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Evaluating the Impact of Transport Costs in Latin America[1]

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Abstract

Applying a multi-region, recursive dynamic general equilibrium model, this study evaluates the impact of a reduction of trade transport costs in Latin America, which are now considered as a significant impediment to trade. The novelty of this study is three-fold. First, the model applies very rigorous and precise estimates of *ad valorem* transport costs and relevant elasticity of substitution on trade for Latin America (Moreira, Volpe and Blyde: 2008). Second, it accommodates the concept of the "effective price and quantity", introduced by Hertel, Walmsley and Itakura (2001). The simulation results on trade are fairly consistent with the econometric estimates (Moreira, Volpe and Blyde: 2008). Third, the model, which is built on the updated 2008 new SAMs, traces growth trajectories and captures the time-path dynamic and cumulative effects.

The simulation results show very promising and strong gains due to reducing transport costs. A 10-percent reduction of transport costs in Latin America would increase the region's real GDP by more than 2 percent. The impact on trade is more dynamic. The intra-regional exports jump by 22 percent, equivalent to $33.8 billion at 2008 prices. But reflecting the initial heterogeneity in the structure of transport costs, the positive impact is fairly asymmetric over sectors and countries. The simulation results also show that an improvement of transport infrastructure is by far an effective policy option to foster growth and trade than tariffs do: in terms of real GDP, it generates 10 times greater gains, and 4.5 times larger effects on trade.

Key Words: Transport costs, Effective price and quantity, Recursive dynamic CGE model, Latin America

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1. Introduction

Over the last two decades, Latin America has made tremendous efforts in liberalizing its regional and extra-regional trade. As a result, tariffs, which have been long considered as the most restrictive barriers to trade until the late 1980s, have come down substantially. Today the region's MFN tariffs are at around 10 percent, whereas its preferential tariffs are less than half of the MFN. Thus, while traditional forms of trade barriers have been reduced significantly, there are still, if not many, unfinished agendas in trade fronts, to name a few, the need to perfect, harmonize, and bridge numerous existing agreements (Estevadeordal et al., 2009), whose potential benefits can be anything but residual. Furthermore, tariffs and non-tariff barriers do not cover the wide range of costs to intra- and extra-regional trade faced by LAC countries. Indeed, while these types of barriers have been prominent and dominant until very recently and the emphasis on their reduction or removal was justified, other less visible costs that increasingly matter for trade were long neglected. These costs can be generally categorized as trade costs, which include transport costs, logistics costs, transaction costs and administrative costs and so on. Taken as a whole, these costs in LAC range from 18 to 40 percent of GDP by country (Guasch and Kogan, 2006) and can constitute more than half of the price of delivered goods (Schwartz, et al. 2009), depending upon product and trade route.

Among trade costs, it is widely recognized that transport costs constitute the major cost components. The recent studies indicate that the region's states of transport costs are, with a few exceptions, far behind the system in advanced countries.[3] High transport costs in Latin America hinder trade in a tremendous magnitude,[4] and more importantly act to undermine the region's global competitiveness. These situations are tremendous threats for Latin America in competing with China, India and other Asian emerging countries in the world market today and in coming decades.

Until very recently, there are few comprehensive studies evaluating the effects of trade-related transport costs. Applying the econometric estimates for 11 counties in Latin America, Moreira, Volpe and Blyde (2008) find that the reduction of transport costs in the form of freight costs would generate potentially sizable effects on trade in the order close of 30 percent. The rigorous applications in a CGE framework are also a few. Hertel, Walmsley and Itakura (2001) pioneered explicitly to deal with trade costs by introducing the notion of "effective price and quantity", and find that the new age free trade agreement between Japan and Singapore will generate the global gains in excess of $9 billion annually by 2020, and

[3] See the following section for more detail.

[4] For instance, exports account for more than 20 percent of GDP in Latin America in 2008, with the largest share of 43 percent in Chile, whereas Peru and Brazil have the smallest share of 13 percent. Moreover, the region's aggregate trade surplus amounts to $64.6 billion in 2008.

the bulk of gains accrue from the reduction in prices in customs atomization. With the use of "iceberg costs", Minor and Tsigas (2008) further elaborate the methodology by Hertel, Walmsley and Itakura (2001), and their study suggest that 50-percent reduction in the "time to exports" will generate huge gains particularly low income developing countries. Applying the same concept of the "effective price and quantity", Stone, Strutt and Hertel (2009) measure the improvement of transport infrastructure in the Greater Mekong Subregion will raise the region's welfare by $7.9 billion. Francois et al. (2003) find in their evaluation of the Doha Round that trade facilitation in the *ad valorem* form yields dramatic short-run effects as well as long-run impact, generating a third of world gains ($212 billion) under the scenario of 50 percent liberalization of border measures. Zaki (2010) estimates that the removal of administrative barriers to trade, measured in terms of *ad valorem* equivalent structure, will have positive effects for the world, with the largest welfare gains by more than 5 percent accrued to the rest of Asia and Africa.

In view of region's challenges on trade front today and few studies in Latin America, this study aims to fill the knowledge gap in this field and to measure the potential impact of reducing trade-related transport costs for Latin America. The novelty of this study is three-fold. First, the model is based on very refined and rigorous estimates on transport costs and trade elasticity aggregated from the product levels for the pooled trade flows in Latin America (Moreira, Volpe and Blyde; 2008). Second, the model explicitly deals with the treatment of transport costs by incorporating the concept of the "effective price and quantity", introduced by Hertel, Walmsley and Itakura (2001). Third, we apply a global milt-region, recursive dynamic model built on the updated 2008 SAMs with a focus on Latin America, thus capturing dynamic and cumulative effects in the region over time.

The preliminary simulation results indicate that a 10-percent tariff reduction in Latin America has barely an impact, with only small but positive effects on trade. The complete tariff elimination will have modest effects, raising the region's aggregate GDP by 0.3 percent and intra-LAC trade by 5 percent, or $7.5 billion at 2008 prices. It is revealed that some countries experience low trade gains as a result of the erosion of preferences and high reliance on the sub-regional markets. This is particularly the case with the Andean countries, which also increase imports of Latin American origins, diverting the sources from extra-LAC regions. The simulations results show encouraging and striking effects from the reduction of transport costs by 10 percent in the region. Intra-regional exports jump by an impressive growth of 22.6 percent, which would be comparable to the econometric estimates (Moreira, Volpe and Blyde; 2008). This is equivalent to $33.8 billion. As domestic prices of imports originating from LAC sources fall relative to the extra-LAC sources, many countries will experience trade diversion effects, depending upon market reliance between intra- and extra-Latin America. Yet the positive effects of trade creation well surpass. In most cases, the reduction of transport costs leads to further reinforcing the pattern of key bilateral trade flows. The region's real GDP and the aggregate outputs increase by more than 2 percent, thus generating a positive win-win nature of economic gains in Latin America.

The rest of the paper is structured as follows. Section 2 analyzes the trade transport costs in Latin America, evaluating the global position and intra-regional assessment. Section 3 presents the main model structure and assumptions, methodology to accommodate transport costs in CGE framework, followed by benchmark trade-related data. Section 4 presents the simulation results with the greater emphasis on trade. Section 6 summarizes the main findings and conclusions.

2. Trade Transport Costs in Latin America

2.1. Latin America's Position of Trade-related Transport Costs in the World

In Latin America, tariffs, which have been long perceived as the most restrictive barriers to trade, have declined substantially since the mid 1980s.[5] The region's MFN tariffs have dropped from an average of close to 40 percent in the middle of 1980s down to 10 percent by the early 1990s and remain that level onward. On the other hand, preferential tariffs have steadily fallen at much faster speed and reached 5 percent in the middle of this decade (Mauricio, Volpe and Ando, 2008). Although tariffs are still high in some commodities, sectors, markets and countries, the importance of this form of barriers to trade diminishes, while less visible trade transport costs have instead increasingly received policy attention in Latin America and elsewhere.[6] Figure 1 demonstrates the trend of the average MFN and preferential tariffs in Latin America in the period of 1985-2005 (Estevadeordal, Volpe and Ando; 2009).[7]

INSERT FIGURE 1

Trade is widely recognized as one of the most important policy tools for economic development. This is particularly the case for Latin America as a driver particularly for growth, key source of foreign earnings contributing to maintaining current account balance. Given already low levels of tariffs in the region, where is Latin America positioned in the world in terms of transport costs as a barrier to trade? Conventional indices all except a few suggest the region lags behind not only developed but also other developing regions in the similar development stage.

[5] Due to lack of accurate data on estimating transport costs in Central America and the Caribbean, Latin America in this study represents the following 11 countries, unless otherwise noted: Mexico, Bolivia, Colombia, Ecuador, Peru, Venezuela, Argentina, Brazil, Paraguay, Uruguay and Chile.

[6] In this study, transport costs refer to only cross-border transport costs, and do not consider domestic ones.

[7] To be clear, tariffs are measured as a simple average at the 5-digit SITC levels.

