General equilibrium analysis of trade policy options in Colombia[1]

Key messages

- *Colombia remains relatively closed to trade despite the number of agreements signed. The tariff structure remains dispersed and with peaks. Non-tariff measures are also high.*
- *The unilateral elimination of non-technical barriers to trade has a higher impact on growth and trade than any tariff reduction policy.*
- *The adoption of a uniform tariff scheme, which reduces tariff peaks and tariff dispersion, has a larger impact on GDP and trade than engaging in any trade agreement, besides being also easier to implement.*
- *The fall in input costs due to the fall in tariffs or NTMs leads to an increase in exports of manufactures.*
- *Of the different trade agreements simulated, the accession of Colombia to CPTPP and the signature of an FTA with China have the highest impact on growth, trade and poverty reduction. In both cases, including reforms in order to reduce NTMs would increase GDP and trade even more.*
- *All policies simulated have a positive impact on export diversification, and poverty reduction.*

Introduction

In spite of the number of trade agreements signed by Colombia, the country remains relatively closed to trade. Tariffs remain high, particularly in some sectors such as agriculture, food, textiles and motor vehicles, and non-tariff measures have increased in the last years. As most economies in the world, in 2020 Colombia is expected to be negatively impacted by the spread of Covid-19 and the containment measures applied. Thus, trade policies can help boost the economy in the aftermath of the crisis and contribute to a more efficient productive structure.

The objective of this note is to analyze the impact of different trade policies that Colombia could implement. It assesses unilateral trade policies, as well as the participation of Colombia on different trade negotiations. In the next section, we present some of the main challenges that Colombia faces in terms of trade policies. All the data is presented for 2014 and using the regional and sectoral aggregation from the CGE model applied to analyze the impact of the different trade policy options. In the appendix, the information on the methodology and the underlying data is described.

[1] This note has been prepared by Carmen Estrades and Israel Osorio-Rodarte in the World Bank Global Trade and Regional Integration Unit. We thank the comments received by Michael Ferrantino and Nadia Rocha.

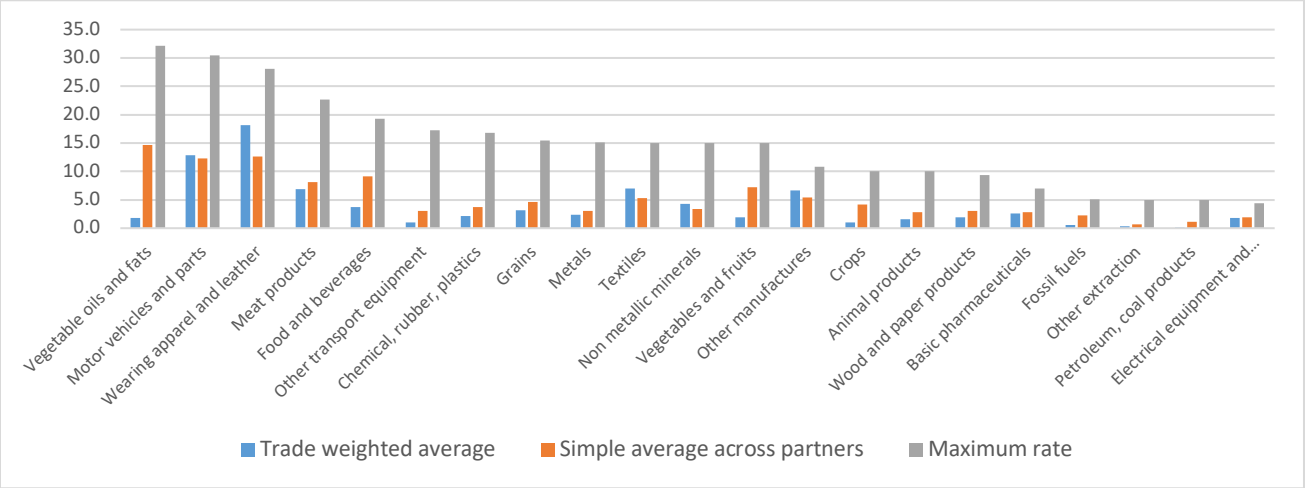
Key challenges

Tariffs

Tariff rates remain relatively high, especially in some goods. Using data from DANE, which allows to estimate tariff rates effectively collected in 2014, Figure 1 presents three tariff rates by sectors: trade weighted average by partners, simple average, and maximum rates. Four groups of goods present high tariff rates: Agriculture and food products (Vegetable oils and fats, Meat products, Food and beverages, and Grains); Textiles, wearing apparel and leather products; Motor vehicles and parts and Transport equipment; and Metals and Non-metallic minerals.

Colombia applies preferential tariff rates to several trade partners, and thus average tariffs are lower than maximum rates. However, three sectors still present high average tariff rates: Motor vehicles and parts, Wearing apparel and leather, and Vegetable oils and fats.

Figure 1. Average tariff rate (%) by sector, 2014



Source: authors' estimation using data from DANE

The tariff structure applied by Colombia to its imports presents high levels of dispersion. This is particularly true for agriculture products. Compared to other Latin American countries such as Chile and Peru, Colombia presents much higher tariff peaks and tariff dispersion (Table 1). Chile is an extreme case, as it applies a uniform MFN tariff of 6%. It should be noted that the information for Colombia does not consider the Andean Price Band System, which increases even more the dispersion and maximum tariff rates.

Table 1. Applied Most Favored Nation tariffs compared. Colombia, Chile and Peru

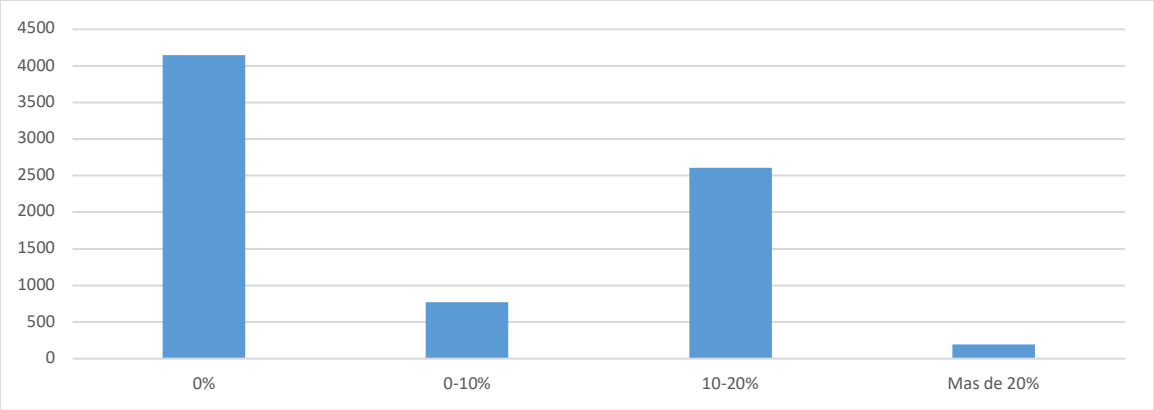
Country	Simple average	Maximum rate	Weighted average
Colombia	6.4	80	7.8
Chile	6.0	6.0	6.0
Peru	2.4	11	1.9

Source: author's elaboration with data from TRAINS

A uniform tariff rate has several benefits. Usually, it entails a low protection level. Also, there is no incentive to misclassify goods at Customs, as all goods are subject to the same rate. This brings about lower administrative costs to trade, as information is more transparent, leading to less corruption levels. Finally, it implies an equal treatment to all productive activities.

Strictly applying a uniform tariff scheme would imply increasing protection for a large number of products. Figure 2 shows the tariff dispersion of Colombia MFN tariff structure. Around half of the products are not subject to tariffs rates, and over 35% are subject to tariff rates above 10%. 192 products defined at the 6-digit HS level are subject to tariff rates above 20%. Most of them are agriculture and food products: meat products, vegetable oils and fats, dairy, vegetables, and also motor vehicles and parts. Thus, for Colombia it would not be convenient to strictly set a uniform tariff scheme.

Figure 2. Number of tariff lines by tariff rate. MFN applied tariffs.



