefits from new opportunities.

+2.1% agro-food exports

0

2 Extended US trade tensions

Proposed and implemented tariffs plus all retaliatory measures announced by the US and China, US steel and aluminum tariffs, and the retaliatory measures from Canada, the European Union, India, Mexico and Turkey.

Mix of benefits and negative impacts.

+2.0% agro-food exports

0

3 Escalating trade wars

Escalation to full-blown trade wars.

LAC sees contraction slightly smaller than global average.

-16% agro-food exports

0

4 Intra-LAC integration

Status quo trade tensions plus a LAC mitigation strategy that reduces transportation costs and increases intraregional integration.

LAC reduces impact of trade tensions.

+5% agro-food exports

0

Conclusion

This chapter has introduced the MIRAGRODEP model. It is a multi-country, multi-sector computable general equilibrium model -static and dynamic versions- that is regularly used for economic and trade reform assessments.

Despite its many uses, the MIRAGRODEP model needs to evolve and incorporate new elements to maintain its relevance in a constantly changing environment. For example, it is necessary to integrate more detailed information on trade costs (access costs to national markets, efficiency of customs procedures, unequal quality of transport infrastructures, among others), firms (with the evolution of international trade theory and the recognition of their differentiation, information on firms is increasingly available), and households. Environmental and nutritional considerations must also be integrated into the model and the model must evolve to study resilience issues. This is the only way that the MIRAGRODEP model can continue to be a reference for the evaluation of economic and trade reforms.

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