Several recent global indicators also support this view. For instance, according to the Global Competitiveness Report 2007-2008 (World Economic Forum, 2007), Latin America is considered as one of the regions bearing the highest logistic and administrative burdens affecting international trade. Only behind are Sub-Saharan Africa and South Asia, the poorest regions in the world. This clearly reveals that the region is inherent to a comparative weakness, regarding trade-related transport costs measured in the form of overall custom procedures. In terms of trade logistic efficiency, Latin America's position in the world is thus ranked behind relative to its level of development classified as middle-income region.

Likewise, measured by the Infrastructure Pillar of the Global Competitiveness Index in the Global Competitiveness Report 2009-2010 (World Economic Forum, 2010), Chile is the only country (30th) in Latin America ranked within top 50, and key countries in the region are far behind: Argentina (88), Brazil (74) and Mexico (69). Doing Business 2008 (World Bank, 2008) reports that, while being slightly ahead of emerging East Asia and Pacific region and other developing regions, Latin America is far behind the global best performer, in terms of the measurement of trading across border. On average, the region takes more than twice as many days (22 days) to export than the high-income OECD countries (10 days). Connecting to Compete Report (World Bank, 2010) shows that Latin America as a whole still lags behind the global top performers, all belonging to high-income developed countries, due to many trade logistics challenges, to name a few, low-quality trade and transport-related infrastructure, inefficient customs clearance procedures, incompetent logistic services, unreliable shipping system and so on. In terms of the Logistics Performance Index (LPI) 2010, Brazil, the best performer in Latin America, is placed 41th, up 20 ranking from 2007, but Argentina's position (48) slips by three and Chile (49) by 17 ranking. Figure 2 shows two global comparisons by region–"burdens of customs procedure" for 2007-08, reported in the *Global Competitiveness Report* 2007-2008 and "time to exports", *Doing Business* 2008.

INSERT FIGURE 2

2.2. Overview of Trade-related Transport Costs in Latin America

According to Mauricio, Volpe and Blyde (2008), trade transport costs in Latin America, measured by the *ad valorem* import freight expenditures, are on average 10.4 percent of good prices at the port of entry, which is more than twice as high as the region's average tariffs of 4.3 percent. (refer to the section 3.2). The analysis of the composition of trade transport costs across product lines can draw at least three main insights. First, Latin America's trade transport costs are nearly twice as high as those of the selected best performer in developed economies, the United States as a reference country. This suggests that the region on average spends twice as much to import its goods as the United States does (Mauricio, Volpe and

Blyde, 2008).[8] The *ad valorem* import freight expenditures of the United States is measured at 3.7 percent, whereas the region's average rate is 7.2 percent, with Argentina being the most efficient (5.1 percent) in Latin America while Paraguay the least (15 percent).

Second, trade transport costs display significantly high dispersions across product lines, with the simple mean of around 10 percent within Latin America but as high as 50 percent of total import expenditures. There may be several key factors behind this fact. Yet the region's high transport costs may be attributed by poor trade and transport-related infrastructure, inefficiencies in customs clearance procedures, incompetent trade logistics systems, delay in shipping and consignment, all of which are roughly in line with the global competitiveness indices cited before. In addition, the composition and structure of the trade within Latin America, transport modes attributed by the geography, longer lead time to exports and distance from origin to entry ports may also be the sources of pushing up transport costs. Figure 3 displays the distribution of transport costs over product lines.

INSERT FIGURE 3

Third, a considerably high proportion of goods are subject to very high transport costs within Latin America, even far beyond the region's own standards. This is clearly driven by such factors as emulated in the second point. Indeed, around 15 percent of total product lines are forced to bear high *ad valorem* import freight expenditures at the upper range between 15 and-50 percent.

With no exception, Latin America bears significantly high trade-related transport costs. In other words, the region's high trade transport costs are not associated with or driven by particular country or group of countries. In fact approximately 22 percent of product lines traded within Latin America face *ad valorem* transport costs at the range of 8.5-12.5 percent (see Figure 3). This might imply that dominant factors behind region's high trade transport costs may be, among many elements, attributed to distances associated with cross-country intra-regional transport costs mostly determined by geography―distance between ports of origin and entry―composition of trade, modes of transportation (maritime, terrestrial, or aerial) and the overall efficiencies of trade and transport infrastructure. Figure 4 displays the aggregate *ad valorem* transport costs by country in Latin America.

INSERT FIGURE 4

When transport costs in Latin America are analyzed on a bilateral basis between Pacific region and Atlantic Ocean, striking intra-regional patterns emerge. Countries along the Pacific Basin each other face

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[8] Refer to chapter 1 of Mauricio, Volpe and Blyde (2008) for the comparison of import freight expenditures between the United States and countries in Latin America on bilateral basis.

slightly lower trade transport costs relative to the region's average: 9.7 percent on average.[9] The countries in the Atlantic Ocean are more efficient, with the lowest *ad valorem* transport costs of 7.1 percent. However, when goods are traded crossing the Andean mountain range, trade costs significantly increase. Average good prices in the Atlantic Ocean exported from the Pacific countries are charged by 11.3 percent higher than the prices shipped in the countries of origin. Transport costs for goods traded in the east-west direction jump to 13.7 percent, more than 2 percentage-points higher than the west-east trade. These salient characteristics in Latin America may be explained by the differences in transport modes. For instance, 86 percent of trade among countries in the Pacific Basin is handled by sea, whose mode of transportation is cheaper and more efficient than aerial and terrestrial modes. On the other hand, only 10 percent of goods are exported to the countries in the Atlantic Ocean by the mode of land. Table 1 shows the aggregate bilateral *ad valorem* transport costs in Latin America.

INSERT TABLE 1

3. IDB-INT CGE Model

The CGE model used for this study is a global, multi-region, multi-sector, recursive dynamic general equilibrium model with several salient extensions beyond standard trade-focused models.[10] The model operates in a two-stage sequential dynamic setting. In the first stage, a static module is solved one period at a time: *within-period* equilibrium. In the second stage, inter-temporal equations linking time-paths update endogenous and exogenous variables as well as parameters for the static module, which then finds a new equilibrium for the next period: *between-period* equilibrium. In particular, capital stock is updated endogenously, governed by the inter-temporal capital accumulation equation. In other words, the recursive dynamic model is a series of static model, which captures dynamic linkages between periods that drive the growth. The time path of the model is solved as a sequence of static equilibria in each period, only dependent on current and past economic outcomes.

The static model, which is the core module, is extended from the traditional IDB-INT trade-focused, static versions, applied for a numerous policy-relevant studies. The model comprises 20 regions and countries (See Annex 1) and 22 sectors, which are aggregated into seven macro sectors (See Annex 2). All regions are fully endogenized and linked only through trade. As such, the model deals only with the real side of the economy and does not consider the financial or monetary markets. The model is built on

[9] Countries in Pacific region comprise Colombia, Ecuador, Peru and Chile, while those in Atlantic coast consist of Argentina, Brazil, Paraguay and Uruguay.
[10] Guzman and Watanuki (2010) apply this line of model, which accomodates complex modules of combining an interntaional migration and remittances in a global scale.

individual Social Accounting Matrices for each region and country at base year 2008, and recursively simulates over the year 2020.

3.1. Structures and Features of the Within-period Static Module

The within-period module is the one-period static component, which is the core of the model. Based on strong microeconomic foundation as well as trade and consumer theories, the model explicitly defines behaviors of the respective economic agents−firms, households and government−as well as economic environments in which these agents operate. The following section outlines key elements of the static module.

Production

Production is modeled in a constant returns-to-scale technology under the perfect competitive market framework. It is modeled in a multi-stage nested structure, expressed in a Constant Elasticity of Substitution (CES) function in all stages. At the top level, domestic output is specified between the aggregate intermediate input and aggregate value added (composite primary factor). At the second stage, each aggregate intermediate input, which comprises domestic output and the aggregate imports, is determined by the fixed Leontief IO coefficients. On the other hand, the aggregate value added is again specified in the CES function among 4 factors of production: labor, capital, land and natural resources. Based on Docquier, Lowell, and Marfouk (2008) with their recent updates supplemented by national labor statistics for some selected countries in Latin America, labor market is decomposed into three categories by skill−low, medium and high−and specified in a CES aggregate function. This is intended to capture the high degree of rigidity, inflexibility and segmentation in labor market in Latin America.

At all levels of production tree, the optimal levels of factor demand in each sector are determined by agents' cost-minimization and profit maximization process, implying that marginal value product exactly equals its corresponding marginal cost. However, each factor does not necessarily generate uniform returns (wages, capital and land rents) across sectors. Instead, the model incorporates factor market rigidities or distortions, which exogenously fix the ratios of the relative sectoral returns to the economy-wide average return for that factor at benchmark. It is assumed that these market distortions remain intact as in base year 2008 over the simulation periods.

The treatment of mobility differs by factor. Labor is assumed to move freely across sectors, or to shift from one sector to another without any relocation costs. But its supply for each category is endogenized as an upward-sloping function of real wage (nominal wage discounted by consumer price index), with its responsiveness being governed by the elasticity of each labor supply. International migration is not considered. Capital is mobile only within each country or region. Land is a mobile factor and used only in agriculture. Natural resources are sector-specific factors and used in resource-based energy and some agricultural sectors.