Source: own elaboration with data from TRAINS

Colombia has not signed a large number of trade agreements. Other Latin American economies, such as Peru, Mexico and Chile have engaged more actively in preferential trade agreements. Colombia also lies behind Asian economies such as Japan and Korea, although it has around the same number of agreements than United States and has more agreements than Mercosur countries in Latin America (Table 2).

Table 2. Number of agreements signed, selected countries

Country	Number of Agreements
Venezuela	3
Uruguay	10
Paraguay	10
Argentina	11
Brazil	12
Colombia	13
United States	14
India	16
Japan	17
Peru	18
Korea	18
Mexico	23
Chile	29
European Union	42

Source: Estrades and Flores (2020)

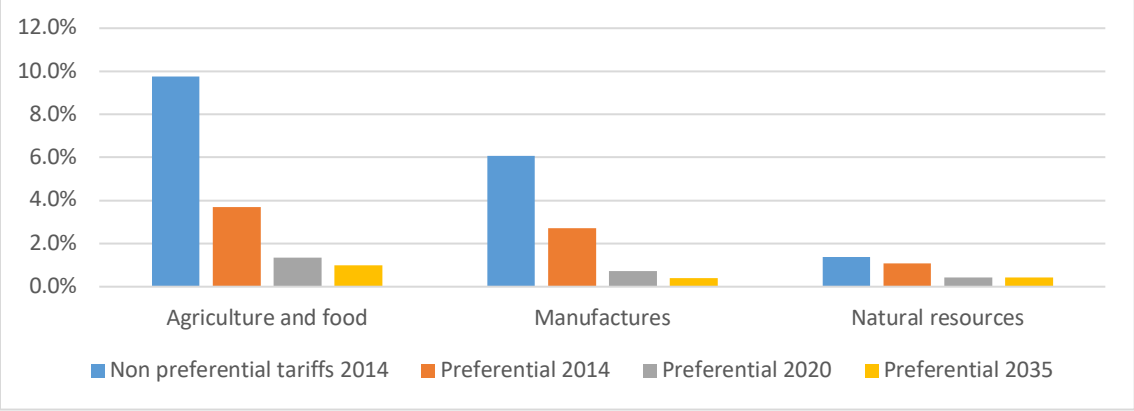
Table 3. Agreements signed by Colombia

Trade agreeement	Entry into force
Latin American Integration Association (LAIA)	1980
Global System of Trade Preferences among Developing Countries (GSTP)	1988
Andean Community (CAN)	1988
Colombia - Mexico	1995
Chile - Colombia	2009
Colombia - Northern Triangle (El Salvador, Guatemala, Honduras)	2009
Canada - Colombia	2011
EFTA - Colombia	2011
United States - Colombia	2012
EU - Colombia and Peru	2013
Pacific Alliance	2016
Costa Rica - Colombia	2016
Republic of Korea - Colombia	2016

Source: own elaboration with data from WTO

In the medium run, the average tariff rate applied by Colombia is expected to fall, due to trade agreements recently signed. Figure 3 shows preferential and non-preferential average tariffs for agriculture and food products, fossil fuels and other primary, and manufactures. It also shows by how much preferential tariffs are scheduled to fall in the medium run. In 2035, preferential tariffs applied on agriculture goods will be as low as 1%, while in manufactures and natural resources will be even lower. Thus, with the signature of new trade agreements, Colombia could reduce even more the average protection.

Figure 3. Average tariff by aggregated sector. Simple average, 2014, 2020 and 2035



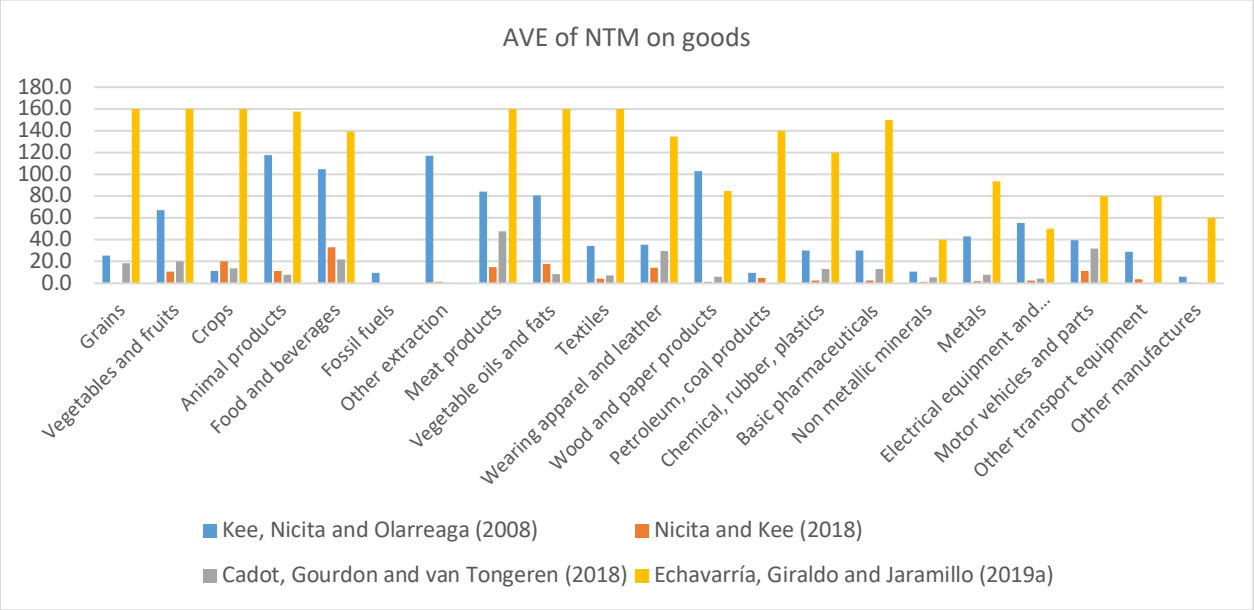
Source: authors' estimation using data from DANE and MacMap

Non-tariff measures

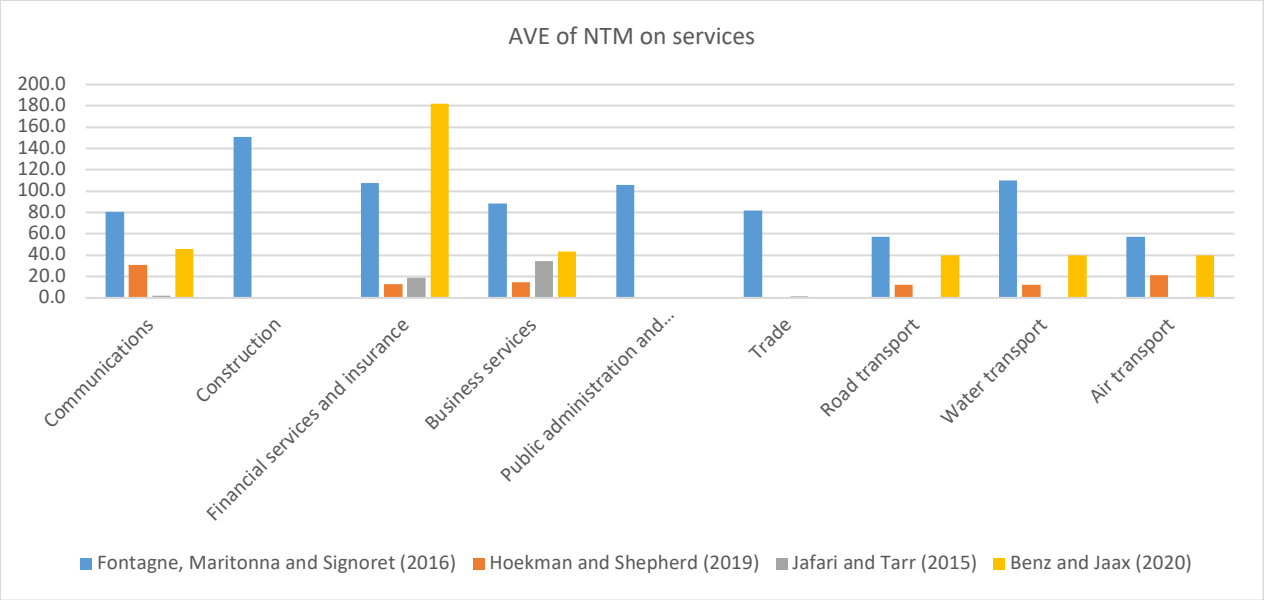
Preferential agreements, especially deep agreements which includes provisions beyond trade in goods, usually reduce NTMs through regulations, especially the mutual recognition of conformity-assessment procedures (Cadot and Gourdon 2015). Non-tariff measures (NTMs) comprise a wide range of trade policies, such as quantitative restrictions, technical measures, sanitary and phytosanitary measures, price-control measures, barriers to trade in services, among others.[2] Applying econometric methods in the form of a gravity equation, ad valorem equivalents (AVE) of NTM are estimated. Different estimates are available, and even though they apply similar methodologies, the AVE of NTMs usually vary across estimations, because of small differences in the methods, in the underlying data, and the year of reference.