International Trade

International trade follows the standard specifications in common with other trade-focused CGE models. The model specifies a set of export-supply and import-demand equations for traded sectors, allowing national product differentiation at each sector. Both exports and imports are modeled in a two-stage nested structure. Exports are modeled in a constant elasticity of transformation (CET) function. The optimal allocation of supply is determined by revenue-maximization choice between domestic sales and aggregate export supply at the upper stage, and among exports destined to different markets at lower stage. On the other hand, imports are modeled by the CES function, following the "Armington" assumption.[11] The optimal allocation of demand is determined by cost-minimization choice between domestic demand and aggregate import purchase at the upper level, and imports from different sources at lower stage. Trade elastcities, key parameters governing the trade responsiveness to policy shocks, are taken from Moreira, Volpe and Blyde (2008), and estimated as a simple average at the highest HS digit in each sector.

Institutional Income and Commodity Demand

The model incorporates and distinguishes different domestic institutions (households, firms, and government), tracing circular flows of income from factor payments embedded in the production process to institutions. These institutions represent economic agents whose behaviors and interactions are explicitly specified in each country. On the income side, a single representative household receives factor income generated in the production in a fixed proportion to each factor income. In addition to factor income, which represents the bulk of the aggregate income and wage remunerations are by far the main components, households also receive various transfers from other domestic institutions−firms (dividends or distributed profits), inter- and intra-household transfers and government subsidies−plus remittances from abroad. This structure is also the same for firms, for which capital income is the main source.

On the expenditure side, households and firms pay income and social security taxes, transfer to domestic households at fixed proportion, save based on either fixed marginal propensities or as residuals, remit to the rest of world. Household consumption demand is specified in a combination of CES and the linear

[11] Armington (1969).

expenditure system (CES-LES) function,[12] derived from the maximization of a Stone-Geary utility function, subject to budget constraints, while composite goods (or absorption) are expressed in a two-stage nested CES function. LES preference parameters are estimated on the basis of the Frisch parameters,[13] which measures the ratio of the households' total income (expenditures) to the supernumerary income. In estimating parameters and calibration process, the so-called "Engel aggregation" is strictly maintained.[14]

For public finance, government collects various taxes: direct taxes from households and firms; production-related output and value-added taxes; social security taxes; commodity consumption taxes; and trade-related import tariffs and export taxes. In addition, the government also receives external transfers as foreign borrowings from the rest of the world. On expenditure side, it expends goods and services as public consumption at fixed rates, earmarks subsidies to domestic institutions (households and firms), and amortizes payments to domestic and foreign lenders. All taxes are imposed by *ad valorem* rates measured at benchmark, which are assumed to remain unchanged over the simulation period. In addition, all domestic and foreign transfers are exogenously fixed.

Saving and Investment

The aggregate savings, which are pooled to finance domestic investment, comprises savings from domestic institutions plus capital inflows as foreign savings from the rest of world. Household savings are modeled in some different ways, depending upon the nature and objectives of the study (refer in the macroeconomic closure). Firms' savings are specified as residuals from their gross income less all expenses, which comprise taxes, dividend payments to domestic households and foreign shareholders. The government savings are defined as the difference between revenues and expenditures at current value. In the case of budget deficit, it is primarily financed through borrowing (dis-saving) from the domestic capital market, supplemented by foreign borrowings from the rest of the world.

The model explicitly specifies a set of investment-related equations. In this regard, investment is distinguished between the sectors or origin and destination.[15] As appeared in the SAM, the aggregate investment quantity is specified in a familiar Cobb-Douglas function. The agents' optimization process

[12] The beauty of the LES function is that it does not imply the unitary income elasticity of demand. As with demand system expressed by Cobb-Douglas or CES functions, the LES maintains straight Engel curve, but starting at a positive coefficient of the demand space, not from the origin, thereby deviating from the unitary income elasticities.
[13] Frisch (1959).
[14] The Engel aggregation requires that the sum of income elasticities weighted by sectoral consumption shares must equal to unity. In other words, the sum of sectoral consumption multiplied by income elasticities must be equal to the aggregate income.
[15] Refer Dervis, de Melo and Robinson (1982) for more detail.

yields the optimum allocation of sectoral demand of investment by sector of origin and the aggregate price of capital or price index of investment.

Regarding the investment in a dynamic setting, two key issues arise: (i) how new investment is allocated among sectors?; and (ii) how it is determined by or linked with new capital stock? In the model, these issues are carried out by the investment demand function. Following Bourguignon, Branson and de Melo (1989), Fargeix and Sadoulet (1990), and Jung and Thorbecke (2003), the investment demand by sector of destination is specified in the second order quadratic functional form. The speed of investment, defined as the ratio of investment by sector of destination over capital stock in each sector, is an increasing function of rental rate of capital and the inverse of product of price of capital (or price index of investment) times interest rate. The model strictly guarantees two balances: (i) saving-investment equality; and (ii) the aggregate investment between the sectors of origin and destination in the current value term.

Macroeconomic Closures

In the model, there are three key macroeconomic closures: public finance; saving-investment; and external account. There are a number of different options available. The choice does not affect the base equilibrium solution, which must exactly replicate the SAMs at benchmark, but influences the simulation results significantly. The rationale is which option would be realistic and preferable, given economic limitations, structural inflexibilities and rigidities as well as macroeconomic constraints for countries under study.

For public fiscal balance, the model applies endogenous public savings, which are determined as the residual between current revenues and expenditures, with treatments of all transfers being fixed. This specification allows fiscal surplus or deficit to adjust to balance public finance.[16] Moreover, to control possible welfare effects arising from variations in public spending, government consumption demand is fixed.

For saving-investment balance, the current investment in value must be completely financed by the aggregate savings in each country and region.[17] The model allows several options to equilibrate this

[16] One of familiar alternatives to balance the public finance is the so-called fiscal neutral application, which allows endogenizing one of tax components, while fixing the public savings.

[17] The saving-investment equality within each country or region is an important assumption influencing simulation results particularly in dynamic models. The IDB-INT model considers no international capital movements, as with the LINKAGE model (World Bank) and Michigan model. The salient opposite is the GTAP model, which allows perfect international capital mobility and cross-country equalization in the rates of return to capital, which would induce high cross-border capital flows. MIRAGE model by CEPII (Bchir, Decreux, Guerin and Jean, 2002) falls in-

balance. The most familiar forms are (i) neo-classical saving-driven closure, in which household saving rates (MPS) are fixed, while investment adjustment factor is the equilibrating variable; and (ii) Johansen investment-driven closure, where MPS is a free equilibrating variable.[18] Another option would be to specify household saving rates as an increasing function of real capital rant (nominal rental rate of capital divided by consumer price index, for instance). For convenience and most popular use, the model applies the first neo-classical closure as a default setting.

Finally for external market closure, there are two options: (i) fixed trade balance and (ii) fixed exchange rate. The choice depends on time horizon to be considered, responsiveness or resilience for countries to the external shocks, but has different implications for the policy outcomes. In the first option, trade is balanced for each country and region valued at world prices. In other words, initial balance of trade in goods and services remains constant over time. With fixed external capital flows and transfers, an increase in import demand due to changes in external market must be completely financed by the increase in exports. Thus, exchange rate plays a key role to equilibrate external market balances. On the other hand, the second closure is to fix exchange rate and the external balance is free to adjust, allowing evaluating the impact on the position of trade balance due to changes in demand at home and by partners. This option is often used for the short- to medium-run experiment, in which exchange rate does not necessarily respond fast enough to adjust the changes in external market. On the other hand, the second option is appropriate for medium- to long-run perspective.

3.2. Between-period Recursive Dynamic Module

The within-period static module expressed in the previous section is extended and linked with a dynamic module, in which selected endogenous and exogenous variables and parameters are updated, based on the inter-temporal behaviors and outcomes of the current and previous periods. Most of the dynamics occurs outside model proper, and one of salient exceptions is the capital accumulation, which is endogenized from one period to the next, following the inter-temporal capital accumulation equation. The aggregate capital stock in the present period is the sum of total investment plus aggregate capital stock less depreciation in the previous period.

In addition, the model has two more key endogenous between-period equilibrating variables to precisely attain or reach the targets in each period to serve as a baseline scenario: one for macroeconomic projection and the other for labor market. First, in order to reach the target real GDP growth trajectory in

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between, in which installed capital is sector-specific, but capital stock is assumed to be mobile across countries in the form of foreign direct investment (FDI)

[18] See Lofgren, Harris and Robinson (2002) for more options and extended explanations.

the baseline, the aggregate total factor productivity (TFP) is computed endogenously in each period. Second, because the static module incorporates endogenous labor supply function in order to measure the impact on labor market, labor supply adjustment factor (LADJ) for each labor category is also computed over the projection period. These variables are endogenized in the baseline to meet the macroeconomic and labor force projections, whereas they are fixed in the subsequent policy simulations. Namely, TFP is endogenous in the baseline, but is exogenous in the simulations, whereas real GDP growth is endogenous. Likewise, LADJ is free to adjust in the baseline, but held fixed in the policy simulations, whereas labor supply for each category is endogenized.

Based on the ILOSTAT projections, demographic variables (population and labor force by skill category) are exogenously updated each year over the period 2020. In the model, the *subsistence minima* (or committed expenditures) are updated in each period in proportion to the population growth. However, it is assumed that marginal rate of consumption is held constant, implying that household consumption patterns or preferences remain unchanged over the periods. On the other hand, most exogenous variables are projected either on the basis of the population growth or long-term growth trajectory (see the Annex 3).

3.3. Evaluating Trade Transport Costs in the CGE Framework

Since non-tariff trade transport costs are not easily quantified, there are only a few rigorous studies but, there are at least two approaches to deal with this topic in CGE applications: (i) conventional approach using *ad valorem* equivalent; and (ii) the new concept of "effective price and quantity". The first approach is implemented by Francois el al. (2003) and Zaki (2010). They find that trade facilitation effects by reducing or eliminating barriers to trade will generate substantial global welfare gains. Although quantifying *ad valorem* equivalents of non-tariff trade barriers itself is a huge task and big academic contribution, this methodology would underestimate the true potential effects to be generated by the reduction of trade transport costs, as demonstrated by many rigorous econometric estimates.[19]

The second approach, to overcome this possible drawback, is pursued by Hertel, Walmsley and Itakura (2001), who evaluated the dynamic effects of the "new age" free trade agreement between Japan and Singapore in a dynamic CGE model. They introduced the notion of an "effective price" and "effective quantity" to deal with trade costs, specifically customs atomization. In order to measure the impact of better trade facilitation in developing countries, Minor and Tsigas (2008) applied the concept of "iceberg" effects on the international cross-border trade transaction costs, further refining the work done by Hertel,

[19] See for example Hummels (2001, 2007), Hummels and A. Skiba (2004), Hummels and V. Lugovskyy (2006). For comprehensive estimations for Latin America, refer to Moreira, Volpe and Blyde (2008).

Walmsley and Itakura (2001). Stone, Strutt and Hertel (2009), using the same approach by their predecessors, assess the socioeconomic impacts of transport infrastructure projects in the Greater Mekong Subregion. All of these studies find that an improvement of trade-related policy measures would generate substantial economic gains, far exceeding effects benefitted from tariff liberalization.

Moreira, Volpe and Blyde (2008) report that trade transport costs are of different nature from the traditional trade barriers particularly tariffs and their determinants are complex. [20] As a result, the reduction of trade transport costs would generate a significant and larger impact than tariff liberalization does. Therefore, the evaluation of trade transport costs by the conventional *ad valorem* equivalents would be likely to underestimate the potential gains in considerable magnitude.

Taking into account these critical points, we follow the second approach. Technically the effective domestic price of imports PM_r^* at home originating from region r is defined as:[21]

$$PM_r^* = PM_r / \chi_r \tag{1}$$

where PM_r is observed domestic price of imports and χ_r is technical adjustment coefficients, which capture the effects of trade transport costs.

The technical adjustment coeffients are unity at the baseline. An increase in χ_r leads to the decline in the effective domestic price of imports of goods exported from region r. In order to maintain the equilibrium in the value of trade, however, volume of imports needs conversely to be adjusted. Then the effective quantity of imports M_r^* is expressed as:

$$M_r^* = \chi_r \cdot M_r \tag{2}$$

In the model, the aggregate volume of imports is specified in a CES function over imports from different sources. Hence the aggregate quantity of imports XM and total expenditures EXP for the corresponding sectors are expressed in equation (3) and (4), respectively.

Aggregate imports: $$XM = AM \cdot \left[\sum_r \delta_r \cdot (\chi_r \cdot M_r)^\rho \right]^{\frac{1}{\rho}} \qquad \left(\sigma = \frac{1}{1-\rho},\ \rho = \frac{\sigma - 1}{\sigma} \right) \tag{3}$$

[20] Moreira, Volpe and Blyde (2008) report that there are at least three factors that set transport costs apart from other trade costs, particularly tariffs: (a) being highly variable and high degree of uncertainty directly linked to the quality of infrastructure; (b) being not a simple, fixed proportion (*ad valorem*) of the price of products; and (c) being not fixed by fiat, but respond to variables such as trade flows, the quality of country's infrastructure and the degree of competition in the transport industries.

[21] To avoid clutters, the sectoral notation *i* is dropped.

Total expenditures : $$EXP = PXM \cdot XM = \sum_r \left(\frac{PM_r}{\chi_r} \right) \cdot (\chi_r \cdot M_r) = \sum_r PM_r \cdot M_r \tag{4}$$

where PXM is the aggregate price of imports, AM Armington function shift parameter, δ_r share parameter, ρ the Armington function exponent and σ elasticity of substitution, respectively.

Minimizing costs yields the optimal quantity of imports from region r and expressed in equation (5):

$$M_r = \left(\frac{1}{AM \cdot \chi_r} \right)^{1-\sigma} \cdot \left(\frac{\delta_r \cdot PXM}{PM_r} \right)^{\sigma} \cdot XM \tag{5}$$

The aggregate price index of imports PXM and regional expenditure share θ_r are then derived as in equation (6) and (7):

$$PXM = \frac{1}{AM} \cdot \left[\sum_r \delta_r^{\sigma} \cdot \left(\frac{PM_r}{\chi_r} \right)^{1-\sigma} \right]^{\frac{1}{1-\sigma}} \tag{6}$$

$$\theta_r = \left(\frac{1}{AM \cdot \chi_r} \right)^{1-\sigma} \cdot \delta_r^{\sigma} \cdot \left(\frac{PM_r}{PXM} \right)^{1-\sigma} \tag{7}$$

Finally total differentiation of equations (6) and (7), with some algebra, yields the linearized forms of the quantity of import demand and the aggregate price of imports, which are exactly the same equations as Hertel, Walmsley and Itakura (2001) with different notations and orders:

$$\hat{M}_r = (\sigma - 1) \cdot \hat{\chi}_r + \sigma \cdot \left(P\hat{X}M - P\hat{M}_r \right) + X\hat{M} \tag{8}$$

$$P\hat{X}M = \sum_r \theta_r \cdot \left(P\hat{M}_r - \hat{\chi}_r \right) \tag{9}$$

These two equations reveal three different effects associated with the decline in trade transport costs. First, the import demand equation (8) shows that, the reduction of transport costs, or the rise in the technical adjustment coefficients, leads to an increase in import demand from region *r*, but its magnitude is controlled by the elasticity of substitution σ. Second, in the same equation, however, there is also an opposite effect associated with the decline in trade transport costs. This is because, as the effective quantity of the aggregate imports increases, less quantity is needed to meet demand in domestic market. Finally from the aggregate import price equation (9), the reduction of trade transport costs governed by the regional expenditure share θ_r lowers the aggregate price of imports, thereby leading to the expansion of imports, relative to domestic goods. As seen in equation (8), it is clear that the elasticity of substitution σ, which governs the substitutability of imports from different sources, plays a critical role in determining the magnitude of imports from the respective sources.

3.3. Benchmark and Trade-related Data

The model comprises 20 regions and countries and 22 sectors, constructed on the Social Accounting Matrices with the benchmark 2008. Its data relies on various official sources: COMTRADE for 2008 trade flows, and macroeconomic data from the World Development Indicators (World Bank), International Financial Statistics (IMF), Country Profiles (Economic Intelligence Unit), relevant country data in Latin America and IDB INTrade database for 2005/06 for applied tariffs.[22]

For this study, there are three sets of key trade-related data: (i) trade flows, (ii) estimation of trade transport costs; and (ii) elasticity of substation on trade. To this end, trade flows for all trade partners in the SAM are constructed on the basis of COMTRADE (2008 data). For Latin America, intra-regional trade, measured in terms of value of exports, reaches $124 billion in 2008, which constitutes around 15.5 percent of the region's aggregate exports. Yet market orientation varies considerably country by country. The United States is by far the key partner for Mexico, Colombia, Ecuador and Venezuela.[23] In contrast, intra-LAC trade is heavily dominated by sub-regional blocs. The Andean market constitutes more than half (54 percent) of intra-Andean exports. This is also the case with Mercosur (again 54 percent). In the meantime, large countries are the main destination for exports from small countries. Approximately 70 percent of Bolivia's exports destined to Latin America are sold to Brazil. Likewise, Argentina and Brazil combined are the main destination for Paraguay (70 percent of intra-LAC exports) and for Uruguay (60 percent). In contrast, Chile has the most diversified market orientations. Table 2 shows Latin America's exports by main destination, and Table 3 reports the bilateral intra-LAC exports in 2008, respectively.