Figure 4 compares AVE of NTMs estimated for goods and for services in Colombia. The goods with highest NTM protection usually also have high tariff rates: Agriculture and Food, Motor vehicles and parts, Wearing apparel, and also Wood and paper products. All service sectors face some form of import restriction.

Figure 4. Ad valorem equivalents of Non-tariffs measures applied by Colombia



[2] A classification of NTMs can be found at UNCTAD: https://unctad.org/topic/trade-analysis/non-tariff-measures/NTMs-classification.



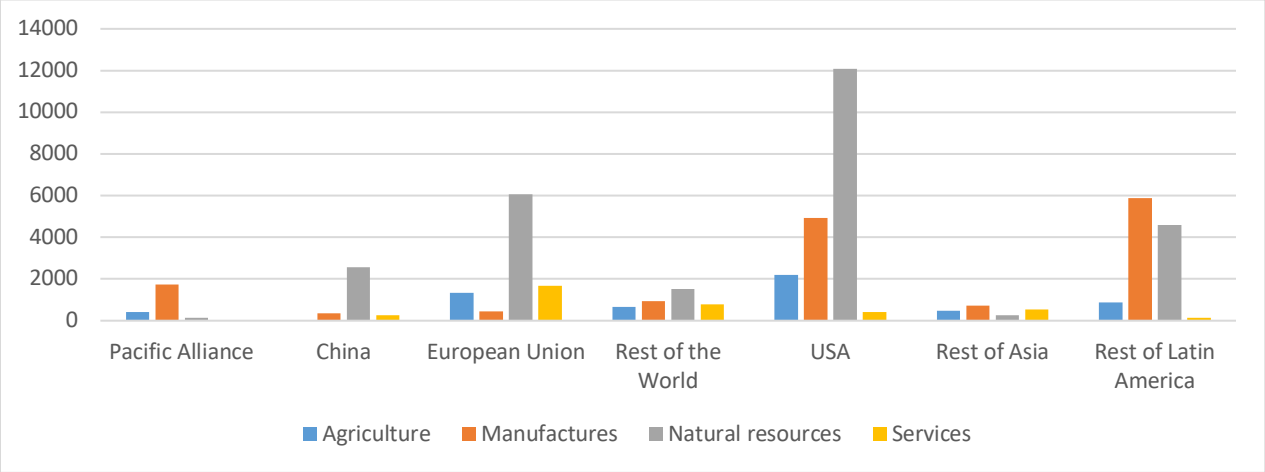
Source: own elaboration

The recent ad valorem equivalents (AVE) of NTM estimates by Kee and Nicita (2018) differentiate between technical and non-technical NTMs for goods. The AVE are estimated at the bilateral level. On average, AVE of non-technical NTM are high among agriculture and food products, as they mainly consist in sanitary and phytosanitary measures. However, when estimated at the bilateral level, we find high non-technical NTMs on imports of Food products from China, Singapore and Mexico; Textiles from Korea and Rest of Latin America; Wearing Apparel from China, other South Asian countries and Middle East and North African countries, and Other transport equipment from Japan.

Trade concentration

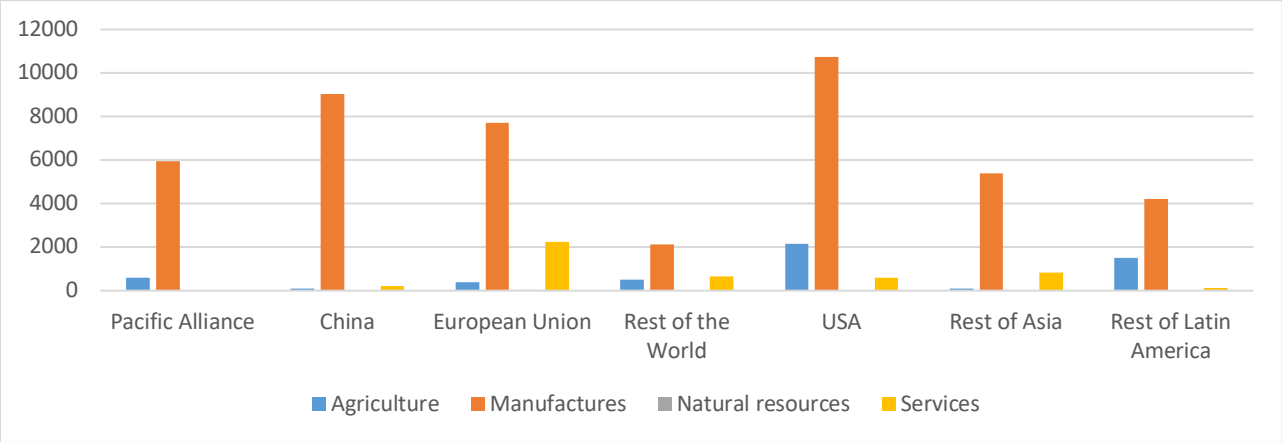
Exports of Colombia are highly concentrated in few markets and few products. The main destinations of Colombian exports are United States, the European Union, and other Latin American countries (Figure 5). Oil exports represent around 60% of total Colombian exports. Manufactures exports are highly concentrated in chemicals, rubber and plastic products and metals, and are mainly directed to other Latin American countries, Pacific Alliance members, and United States. Exports of services, on the other hand, are mostly directed to the European Union. Manufactures account for the largest share of imports, sourced from different regions in the world. Imports of services are mostly from the European Union.

Figure 5. Main export products and destinations, 2014. In million US dollars.



Source: own elaboration with data from GTAP v10

Figure 6. Main import products and origins, 2014. In million US dollars.



Source: own elaboration with data from GTAP v10

Policy Options

Using a global, dynamic general equilibrium model, calibrated with data for Colombia, we analyze the impact of the different options for Colombia. The details of the model and the underlying data are presented in the methodological appendix. For each scenario, we assume three alternatives: no movement of international capital, movement of international capital, and changes in productivity as a result of the tariff reductions and the inflow of international capital.[3]

[3] The elasticities of tariff reduction to productivity and FDI inflows to productivity are from Echavarría, Giraldo and Jaramillo (2019b) and Amann and Virmani (2014) respectively. Echavarría, Giraldo and Jaramillo find very low impact of NTM reduction on productivity, and thus we do not assume changes in productivity due to a fall in NTMs.

The proposed scenarios simulate changes in tariffs and changes in NTMs, both unilaterally and within trade agreements. We first present the scenarios in which we only simulate changes in tariffs (market access scenarios) and then we present the scenarios which also incorporate changes in NTMs (NTMs scenarios).

There are two scenarios of unilateral trade reform. First, a scenario of unilateral reduction in tariffs reduces all MFN tariffs to 6%, leaving the tariffs below 6% at their initial level. Then, we simulate a scenario of elimination of non-technical NTMs, from the Kee and Nicita (2018) database used to calibrate the model.