INSERT TABLE 2

INSERT TABLE 3

Other two key datasets―estimation of trade transport costs and the elasticity of substitution―are due to Moreira, Volpe and Blyde (2008). To be precise, trade transport costs are estimated as the *ad valorem* equivalent rates based on trade flows at FOB prices (countries of origin) estimated from import freight expenditures, at HS 8 or 10-digit product levels. Then *ad valorem* rates at product levels are aggregated

[22] Tariffs for Colombia and Peru, provided from the respective authorities for trade policy evaluation, are updated for 2007.

[23] The composition of exports to the United Sates sharply differentiated between Mexico and the other three countries-Colombia, Ecuador and Venezuela. Manufacturing goods account for 75 percent of Mexico's exports to the United States, whereas exports are completely dominated by resource-based commodities, essentially crude oil, in Colombia (60 percent), Ecuador (80 percent) and Venezuela (85 percent).

into the model sectors for each country in Latin America.[24] In the aggregate, the region's average transport costs are measured at 10.4 percent, more than twice as large as the corresponding average tariffs of 4.3 percent. At bilateral levels, there exist tremendous heterogeneities, which reflect region's inherent nature of regional patterns associated with distance, geographic constraints, structure of trade as well as the degree of integration. Colombia is the country to bear the highest transport costs (12.1 percent) in Latin America, followed by Peru (11.6 percent) and Ecuador (10.6 percent). In contrast, Brazil bears the least transport costs (8.7 percent). This would suggest how distance matters. Its bulk of products (55 percent of intra-regional imports) are purchased from neighboring Mercosur member countries–Argentina alone accounting for nearly the half and another 15 percent supplied from Chile. The same is true for Argentina, Bolivia, Paraguay and Uruguay (see Table 3).

Regarding tariffs, the region's average tariffs in Latin America are at 4.3 percent, which is less than the half of the aggregate transport costs. This is largely attributed to the fact that trade is already liberalized particularly within each sub-regional blocs–Andean group and Mercosur, while a number of preferential treatments are also in place largely on bilateral basis–associate member status for Chile with Mercosur and complementary agreements plus partial scope agreements between the Andean countries and Mercosur. Table 4 reports the bilateral applied tariffs in line with *ad valorem* transport costs in Latin America.

INSERT TABLE 4

Based on the aggregate tariffs and transport costs in Table 4, Figure 5 displays the structure of costs of imports at the port of entry for each of the countries in Latin America. It clearly shows, for most countries, transport costs, which are far greater cost components than tariffs in the aggregate, are a major obstacle to trade. The only exception is Venezuela, for which present tariffs are roughly as high impediments as transport costs. Tariffs and transport costs combined substantially raise the prices of imported goods. They constitute more than 15 percent of the aggregate costs of goods shipped at countries of origin for Colombia, Peru, Paraguay, Ecuador and Mexico.

INSERT FIGURE 5

Finally, the elasticity of substitution on trade is an extremely important parameter governing the quantity of imports from different sources. It also influences the magnitude of trade diversion effects between intra- and extra Latin America. This study fully relies on the extensive econometric estimates made by

[24] To be consistent with the treatment of tariffs in Latin America, *ad valorem* transport costs are in principle estimated as a simple average, unless some treatments are necessary to avoid unintended distortions due to small trade flows on which extremely high or low transport costs are associated.

Moreira, Volpe and Blyde (2008). It is revealed that most industrial goods tend to have higher substitutability with large elasticity than non-industrial products: for instance, the highest 6.73 for textiles, followed by motor vehicles of 6.06, and metals and metal products of 5.84. On the other hand, interestingly vegetables and fruits have the lowest substitutability (1.45) in the region. This might explain that vegetables and fruits are most time-sensitive products so that poor transport infrastructure tends to hinder fast transports on one hand, and local consumers tend to have home bias in favor of domestic varieties on the other.

4. CGE Simulation Results

4.1 Baseline Scenario

Because the model used for the study is recursive dynamic, the impact of policy shocks needs be evaluated against baseline scenario (or often called reference scenario or business as usual scenario), which gives growth trajectory or time paths without any policy interventions over the projection period. The base year is 2008, and the macroeconomic variables are updated up to 2010 following the actual macroeconomic growth paths, and then updated and projected each year over 2020, based on the World Economic Indicators (World Bank, 2010) and World Economic Outlook (IMF, 2010). The macroeconomic variables in the baseline include growths in real GDP, population and labor force. As explained in the previous section, the aggregate total factor productivity is endogenized to reach the target real GDP, and labor supply adjustment factors adjusts to meet the projected labor supply for the respective labor categories in each country in Latin America.

In 2008, the global real GDP is reported at $60.1 trillion, and provisionally grows to $63.5 trillion in 2010 and projected to reach $86.8 trillion at 2008 prices, with an overall average growth rate of 3.1 percent. On the other hand, Latin America excluding Central America with the real GDP at $4.0 trillion in 2008, accounting for 6.9 percent of the world economy, is projected to grow at an annual growth rate of 3.5 percent, slightly higher than the global growth, to $6.0 trillion in 2020. Among Latin America, Peru is projected to grow at the fastest rate of 5.0 percent annum, whereas oil-dependent Venezuela and Ecuador will grow at the slowest rate at 2.1 percent and 1.95 percent, respectively. Brazil, the region's pillar, is projected to grow at a strong growth rate of 3.7 percent, with Mexico and Argentina at 3.3 percent each.

Based on the LABSTAT projection (ILO), the global population is projected to grow from 6.75 billion in 2008 to 7.67 billion in 2020, corresponding to an annual growth rate of 1.07 percent. On the other hand, Latin America's population will grow from 492 million in 2008 to 548 million in 2020, with an annual growth rate of 0.91 percent. Despite slightly slower rate than the world growth, the region's population remains to account for 7 percent in the world. In Latin America, Bolivia and Paraguay will expect the highest population growth of 1.5 percent followed by Venezuela (1.4 percent), whereas Uruguay will experience the slowest growth at 0.35 percent. The population growth of large countries, Argentina, Brazil and Mexico, is projected to grow at somewhat slower rates than the region's average: 0.88 percent for Argentina, 0.71 percent for Brazil and 0.81 percent for Mexico.

Labor force (LABSTAT) in the world is projected to increase from 3.18 billion in 2008 to 3.68 billion. This corresponds to an annual growth rate of 1.22 percent, or 0.15 percentage-points higher than the global population growth. Labor force in Latin America grows from 234 million in 2008 to 279 million in 2020, with an annual average growth rate of 1.50 percent. Thus, the region will face greater pressure to accommodate rapidly increasing labor force. In particular, the region's poor countries−Bolivia and Paraguay−will face strongest pressure, with more than 0.8 percentage-points higher growth differences between labor force and population, followed by Ecuador and Peru.

Regarding trade protection, the model database accommodates major trade agreements in the world and multilateral commitments. In the Americas, based on INTrade database, it captures all sub-regional agreements, between sub-regional blocs especially commitment between the Andean group and Mercosur, as well as bilateral and economic complementary agreements at the highest product levels (HS8 or 10 digits) as well as phase-out schedule. Its database also covers trade agreements for each country in Latin America with extra-hemispheric partners, especially with the European Union. All tariffs are based on the base year 2008, and no any changes in protection regimes are projected in the baseline.

4.2. Design of Policy Scenarios

The main objective of this study is to measure the impact of reducing transport costs, or improvement of trade-related infrastructure, in Latin America. The impact of reducing transport costs (main policy scenario) is evaluated relative to the baseline scenario. In order to evaluate and compare its relative magnitude, the study first considers as references tariff reduction and trade liberalization scenarios in Latin America, without any policy changes influenced by partners outside Latin America. Thus, it considers three policy scenarios as below:

Scenario-1: 10-percent Tariff Reduction

Applied tariffs at base year will be reduced by 10 percent within Latin America excluding Central America. To be precise, since recently there are no substantial movements in tariff regimes in Latin America, it is assumed that base year tariffs are all in effect until 2010. After year 2010, tariffs are assumed to be reduced following a linear reduction phase-out schedule until 2020, namely 1 percent reduction each year on a bilateral basis. This is because there is no region-wide collective actions as well as concrete initiatives ahead in external agendas. This scenario does not consider any exclusions and sensitive products at all.

Scenario-2: Complete Tariff Elimination (Full Trade Liberalization)

This scenario considers Latin America's collective commitment of completely eliminating tariffs in the region. Like scenario-1, tariff regimes in each country are assumed to be intact until 2010, then will be reduced in a linear reduction schedule until 2020, when trade is completely liberalized within Latin America. Again, there is no consideration on sensitivity products and exceptions for simplicity.

Scenario-3: 10-percent Trade Transport Cost Reduction

This is the central scenario, measuring the impact of reducing trade transport costs in Latin America. As explained in the precious section, the *ad valorem* estimations of the benchmark trade transport costs are due from Moreira, Volpe and Blyde (2008), based on measured differences in freight costs at product levels. To be comparable with the preceding scenarios and realistic for policy application, the structure of transport costs are assumed to be unchanged until 2010, and the reduction will start in 2011 until 2020 on a linear reduction basis, implying that all countries in Latin America will participate in the joint efforts of improving transport infrastructure over 10 years starting 2011.

The impact is evaluated on selected macroeconomic variables, followed by intra-regional trade with some detail.

4.2. Aggregate Macroeconomic Impact

Table 5 summarizes the aggregate impact of the three scenarios. As region's base tariffs are relative low except for some specific products, the reduction of 10-percent tariffs (scenario-1) will hardly generate visible economic gains on key macroeconomic variables. The region's aggregate real GDP measured at 2008 prices will increase by a tiny 0.03 percent and output by 0.05 percent.[25] The impact on each country is also very tiny, but all positive. Despite being quite small, the Andean countries, particularly Peru and Venezuela, will be the beneficiaries, whereas Chile will be least benefited. On trade, the impact is one-order up. Intra-Latin American trade rise by 0.55 percent, or nearly $820 million for exports and $890 million for imports. Mexico's exports increase by the largest 1.6 percent, due to relatively high protection by its partners in Latin America and low exchanges in exports in the region relative to its economic size (see Tables 2 and 3). In value term, new exports from Brazil and Mexico combined reach $580 million, which account for nearly 70 percent of the intra-LAC exports. As seen in table, trade diversion with low degree is observed; trade is shifted towards Latin America on both exports and imports for some countries (detailed in the following section). Figure 6 shows the trajectory of Latin America's net intra-regional exports relative to the baseline.

INSERT TABLE 5

INSERT FIGURE 6

Scenrio-2 amplifies the impact measured in scenario-1. The region's real GDP will increase by 0.3 percent and aggregate outputs by 0.4 percent, 8-9 times larger than the gains in scenario-1. Again, Peru will be the largest winner with an increase in GDP by 0.75 percent, followed by Venezuela with 0.59 percent. The aggregate intra-LAC exports rise by 5.0 percent, but its effects are very heterogeneous among countries. Brazil and Mexico boost their exports by 7.4 percent, and 8.6 percent, respectively. On the contrary, due to sharp erosion of preferences, three countries in Andean group (Bolivia, Colombia and Ecuador) will experience low trade effect. It is likely that Colombia's sales to Latin America will suffer modestly, although the country's total trade will increase. In value, intra-LAC exports increases by $7,460 million, in which Brazil alone accounts for 46 percent ($3,480 million), followed by Mexico ($1,450 million). On imports, there will be a significant market orientation (trade diversion) towards Latin America, particularly for the Andean countries, shifting imports away from the extra-LAC origins.

Finally scenario-3 shows very promising results for each country and Latin America as a whole. Although the impact is very asymmetric among countries, the simulation results suggest that the composition and structure of trade, its linkages with partners, initial levels of transport costs and economic size are the dominant factors. The 10-percent reduction of transport costs in Latin America expands region's real GDP and outputs by 2.2 percent from the baseline. In terms of relative magnitude, Bolivia and Paraguay, region's two smallest countries, will be the largest beneficiaries with a sharp economic growth: 6.1 percent for Bolivia and 6.6 percent for Paraguay. The opposite is also true for large countries. Mexico, due to low trade linkages with Latin America (5 percent exports share in Latin America, see table 2) and its large economic size, will be the least beneficiary, with an increase in GDP by only 0.86 percent.[26] The real GDP will grow at 4.7 percent for Argentina and 2.5 percent for Brazil. The impact on trade is striking. The intra-LAC exports sharply increase by 22.6 percent, with the highest growth of 26.2 percent for

[25] The impact in all variables is evaluated at 2008 prices, unless otherwise noted.
[26] In fact, Venezuela has the lowest export intensity to Latin American market with 3.7 percent share in 2008, and 3.6 percent in 2020.

Mexico, followed by Argentina and Chile with over 24 percent growth.[27] Paraguay, on the other hand, experiences the slowest export growth at 15.7 percent, but still impressive. The value of intra-LAC exports will reach $33.8 billion, out of which around one-third accrues to Brazil, 20 percent to Argentina and 13 percent to Mexico. Many countries in Latin America will experience strong trade diversion effects on import side, as they shift the sources of imports from non-regional to Latin American origin. This will be explained in some detail in the following section.

4.3. Impact on Intra-regional Exports

This section evaluates the impact on intra-regional trade with a focus on exports, which are directly influenced as a result of changes in trade policies and reducing transport costs. Table 6 presents the bilateral impact for Latin America in terms of percentage changes from the baseline.

INSERT TABLE 6

Although the impact is marginal, Scenario-1 clearly shows trade effects, reflecting linkages through trade with the respective partners in Latin America and initial protection. In the table, larger impact is seen in the minor diagonal (top-right to bottom-left) direction, namely between the Andean group and Mecosur on both ways, as trade is not fully liberalized yet (see Table 4). In the aggregate, Andean countries increase exports to Mercosur (largely Argentina and Brazil) by 0.6 percent, or $45 million. Peru leads the export growth by 1.2 percent, followed by Colombia by 0.9 percent. The only exception is Bolivia, whose export growth effects particularly to Argentina and Brazil are negligible, as the country faces lower protection with Mercosur. Likewise, Mercosur's exports to the Andean market rises by 1.7 percent, corresponding to $280 million. In particular, Brazil expands its exports by 1.8 percent to the Andean countries except Bolivia, followed by Argentina (1.5percent).

In sharp contrast, countries in a diagonal direction have little impact. This clearly reflects the effects of the erosion of preferences in each sub-regional market, as trade is already completely liberalized both in the Andean group and Mercosur. In fact, the Andean countries experience small but negative impact. Mexico, without any comprehensive preferences and agreements in Latin America, increases its exports to selected Andean countries−in value term, especially to Colombia, Venezuela and Peru in this order−and to Mercosur (Argentina and Brazil). As Chile has the lowest tariffs of its own and faces relatively low protection in the region, trade impact with its key partners is not strong: 0.36 percent with Brazil and 0.07 percent with Mexico.

[27] These effects would be fairly close and comparable to the econometric estimates of above 25 percent, made by Moreira, Volpe and Blyde (2008).

Scenario 2 (complete tariff elimination) amplifies the results under scenario 1. The Andean countries expand exports to Mercosur by 6.8 percent ($505 million): in value term, Peru by $200 million, Venezuela by $130 million and Colombia $120 million. Likewise, Mercosur sharply boosts its exports to the Andean market by almost 20 percent, equivalent to $3,220 million. Brazil reaps huge new export gains with the amount of $2,320 million: $1,080 million to Venezuela, $540 million to Colombia and $470 million to Peru. In sharp contrast, intra-bloc trade has either marginal or negative effects. The Andean countries experience strong negative effects on the intra-bloc trade due to the erosion of preferences. The bloc as a whole suffers the decline in intra-Andean exports, amounting to $290 million. In value term, Colombia will be hardest hit; the decline in intra-bloc exports reaches $215 million, out of which the drop in exports to Venezuela alone amounts to $210 million due to extremely high market reliance (50 percent of the country's total exports). Mexico expands exports to the Andean and Mercosur markets, with the value of $1,450 million, second after Brazil.

In the meantime, the full tariff elimination in Latin America would cause to divert trade flows from extra- to intra-LAC sources. This also influences exports to outside Latin America, as each country needs to finance an increase in imports by new exports. On imports, the Andean countries as a whole reduce imports of $2,320 million from extra-LAC sources, while expanding imports with the value of $4,050 million from LAC sources. On exports, in particular, Brazil shifts its exports worth of $595 million by diverting from extra-LAC destinations mostly to Mexico and Venezuela.

The 10-percent reduction of *ad valorem* transport costs generates very strong and promising intra-regional exports throughout Latin America, although the bilateral aggregate impact is fairly asymmetric, ranging from the lowest 2.3 percent (Venezuela to Peru) to the highest 35.1 percent (Paraguay to Mexico). The bilateral impact is the compound effects of three key variables: trade flows (linkages), initial *ad valorem* transport costs and the sectoral composition of trade.[28] While the impact in percentage measures relative importance of the effects, the absolute changes in value term gives also valuable clues to identify dominant sources contributing to the aggregate gains. Based on the value in new exports, several key corridors (arteries or network) in Latin America are identified. The largest flows are in the horizontal axis between Argentina and Brazil, extending to Chile, This artery boosts the new exports of $13,230 million, accounting for 40 percent of the intra-regional exports. The second is the vertical axis Mexico-Argentina cum Brazil with Colombia, generating $5,470 million of new exports, equivalent to 16 percent of the intra-regional exports. In the meantime, intra-Andean network also creates new exports worth of $3,660

[28] As evaluated in the section 3.3, the elasticity of trade is also an important factor, influencing the magnitude of imports.

million (10 percent share), and bi-subregional flows from Argentina and Brazil to the Andean countries−particularly Colombia, Peru and Venezuela−with the new exports of $3,300 million.