Two scenarios of Free trade agreements, with two Asian economies: China and Japan are simulated. In the case of China, we assume that Colombia reaches an agreement like the one signed by Peru in terms of merchandise trade liberalization, although we assume that Colombia has reservation in the automotive sector. We also assume a reduction in non-tariff measures: 15% reduction in goods except textiles, 5% reduction in textiles, and 2.5% reduction in services. The agreement with Japan is assumed to be less ambitious. It only covers goods, with tariff reduction schemes like the ones negotiated by Mexico with Japan. We assume that Colombia has reservations in sensitive products: motor vehicles and parts, textiles, wearing apparel and electrical equipment.

We also simulate the accession of Colombia to the Comprehensive and Progressive Agreement for Trans-Pacific Partnership (CPTPP). The CPTPP entered into force in 2019 among 11 countries: Australia, Brunei Darussalam, Canada, Chile, Japan, Malaysia, Mexico, New Zealand, Peru, Singapore and Vietnam. The agreement allows for the accession of new members, if all member countries agree. Colombia has shown some interest in the past in being part of the agreement. Its three partners from the Pacific Alliance, Mexico, Chile and Peru, were in CPTPP negotiations from the beginning. We simulate the potential accession of Colombia into CPTPP starting in 2021. We assume that the country applies a similar tariff reduction schedule as Peru, and that it obtains similar tariff reductions also as Peru. The main scenario assumes only changes in tariffs, without any modifications in NTMs or trade costs, and we run an alternative scenario assuming a 25% reduction in NTMs.

Finally, we simulate a scenario in which the Pacific Alliance is deepened. The Pacific Alliance is an initiative of regional integration comprised by Chile, Colombia, Mexico and Peru, established in 2011. The agreement has four associated countries: Australia, Canada, New Zealand and Singapore, with which the regional bloc is currently negotiating trade agreements. In this scenario, we assume that negotiations with associated countries finalize in 2021 and Colombia deepens its tariff reduction commitments with Australia, New Zealand and Singapore (Colombia already has a Free trade agreement with Canada, and thus we assume that no further commitments on goods are obtained within the Pacific Alliance negotiations). Also, in this scenario we assume that non-tariff measures among the Pacific Alliance members are reduced 30% for both goods and services, and that Colombia and Mexico liberalize completely trade in goods.

Market access scenarios

Table 4 compares the different market access scenarios and the impact on those policies in real GDP, exports, and imports. We present results for lower bound scenarios, which only simulates changes in tariffs, assuming no international movement of capital, as well as upper bound scenarios, which also assume international movement of capital and productivity kicks linked to the fall in protection and the increase in international capital flows.

Table 4. Macroeconomic impact of tariff reduction scenarios

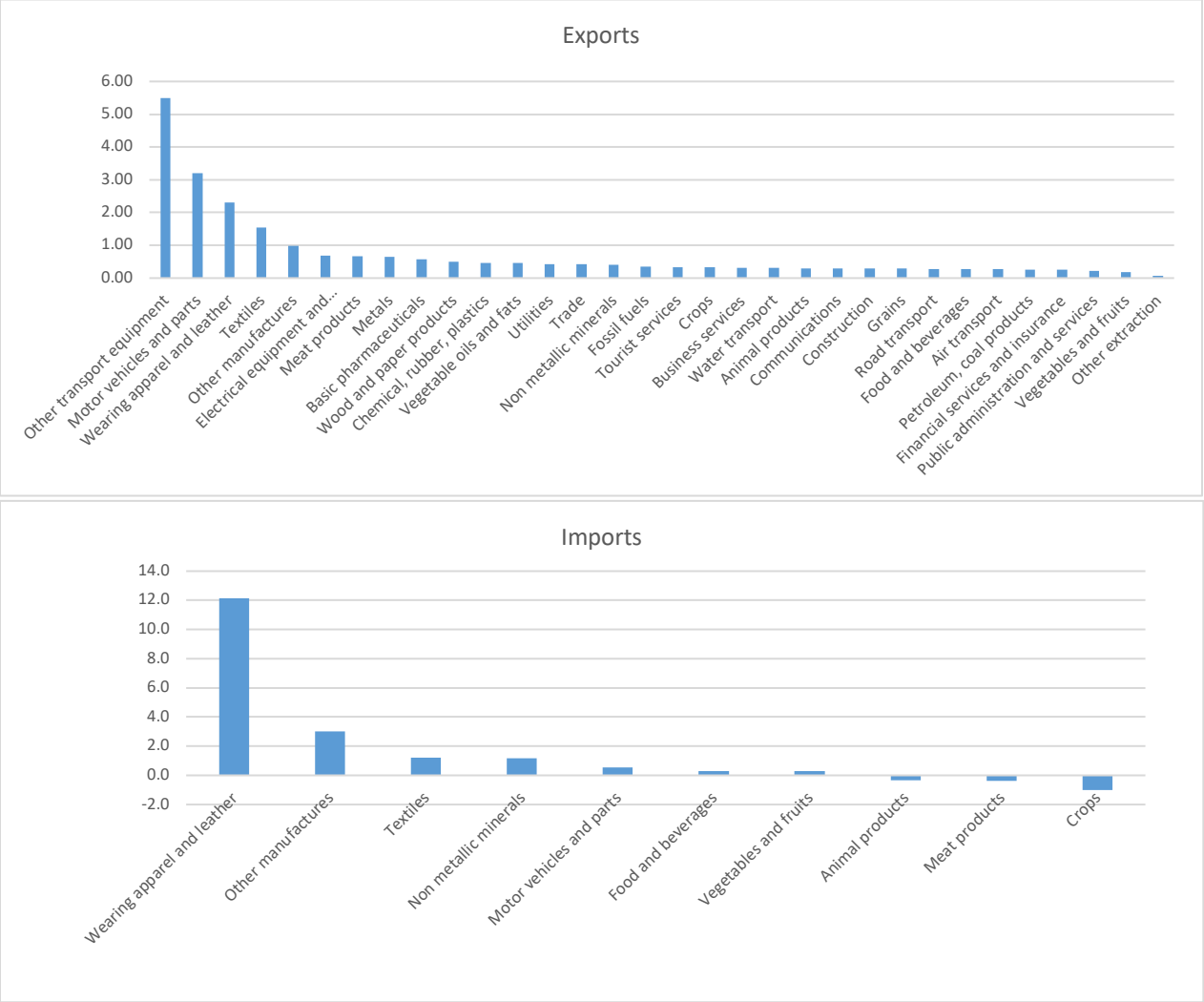
Scenario	Average tariff cut (%)	Change in real GDP (%) – lower bound	Change in real GDP (%) – upper bound	Exports - lower bound	Imports - lower bound
Uniform tariff scheme	-37.6	0.12	0.40	0.41	0.40
FTA with China	-38.8	0.09	0.36	0.65	0.61
Accession to CPTPP	-17.4	0.03	0.21	0.17	0.16
Deepening of PA	-0.4	0.01	0.09	0.17	0.15
FTA with Japan	-2.1	0.00	0.02	0.02	0.02

Source: Envisage results

The adoption of a uniform tariff scheme has a larger impact on GDP than engaging in any trade agreement, and it is easier to implement. Real GDP could increase between 0.12% and 0.40% compared to baseline values in 2035, depending on the model assumptions. The fall in tariffs has an impact on imports, which increase on average 0.40% with respect to the baseline value. Exports on average also increase 0.41% compared to the baseline. Considering non-mining products, exports increase 0.5% with respect to the baseline in 2035. This implies an annual increase of 156 millions of US dollars on average in the period 2022-2035.

Imports of goods with the highest tariff peaks rise significantly: 12% Wearing apparel and leather, 3% Other manufactures, 1.2% Textiles and 1.2% Non-metallic minerals (Figure 7). The increase in imports leads to a reduction in inputs costs, which leads to a boost in exports, especially in the manufacturing sector. The main sectors which increase exports are Other transport equipment, Wearing apparel and leather, Motor vehicles and parts and Transport equipment. When we assume an increase in productivity from the fall in tariffs, a similar picture is observed, with a slightly higher percentage change in exports. As exports of oil are almost unchanged, the country diversifies its exports. In the scenario with international capital inflows, exports increase less, as the increase in capital inflows leads to a strong real exchange rate appreciation and a loss of competitiveness of Colombian exports.