As in scenario 2, this policy option will be likely to divert trade flows, with much stronger effects than in scenario 2. As transport costs declines by 10-percent in Latin America relative to the extra-region, Latin American countries expand trade within intra-regional market, by shifting the sources away from the extra-region. Latin America as a whole, the value of diverted imports amounts to $2,890 million, with the largest value of $1,690 million by Venezuela, and $1,000 million by Chile. On the contrary, Brazil and Mexico, two largest countries in the region in economic size, even increase the extra-regional imports−$1,130 million by Brazil and $970 million by Mexico−to meet the rising domestic demand, contributing to reduce trade diversion effects in Latin America as a whole.

4.4. Composition of New Intra-regional Exports

Figure 7 presents the composition of the new aggregate intra-regional exports by macro-sector for each country in Latin America. Reflecting the structure of exports and market orientation with intra-regional partners, the impact differs considerably from one country to another. In addition, initial levels of tariff protection are also key determinants for scenarios 1 and 2, whereas the initial degree of *ad valorem* transport costs is critical for scenario 3.

INSERT FIGURE 7

In scenario 1, heavy manufacturing products account for 94 percent of the new exports for Mexico, reflecting the fact that the country is the factory of producing and exporting wide range of heavy manufacturing products, which are the mainstay of its exports to Latin America as well as to the rest of the world.[29] For the Andean countries, resource-based products are the main exports. Ecuador is the most typical case with 87 percent share of energy (crude oil and oil products), and Venezuela (16 percent). As seen clearly and differentiated from other countries, Bolivia and Colombia experiences the decline in intra-regional exports particularly of processed foods products, as a result of the erosion of preferences in the Andean market. For Bolivia, these losses are offset by energy (natural gas) exports to Brazil. Likewise, for Colombia, sales of heavy manufacturing goods represented by chemical products supplemented by energy products to Mercosur offset the export losses incurred in the Andean market. For Peru and Venezuela, resource-based heavy manufacturing products are the main new exports: metals for Peru and petroleum-related products for Venezuela.

[29] Refer to the Annex Table 2 for the macro-sectoral and sectoral concordances.

In Mercosur, the impact on the composition is classified into three groups: industry-dominant; agriculture-dominant; and in-between. Argentina and Brazil belong to the first group. In particular, for Brazil, heavy manufactures represented by machinery and vehicles sold largely to Mexico and the Andean countries (Venezuela in particular) together constitute almost three-quarters of the new exports. Together with light manufacturing products, exports of industrial goods constitute more than 85 percent. For Argentina, heavy manufactures sold largely to Mexico and Venezuela alone account for 55 percent, while exports of processed foods share a quarter. In sharp contrast, for Paraguay, exports of agriculture-origin sold mostly to Peru and Venezuela constitute 90 percent of the intra-regional exports: 74 percent share of food products and 15 percent of agriculture. Uruguay belongs to the third group. Heavy manufactures, represented by chemical products, account for the half of intra-regional exports, while processed foods constitutes another 37 percent mostly sold to Venezuela. Finally Chile has the composition similar to that of Argentina. Heavy manufacturing products (essentially metal products) account for more than half (58 percent), followed by light manufactured goods (15 percent) and processed foods products (18 percent).

As examined in the previous section, each country in Latin America will undergo strong trade diversion effects for its exports and imports between intra- and extra-regional markets. But essentially the composition of intra-regional exports under scenario 2 follows the structure quite similar to the one seen in scenario 1 for each country. The exception is Colombia, which incurs the decline in intra-regional exports by -$19 million (see Table 5). As explained in scenario 1, the country suffers huge decline in exports to its sales largely to Venezuela ($210 million) in a wide range: $76 million of processed foods; $62 million of light manufactures; and $59 million of heavy manufactures. Even though Colombia expands its exports of heavy manufacturing products ($79 million) to Mercosur and Mexico, supplemented by energy products, these new exports cannot offset the decline in intra-regional exports.

Compared with scenario 1 and 3, the composition of the new intra-regional exports in scenario 3 is in the similar structure for some countries, but quite different for others. Mexico and Venezuela have the same composition as with the previous scenarios. Peru and Chile increase their energy share by 6 and 3 percentage-points, respectively. Yet the striking outcome is that the share of heavy manufacturing products in the intra-regional exports increases in most countries: compared with scenario 2, 31 percentage-points (ppt) for Ecuador; 21 ppt for Argentina; 12 ppt for Brazil and Chile; and 8 ppt for Paraguay. For Ecuador, the share of energy exported to Peru and Chile nearly halves down to 45 percent. For Paraguay, the share of processed foods declines by 47 percentage-points to 26 percent share, while agriculture increases its share to by 30 ppt to 44 percent. The big changes are seen for Bolivia and Colombia. For Bolivia, energy products (natural gas), which are almost entirely shipped to Brazil ($530 million), alone constitute 81 percent of the intra-regional exports. For Colombia, heavy manufacturing goods, mostly represented by chemical products and machinery, constitute 60 percent share of the intra-regional exports, followed by light manufactures by 27 percent and energy by 8 percent.

4.5. Impact on Factor Markets

Table 7 shows the impact on factor markets: changes in factor prices–wages for labor, rental rate for capital, rents for land and natural resources–and changes in employment differentiated by three categories. It is significantly influenced by the impact on outputs via trade, composition of sectoral outputs, structure of each factor uses, substitutability among factors, and degree of factor mobility. In scenario 1, the impact is very small but positive for all factors and employment. The only exception is the return on land in Venezuela, which incurs a small negative effect due to decline in outputs in vegetables, livestock and other agriculture, all of which are weak and minor industries for production and exports in Venezuela. Rising wages even in a small magnitude create an employment for all labor categories in all countries. Latin America as a whole, around 57,600 workers will be employed, distributed by 23,900 workers in Brazil (41 percent share), followed by 7,700 workers in Mexico (13 percent), 6,150 in Venezuela (11 percent) and 5,900 in Peru (10 percent). Out of new employment, the vast majority (70 percent) belongs to low-skill labor and 22 percent to mid-skill category.

INSERT TABLE 7

In scenario 2, the positive impact is amplified, yet the magnitude still remains marginal. Due to the same reason, land return in Venezuela is negative with larger magnitude. Regarding the impact on employment, Latin America boosts new employment of 475,800 workers. Again Brazil leads the job creation in Latin America, generating 212,200 workers (44 percent share). As with scenario 1, Mexico, Peru and Venezuela altogether create new 144,400 jobs, accounting for 30 percent share. The composition of new employment in the region follows the quite similar distribution over labor category: 70 percent by low-skill and 21 percent by mid-skill. Yet the composition of new employment varies significantly country by country. In Brazil, low-skill workers constitute 80 percent of the new lobs, second highest share after Paraguay (85 percent). In Mexico and Venezuela, low-skill workers account for two-thirds of the new employment, while mid-skill workers share approximately a quarter. This is very different in Peru, where mid-skill employment accounts for the half of new jobs, followed by 40 percent by low-skill category.

In scenario 3, the impact is positive and strong, but considerably asymmetric over countries. Wages in Bolivia and Paraguay rise by more than 3 percent. In addition, strong energy exports raise the return of natural resources by almost 8 percent in Bolivia. In Paraguay, the robust sales of agricultural products to

Argentina and Brazil sharply raise the factor returns of land (7.6 percent) and natural resources (8.3 percent). Only the negative impact is seen on land (-2.75 percent) in Venezuela due to the same reason as before and land (-0.8 percent) in Chile, where the sharp rise in imports of cereal grains dampens the outputs by 5 percent, which in turn causes lowering land rent. Due to the lowest trade linkages (both exports and imports) with Latin America, the impact is the smallest but positive for Mexico, ranging from 0.35 percent on low-skill wages to 0.87 percent on land.

The impact on employment is strong, reflecting the positive effects on wages. In Latin America, a little less than 3 million workers will be employed in 2020. Brazil creates new 1.24 million jobs (42 percent of the regional total), out of which 80 percent belong to low-skill workers. Argentina adds new 393,200 workers with the regional share of 13 percent, followed by Colombia (241,600 workers), Peru (216,000 workers) and Venezuela (195,800 workers). Mexico creates 157,500 jobs (5 percent share), slightly larger than Ecuador (122,700 workers). Bolivia and Paraguay, two small and labor-abundant countries, also increase employment by almost 3 percent, and the vast majority belongs to low-skill workers. Thus, the reduction of transport costs or improvement of transport infrastructure has strong and promising impact of creating jobs in Latin America.

5. Summary and Conclusion

Since Latin America has made tremendous efforts in liberalizing trade over the past two decades, tariffs, traditional form and the most restrictive barriers to trade have declined substantially. Although tariffs are still high for some specific and sensitive products, additional gains from further liberalizing trade will not be large as expected relative to its efforts and costs. As a result, the economic importance and policy relevance as trade agenda diminishes. Today Latin America instead faces a new type of challenge of high transport costs, which were not well recognized until very recently. As several recent global indicators suggest, the region's states of transport costs are far behind the advanced countries, and even some developing countries with a similar development stage. This creates a grave threat for the region in competing with rising China, India and other Asian emerging countries in the global markets.