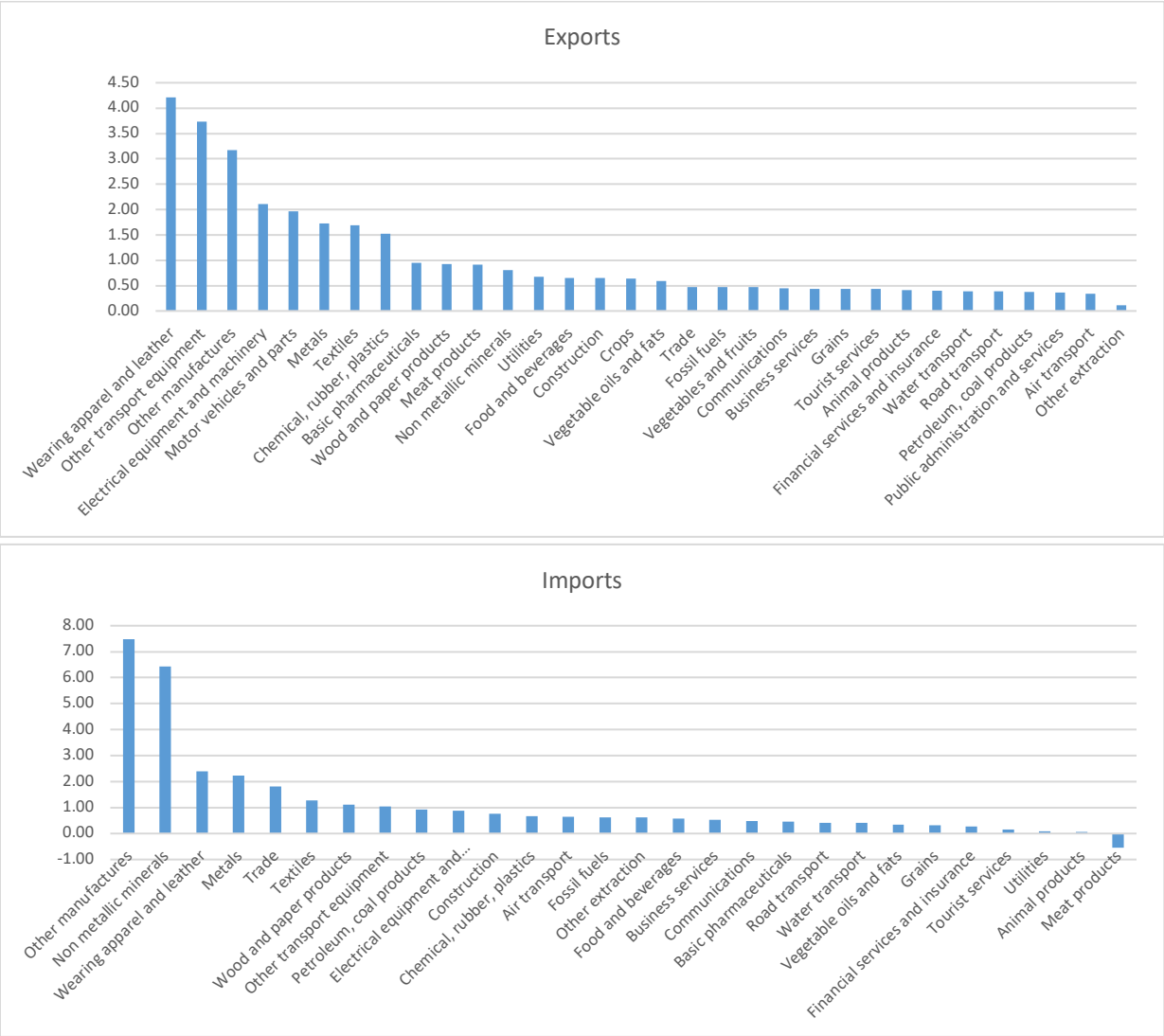
Figure 7. Uniform tariff scheme: Exports and imports by sector. Percentage change wrt BaU, 2035



Note: Lower level scenario. Source: Envisage results

A Free trade agreement with China has a higher impact on trade, as Figure 8 shows. Total exports increase 0.65% and non-mineral exports increase 0.97% in 2035, with an annual increase of 275 US million dollars on average in the period 2022-2035. The agreement grants market access to Colombian exports, and the sectors that increase exports the most are Wearing apparel and leather, Other transport equipment, Other manufactures, Electrical equipment and machinery, and Motor Vehicles. These results do not consider the increase in productivity expected due to the fall in tariffs applied on goods. With a productivity increase, exports increase slightly more.

Figure 8. FTA with China: Exports and imports by sector. Percentage change wrt BaU, 2035.



Note: Lower level scenario. Source: Envisage results

A shallow FTA with Japan would not have a significant impact on growth and trade in Colombia. Also, the impact of deepening the Pacific Alliance with the reduction of NTMs among its members and the reduction of tariffs with associated countries is very low. On the other hand, the accession of Colombia to the CPTPP leads to more significant impacts on growth and trade. Real GDP would increase up to 0.21%. Accessing CPTPP would boost exports of Transport equipment, Motor vehicles and parts, Electrical equipment, Wearing apparel and leather products, Meat products, and Textiles. If Colombia needs to focus on signing a new trade agreement, the accession to CPTPP seems a better option than negotiating bilaterally with Japan or deepening the Pacific Alliance, although the impact of an FTA with China is higher.

All scenarios increase the sectoral diversification of exports. In terms of destination markets, export diversification increases with new trade agreements, especially with China and CPTPP. The unilateral reduction of tariffs, on the other hand, leads to a higher concentration of exports in destination markets.

NTM scenarios

We focus on two scenarios which imply reductions of NTMs: a unilateral elimination of non-technical barriers, and the introduction of NTM reductions in an FTA with China. The first scenario is not strictly realistic, as many non-technical measures are actually trade-enhancing, such as sanitary and phytosanitary measures. However, as the higher AVE estimates applied by Colombia are found in manufacturing sectors, the elimination of these barriers is feasible. The unilateral reduction has a higher impact on real GDP under the lower bound scenario, and also a higher impact on trade, than the FTA with China, as Table 5 presents.

Table 5. Macroeconomic impact of NTM scenarios

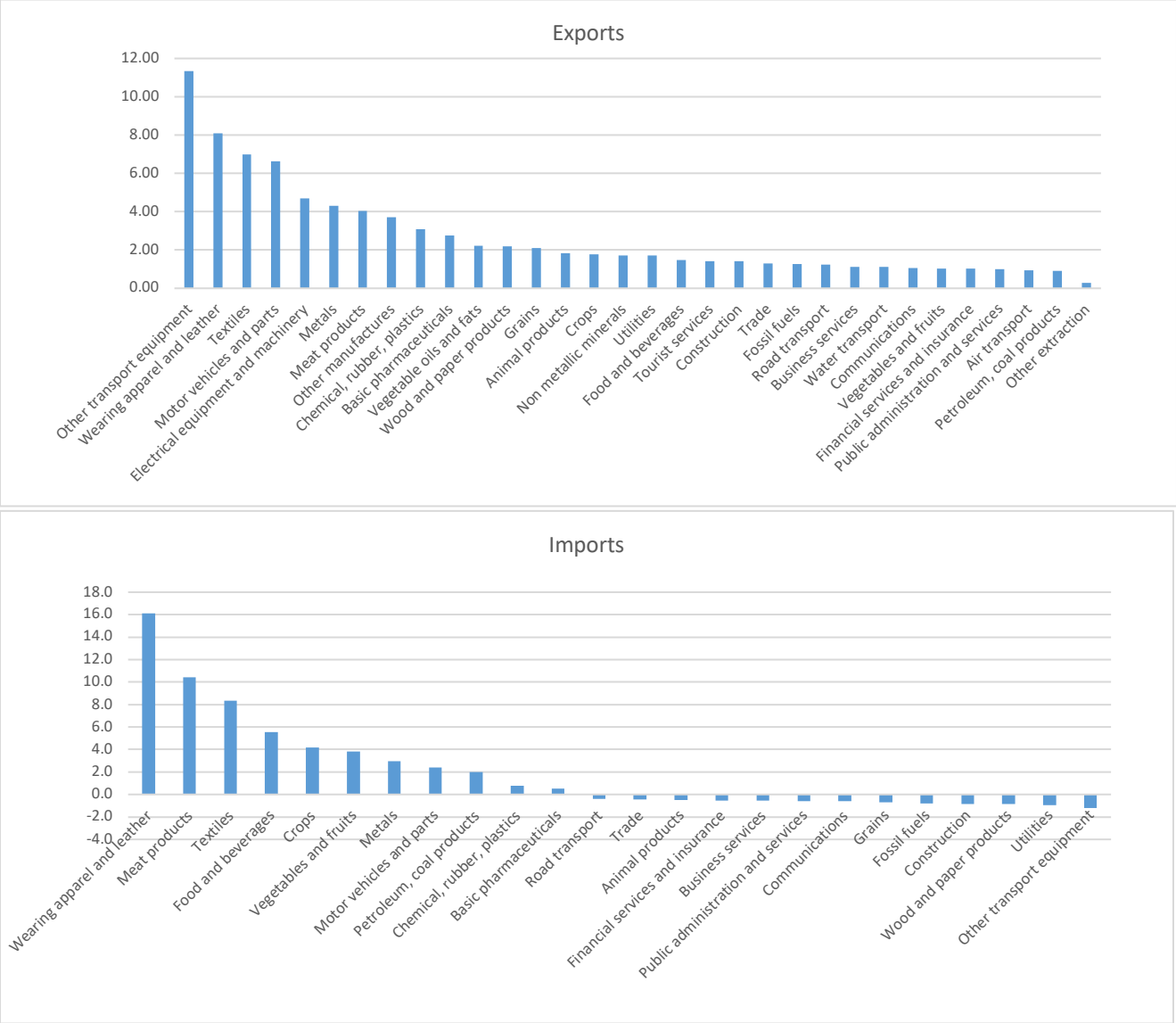
Scenario	Average NTM reduction (%)	Change in real GDP (%) – lower bound	Change in real GDP (%) – upper bound	Exports -lower bound	Imports -upper bound
Non-technical NTM elimination	-32.0	0.20	0.56	1.65	1.52
FTA with China with NTM reduction	-11.5	0.12	0.66	0.97	0.89

Source: Envisage results

The impact on exports and imports by sector is higher than under any market access scenario. The sectors that increase exports the most are mainly manufactures (Other transport equipment, Wearing apparel and leather, Textiles, and Motor vehicles and parts), which benefit from the fall in input costs, such as in the market access scenarios. Tariffs peaks and more restrictive non-technical NTMs are applied broadly in the same sectors, and thus imports of Wearing apparel and leather, Textiles, Metals, and Motor vehicles and parts increase, as well as agriculture imports, on which sanitary and phytosanitary measures are applied.

Sectoral diversification of exports increases under both NTM scenarios, more than under market access scenarios. Market diversification also improves under both scenarios.

Figure 9. Unilateral NTM reduction: Exports and imports by sector. Percentage change wrt BaU, 2035.



Note: Lower level scenario. Source: Envisage results

Distributional results

Extreme poverty in Colombia at PPP(2011)$1.90/day is projected to decline to 2.5% by 2035. The World Bank estimates that in 2018, the incidence of extreme poverty in Colombia was 4.2% (as measured by the headcount ratio at PPP(2001)$1.90/day); while the same rate for Latin America & the Caribbean (LAC) stand at 3.8%. In other words, it is estimated that in 2018 there were 24.2 million people living in extreme poverty in LAC, of which 2.1 million reside in Colombia. During the last two decades, Colombia has been closing this gap with the LAC region. For instance, the incidence of extreme poverty in Colombia was 16.8% in the year 2000 (6.6 million), or four percentage points above that of the LAC region in the same year (at

12.8% or 65.7 million)[4]. For 2020 and as a result of the COVID19-induced economic depression, extreme poverty headcounts in Colombia and the LAC region are expected to rise 0.5 and 0.6 percentage points, respectively (Figure 10). For Colombia, this represents close to 250 thousand people pushed into extreme poverty as a result of the economic shock of the COVID-19 pandemic. Thereafter and under the conditions of our baseline scenario, extreme poverty reduction is projected to resume its long-term trajectory towards eradication. For the case of Colombia, extreme poverty - at PPP(2011)$1.90/day, is projected to decline to 2.5% by 2035.

By 2035, more than half of the Colombian population is projected to be part of the global middle class, with incomes above PPP(2011)$10.00/day. As an upper-middle income country, a higher-value poverty-line results more adequate to measure standards of living in the Colombian context, such as the World Bank poverty line at PPP(2011)$5.50/day or a national poverty line of PPP$(2011)10.00/day for global middle class status[5]. Figure 11 shows, under baseline conditions, the projected evolution of the poverty headcount ratio under these two poverty lines. In the baseline scenario, Colombia would experience a decline, from 31.5 to 19.5% at the PPP$(2011)5.50/day poverty line, and from 59.2% to 44.2% using the PPP$10.00/day poverty line, during the same period.

The reduction of non-technical NTMs or a Free Trade Agreement with China could raise close to 180,000 people into global middle-class status, by 2035. Under the assumptions of the Free Trade Agreement with China, 115,000 people would be lifted from poverty, at PPP(2011) $5.50/day, and 178,000 additional Colombians would reach global middle-class status by 2035. In line with the macroeconomic results presented above, the scenario that is equal in terms of magnitude is the Non-technical reduction of NTMs, on which 183,000 people would reach middle-class status and 117,000 would be lifted from poverty (at $5.50-day). These figures approximately represent declines in the 2035 poverty headcount ratios of 0.2 and 0.3 percentage points for the PPP$5.50 and PPP$10.100/day poverty lines, respectively. The Uniform Tariff Scheme scenario follows in importance, lifting 112,000 people into middle-class status and 66,000 from poverty (at PPP$5.50/day).

Trade policy options discussed in this note slow marginally the projected reduction in gender wage gaps. Under baseline conditions, the ratio of male to female wages is projected to decline 2.1% by 2035 with respect to its current level. This positive trend reflects higher demand for female labor, as the service-oriented sectors play a more prominent role in the economy. The simulation results show that the trade policy options discussed in this note slows the gains in relative wages for women by marginally moving production into agriculture and manufacturing. However, the effect is small. For instance, under the uniform tariff scheme scenario, the ratio of male to female is reduced 2.03% by 2035 with respect to its current level. – or 0.07% higher than the baseline.

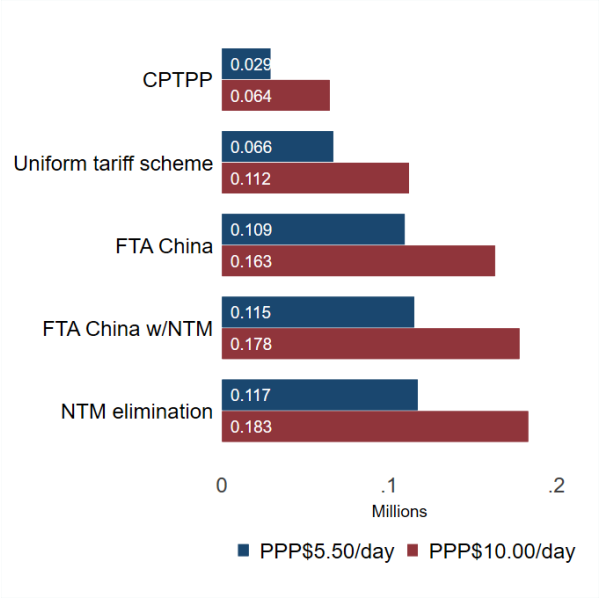
[4] With these extreme poverty headcount ratios and considering the size of the population in the year 2000, it is estimated that there were 65.7 and 6.6 million living in extreme poverty in Colombia and the LAC region, respectively.

[5] In 2018, the poverty headcount ratio in Colombia using the World Bank PPP$(2011)5.50/day is estimated at 31.5%. The headcount ratio using the PPP$(2011)5.50/day poverty line is 3.2 percentage points below the rate calculated using Colombia´s national monetary poverty line for 2018. See https://www.dane.gov.co/index.php/estadisticas-por-tema/pobreza-y-condiciones-de-vida/pobreza-y-desigualdad/pobreza-monetaria-y-multidimensional-en-colombia-2019

Figure 10 Poverty headcount ratio (%), at PPP$5.50 and PPP$10.00/day poverty lines

Source: ENVISAGE and microsimulation results

Figure 11 Additional people lifted above the PPP$5.50 and PPP$10.00/day poverty lines, by scenario



Source: ENVISAGE and microsimulation results

References

Aguiar, Angel, Maksym Chepeliev, Erwin Corong, Robert McDougall, and Dominique van der Mensbrugghe (2019) The GTAP Data Base: Version 10, Journal of Global Economic Analysis, Vol.4 No.1.

Amann, Edmund, and Swati Virmani (2015) Foreign direct investment and reverse technology spillovers: The effect on total factor productivity, OECD Journal: Economic Studies Volume 2014.

Benz, S. and A. Jaax (2020), "The costs of regulatory barriers to trade in services: New estimates of ad valorem tariff equivalents", OECD Trade Policy Papers, No. 238, OECD Publishing, Paris, https://doi.org/10.1787/bae97f98-en.

Cadot, O., J. Gourdon (2015) NTMs, Preferential Trade Agreements, and Prices: New evidence, Working Paper 2015-01, CEPII. http://www.cepii.fr/PDF_PUB/wp/2015/wp2015-01.pdf

Cadot, O., J. Gourdon and F. van Tongeren (2018), "Estimating Ad Valorem Equivalents of Non-Tariff Measures: Combining Price-Based and Quantity-Based Approaches", OECD Trade Policy Papers, No. 215, OECD Publishing, Paris, https://doi.org/10.1787/f3cd5bdc-en.

Echavarría Soto, J.J., I. Giraldo Salazar, and F. Jaramillo Mejía (2019a) Equivalente arancelario de las barreras no arancelarias y la protección total en Colombia, in García García, J., E. Montes Uribe, I. Giraldo Salazar (eds.) *Comercio exterior en Colombia: política, instituciones, costos y resultados*. Bogotá: Banco de la República.

Echavarría Soto, J.J., I. Giraldo Salazar, and F. Jaramillo Mejía (2019b) Protección y productividad en la industria colombiana 1993-2011, in García García, J., E. Montes Uribe, I. Giraldo Salazar (eds.) *Comercio exterior en Colombia: política, instituciones, costos y resultados*. Bogotá: Banco de la República.

Estrades, C., M. Flores (2020) Trade policymaking in Uruguay: Recent trends and challenges ahead, The World Economy, Special Issue Article.

Fontagné, Lionel, Cristina Mitaritonna and José E. Signoret (2016). "Estimated Tariff Equivalents of Services NTMs," CEPII Working Paper 2016- 20, August 2016, CEPII.

Hoekman, B. and B. Shepherd (2019) Services Trade Policies and Economic Integration: New Evidence for Developing Countries. CEPR Discussion Paper No. DP14181, Available at SSRN: https://ssrn.com/abstract=3504610.

International Monetary Fund (2019) World Economic Outlook: Global Manufacturing Downturn, Rising Trade Barriers. Washington, DC, October.

Jafari, Y., D.G. Tarr (2015) Estimates of Ad Valorem Equivalents of Barriers Against Foreign Suppliers of Services in Eleven Services Sectors and 103 Countries. The World Economy Vol 40 Issue 3, Special Issue: Services and Manufacturing Activity, pages 544-573.

Kee, H., Nicita, A., & Olarreaga, M. (2009). Estimating Trade Restrictiveness Indices. The Economic Journal, 119(534), 172-199. http://www.jstor.org/stable/20485299

Kee, Hiau Looi, and Alessandro Nicita (2017) Trade Frauds, Trade Elasticities and Non-Tariff Measures, mimeo, World Bank.

Maliszewska, Maryla; Osorio-Rodarte, Israel; Gupta, Rakesh. 2020. Ex-Ante Evaluation of Sub-National Labor Market Impacts of Trade Reforms. Policy Research Working Paper; No. 9478. World Bank, Washington, DC. World Bank. https://openknowledge.worldbank.org/handle/10986/34833

United Nations (2020) World Population Prospects 2019.

van der Mensbrugghe, Dominique (2019) The Environmental Impact and Sustainability Applied General Equilbirium (Envisage) Model. Version 10.01, The Center for Global Trade Analysis, Purdue University.

Methodological appendix

1. Envisage model

We use a global recursive dynamic computable general equilibrium (CGE) model, ENVISAGE, which has been applied at the World Bank for a number of studies. Full documentation of the model is found in van der Mensbrugghe (2019). The model is a relatively standard multi-country model, with a focus on the economics of climate change.

Production in the model is implemented as a series of nested constant-elasticity-of-substitution (CES) functions aiming to capture the substitutability and complementarity across all inputs. Crops and livestock have a differentiated production structure from the rest of the production goods, as fertilizers and feed are incorporated into the value-added bundle respectively. The model incorporates five types of production factors: labor (differentiated by skill and by gender); capital; land; a sector specific natural resource (such as fossil fuel energy reserves); and water.

Domestic production is allocated in the domestic market or exported, following a constant elasticity of transformation (CET) function. There are three domestic final demand agents: households (h), a government sector (gov) and an aggregate investment sector (inv). Income comes from payments to factors of production and is allocated to households (after taxes). The government sector accrues all net tax payments and purchases goods and services. Investment income is equated to the sum of domestic and foreign savings. A portion of capital income flows to a 'global' holder of equity that then portions out profits from the global fund. Remittances are also incorporated and are fully bilateral.

The model incorporates multiple utility functions for determining household demand. In this specification, a constant-differences in elasticities (CDE) utility function is assumed. This function allows for more flexibility in terms of substitution effects across goods and for non-homotheticity.

The capital market assumes vintage capital. New capital is allocated across sectors to equalize rates of returns. Installed capital is imperfectly mobile across sectors. If all sectors are expanding, old (installed) capital is assumed to receive the economy-wide rate of return. In contracting sectors, old capital is sold on secondary markets using an upward sloping supply curve. This implies that capital is only partially mobile across sectors. Land and water are allocated across activities using a nested CET specification. Natural resources are supplied to each sector using an iso-elastic supply function with the possibility differentiated elasticities depending on market conditions.

Trade is modeled using the so-called Armington specification that assumes that demand for goods is differentiated by region of origin. The model allows for domestic/import sourcing at the aggregate level (after aggregating domestic absorption across all agents), as well as at the agent level. Thus, a second Armington nest allocates aggregate import demand across all exporting regions using a representative agent specification. Exports are modeled in an analogous fashion using a nested constant-elasticity of-transformation (CET) specification. The domestic supply of each commodity is supplied to the domestic market and an aggregate export bundle using a top-level CET function. The latter is allocated across regions of destination using a second-level CET function.

As standard, the model considers trade policy instruments, such as tariffs and non-tariff measures. Cross-border trade in services is modelled as trade in goods, also following the Armington specification. We assume cross-border barriers to trade in services, which are usually included in the so-called non-tariff measures, which account for any discriminatory measures or regulations. NTM measures generate a revenue, collected by the government in each country.

The model allows for cross-border mobility of capital directed to investment in the recipient country. To do so, the model assumes a capital supply schedule that links the growth in capital (for each region) to deviations in the region's rate of return relative to an exogenous normal rate of return. A positive deviation leads to growth in capital above trend, GrK_{trend}, with lower and upper bounds for capital growth. A logistic function describes the capital growth schedule where the curvature parameter, χ, is calibrated to account for FDI inflows in the baseline. We also assume that total factor productivity in the economy increases as a consequence of an increase in capital inflows, using the elasticities of TFP to FDI increase estimated in Amann and Virmani (2014). Finally, when capital inflows increase, the share of capital income destined to the global fund also increases proportionally.

Dynamics in Envisage involve three elements. Labor supply (by skill level) grows at an exogenously determined rate. The aggregate capital supply evolves according to the standard stock/flow motion equation, i.e. the capital stock at the beginning of each period is equal to the previous period's capital stock, less depreciation, plus the previous period's level of investment. The third element is technological change. The standard version of the model assumes labor augmenting technical change—calibrated to given assumptions about GDP growth and inter-sectoral productivity differences. In policy simulations, technology is assumed to be fixed at the calibrated levels.

2. Calibration and scenarios

2.1. Data and calibration

The model is initialized and calibrated to the GTAP Data Base, Version 10, with 2014 as reference year (Aguiar et al. 2019). The 141 regions in the database have been aggregated to 19 regions (see Table A1), including Colombia's main trade partners. Similarly, the database's 65 sectors have been aggregated to 32 (Table A2), among which there are 7 agriculture and food sectors, 3 extractive sectors, 11 manufacture sectors, and 11 service sectors.

Table A1. Regional aggregation

Region	Description	Region	Description
CHL	Chile	JPN	Japan
COL	Colombia	KOR	Korea
PER	Peru	IND	India
XLAC	Rest of Latin America and Caribbean	XASIA	Rest of Asia
CAN	Canada	MENA	Middle East and North Africa
USA	United States	NGA	Nigeria
MEX	Mexico	ZAF	South Africa
EU27	European Union	SSA	Rest of Sub-Saharan Africa
XEE	Rest of Europe and ex-USSR	ROW	Rest of the World
CHN	China		

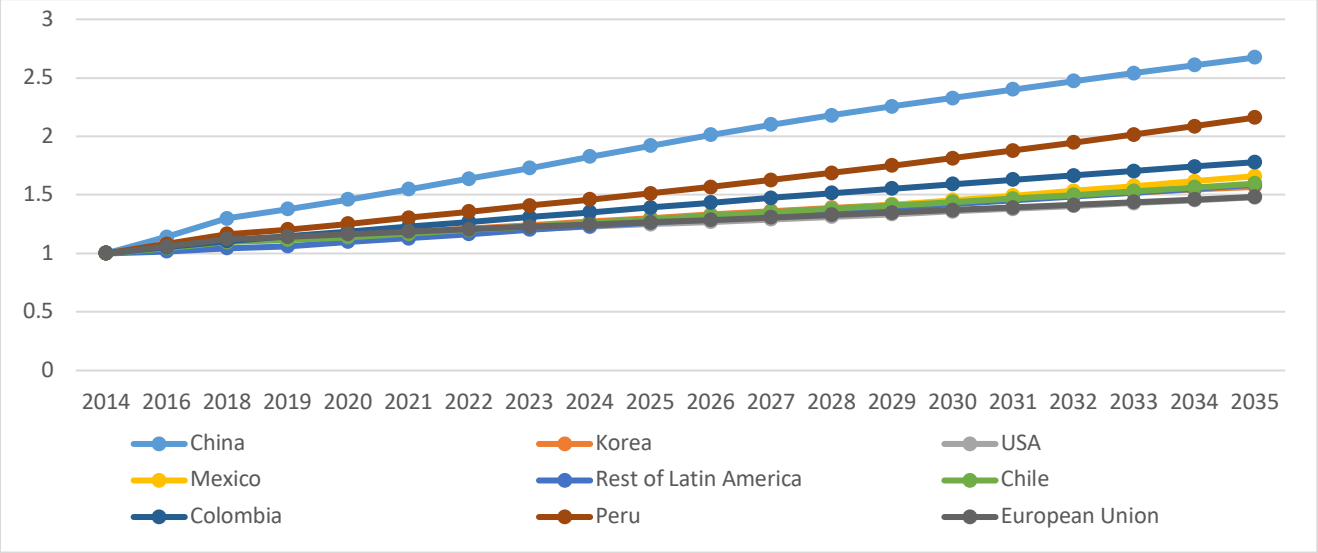
Table A2. Sectoral aggregation

Sector	Description	Sector	Description
GRA	Grains and oilseeds	MET	Metals
V_F	Vegetables and fruits	ELM	Electrical equipment and machinery
CRO	Crops	MVH	Motor vehicles and parts
APR	Animal products	OTN	Other transport equipment
PFD	Food and beverages	OMF	Other manufactures
FFL	Fossil fuels	UTL	Utilities
OXT	Other extraction	CNS	Construction
MEA	Meat products	TRD	Trade
VOL	Vegetable oils and fats	AFS	Tourist services
TEX	Textiles	OTP	Road transport
WAL	Wearing apparel and leather	WTP	Water transport
WDP	Wood and paper products	ATP	Air transport
P_C	Petroleum, coal products	OBS	Business services
CRP	Chemical, rubber, plastics	CMN	Communications
BPH	Basic pharmaceuticals	FIS	Financial services and insurance
NMM	Non-metallic minerals	PUB	Public administration and services

The baseline, or Business-as-Usual (BaU) scenario, runs from 2014 through 2035. The baseline targets real GDP growth and calibrates labor productivity, which is then fixed in the simulation scenarios. GDP projections are taken from the World Economic Outlook database, October 2019 (IMF 2019). Thus, the BaU does not consider the negative impact on GDP from COVID. Figure 1 shows the impact on real GDP growth rate in the BaU of Colombia and some of the regions included in the model aggregation. In the

medium run, the real GDP growth rate for Colombia is 2.4% (see Figure A1).[6] After China and Peru, Colombia shows the fastest growth rate among the selected economies in the period 2014-2035.

Figure A1. Real GDP. Index 2014= 1



Source: Envisage results

The baseline also targets population growth following the latest UN population projections (UN 2020), as well as the GIDD projections, available by broad age group (we use the 15-64 age cohort for labor force), gender, and education (primary, secondary and tertiary). Growth of skilled labor is equated with the growth of specific education categories. For low- and lower-middle income countries, skilled workers are equated with secondary and tertiary levels. For upper-middle and high-income countries, skilled workers are equated with tertiary levels only.

The baseline includes tariff reduction schedules of all trade agreements in force, from MacMap, International Trade Center (ITC) database.[7] In the case of Colombia, it includes tariff reduction schemes from Free Trade Agreements signed with United States, Canada, the Pacific Alliance members, European Union, and Korea.

3. Distributional analysis

Poverty estimates were obtained from a reduced from of the ENVISAGE-GIDD macro-micro simulation model (Maliszewska, Osorio Rodarte, and Gupta, 2020). The ENVISAGE-GIDD model has been used in prospective studies for the analysis of policy scenarios that involve general equilibrium assumptions such as those related with trade policy, long-term demographic changes, or climate change.

Linkage between a macro CGE and micro data is established with only 2 aggregate variables: a) growth in per capita household consumption and b) the size of working-age and total populations. This reduced

[6] In the most recent GDP projections, which consider the 2020 negative Covid shock, the long-term GDP growth is not affected. For this reason, we chose not to consider the 2020 GDP fall in the BaU, as it would not imply long-term changes in the economies.
[7] https://www.macmap.org/en/about/methodology

form of the ENVISAGE-GIDD provides a good first-order approximation of poverty estimates, especially in the short-to-medium term. While it is easy to implement, simplicity in the number of linkage aggregate variables make the model incapable of simulating within-country inequality changes.

The initial distribution of per capita consumption/income is constructed with household-based data. For the case of Colombia, nationally representative household surveys obtained from the World Bank's Global Micro Database (GMD). Additional per capita consumption/income distributions were obtained from the PovcalNet website. In both cases, the most recent distribution of per capita consumption/income was aligned to the 2018 World Bank poverty estimate.

Growth is transmitted from macro CGE to household survey data. Growth in real per capita household consumption is obtained from the World Bank Macro and Poverty Outlook (2020 and 2021) and from the CGE model, for the period of 2021 to 2035 – This rate of growth is transmitted, under distribution-neutral assumptions, the distribution of per capita consumption/income. The total population is adjusted to reflect population growth according to the United Nation's World Population Prospects (United Nations-The Population Division of the Department of Economic and Social Affairs, 2017).