In view of this situation, by applying a global, multi-region, recursive dynamic CGE model, this study measures the impact of reducing transport costs in Latin America, in comparison with the scenarios of reducing or eliminating tariffs as references, traditional forms of trade impediments,. A 10-percent tariff reduction in Latin America, as expected, generates very little but positive impact. Intra-regional exports will increase $820 million, corresponding to 0.55 percent increase from the baseline. Employment effects are again insignificant. The complete tariff elimination generates region's real GDP by 0.3 percent, raise intra-regional trade by 5 percent, and increase employment by 475,800 workers. Finally the 10-percent reduction of *ad valorem* transport costs would increase the region's real GDP by 2.2 percent. The impact on trade is more impressive. The intra-regional exports sharply increase by 22.6 percent, corresponding to $33.8 billion. Although most countries in Latin America will experience trade diversion effects, positive effects of trade creation well surpass. In most cases, the reduction of transport costs is likely to further reinforce the initial pattern of key bilateral trade linkages. In addition, this policy option will create new employment close to 3 million workers, out of which 70 percent belong to low-skill and 20 percent to mid-skill categories. Thus, the simulation results suggest that the reduction of transport costs, or improvement of transport infrastructure, appears to be a very attractive and promising policy instrument, which would potentially generate far greater impact than tariffs.

In interpreting the above results, some cautions and caveats are advised. Although the methodology used for this study is theoretically valid and appealing for policy applications, as the simulation exercises generate trade impacts with the similar magnitude as calibrated by the econometric estimates, it has also some limitations. First, for instance, an improvement of port facilities in a specific country will eventually reduce transport costs irrespective of where products come from or are shipped. Thus, the improvement of any infrastructures or modes of transport would have a unilateral and non-discriminatory effect, not necessarily bilateral. As a result, although the country, which undertakes an improvement of infrastructure will reap the largest gains from the reduction of transport costs, its trade partners are also likely to benefit from lower transport costs, albeit to a lesser extent. This would reduce trade diversion effects so that potential gains would be much larger than the simulation results as captured in this study.

Second, this study borrows the estimates, albeit being thorough and very detailed, based on import freight expenditures on bilateral basis.[30] Although transport costs are the core and key impediment to trade, there are also other types of trade-related costs, to name a few, cross-border transaction costs (customs fees, port handling charges and other payments), logistic and administrative costs and so on. All of them are also tremendous barriers to trade, as the cited studies suggest, gains from reducing some of these costs would be significant. In this respect, while what this study captures would be the main impact, it certainly underestimates the overall potential effects.

Finally but not the last, the region's trade agenda should focus on the topic of transport costs with higher priority. A reduction of transport costs, or an improvement of transport infrastructure, would have huge potentials of increasing trade, welfare and global competitiveness. This is critical, as the intra-regional trade has significant share in the aggregate trade. The focus on the improvement of transport infrastructure would (might) vary country by country, but should be well designed, taking into account the composition of trade and linkages with respective partners as well as modes of transportation through which intra-regional trade occurs.

[30] As cited several times in the text, the source is Moreira, Volpe and Blyde (2008).

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Table 1. Bilateral *Ad Valorem* Transport Costs by Geographic Region in Latin America

		Destination	
		Pacific Region	Atlantic Ocean
Origin	Pacific Region	9.70%	11.28%
	Atlantic Ocean	13.66%	7.14%

Source: Authors' estimations based on Mauricio, Volpe and Blyde (2008).

Table 2. Latin America's Trade by Main Partner (2008)

(1) Exports by Destination

(a) Value of Exports

($million)

Destination / Origin	United States	Latin America	Rest of WH	EU27	China	Rest of Asia	Rest of World	**Total**
Mexico	197,918.8	12,861.9	10,981.3	17,239.1	2,043.3	6,014.6	7,642.4	**254,701.5**
Bolivia	457.0	3,615.6	61.0	388.4	104.1	640.7	288.3	**5,555.1**
Colombia	11,751.4	12,615.9	1,474.7	4,817.8	433.1	1,367.0	4,852.2	**37,312.0**
Ecuador	8,668.7	4,884.1	721.2	2,110.4	384.7	309.4	1,768.6	**18,847.1**
Peru	5,518.7	5,282.9	2,249.3	5,470.7	3,737.2	3,567.4	4,690.6	**30,516.8**
Venezuela	46,342.3	3,956.5	1,373.3	7,063.3	5,588.1	10,062.5	33,401.3	**107,787.4**
Argentina	5,419.9	25,274.9	842.4	13,133.9	6,390.2	4,825.3	11,262.1	**67,148.7**
Brazil	28,049.0	39,306.7	3,213.5	46,383.1	16,395.8	21,552.8	36,138.5	**191,039.3**
Paraguay	74.3	2,854.6	26.8	433.8	105.7	384.8	606.5	**4,486.5**
Uruguay	207.3	2,464.0	176.8	1,152.0	361.4	382.4	1,826.6	**6,570.5**
Chile	7,815.3	10,767.2	2,435.9	16,871.5	9,848.1	21,535.4	2,747.8	**72,021.2**
Latin America	**312,222.8**	**123,884.4**	**23,556.1**	**115,063.8**	**45,391.8**	**70,642.4**	**105,224.8**	795,986.2

(b) Market Orientation by Destination

(percent)

Destination / Origin	United States	Latin America	Rest of WH	EU27	China	Rest of Asia	Rest of World	**Total**
Mexico	77.71	5.05	4.31	6.77	0.80	2.36	3.00	**100.00**
Bolivia	8.23	65.09	1.10	6.99	1.87	11.53	5.19	**100.00**
Colombia	31.49	33.81	3.95	12.91	1.16	3.66	13.00	**100.00**
Ecuador	45.99	25.91	3.83	11.20	2.04	1.64	9.38	**100.00**
Peru	18.08	17.31	7.37	17.93	12.25	11.69	15.37	**100.00**
Venezuela	42.99	3.67	1.27	6.55	5.18	9.34	30.99	**100.00**
Argentina	8.07	37.64	1.25	19.56	9.52	7.19	16.77	**100.00**
Brazil	14.68	20.58	1.68	24.28	8.58	11.28	18.92	**100.00**
Paraguay	1.66	63.63	0.60	9.67	2.35	8.58	13.52	**100.00**
Uruguay	3.16	37.50	2.69	17.53	5.50	5.82	27.80	**100.00**
Chile	10.85	14.95	3.38	23.43	13.67	29.90	3.82	**100.00**
Latin America	**39.22**	**15.56**	**2.96**	**14.46**	**5.70**	**8.87**	**13.22**	100.00

(2) Imports by Origin

(a) Value of Imports

($million)

Source / Target	United States	Latin America	Rest of WH	EU27	China	Rest of Asia	Rest of World	**Total**
Mexico	150,897.3	11,477.4	11,340.7	38,627.9	34,008.1	49,058.6	8,894.7	**304,304.7**
Bolivia	406.1	2,008.5	37.2	322.5	267.1	431.0	59.4	**3,532.0**
Colombia	11,573.3	10,070.9	920.1	5,341.3	4,465.5	3,683.8	3,309.7	**39,364.6**
Ecuador	2,589.8	5,278.5	283.7	1,501.9	2,124.9	2,322.8	3,311.5	**17,413.2**
Peru	5,202.2	9,491.0	485.6	3,380.4	3,715.2	3,284.0	1,965.6	**27,523.9**
Venezuela	11,798.8	17,600.7	830.5	5,841.3	4,209.5	2,359.0	2,502.0	**45,141.9**
Argentina	7,023.2	23,039.7	332.9	9,010.8	7,103.9	4,651.1	5,549.8	**56,711.4**
Brazil	25,849.7	27,406.1	3,496.3	36,214.1	20,039.9	27,010.7	33,036.1	**173,052.9**
Paraguay	407.4	4,398.7	15.5	487.5	2,471.1	1,064.7	332.8	**9,177.7**
Uruguay	536.6	4,564.9	206.0	770.1	905.2	631.5	1,337.7	**8,952.0**
Chile	11,524.7	18,420.1	1,218.1	7,206.8	6,970.8	12,006.1	4,480.7	**61,827.2**
Latin America	**227,809.2**	**133,756.4**	**19,166.5**	**108,704.6**	**86,281.4**	**106,503.3**	**64,780.1**	747,001.5

(b) Market Orientation by Origin

(percent)

Source / Target	United States	Latin America	Rest of WH	EU27	China	Rest of Asia	Rest of World	**Total**
Mexico	49.59	3.77	3.73	12.69	11.18	16.12	2.92	**100.00**
Bolivia	11.50	56.87	1.05	9.13	7.56	12.20	1.68	**100.00**
Colombia	29.40	25.58	2.34	13.57	11.34	9.36	8.41	**100.00**
Ecuador	14.87	30.31	1.63	8.63	12.20	13.34	19.02	**100.00**
Peru	18.90	34.48	1.76	12.28	13.50	11.93	7.14	**100.00**
Venezuela	26.14	38.99	1.84	12.94	9.33	5.23	5.54	**100.00**
Argentina	12.38	40.63	0.59	15.89	12.53	8.20	9.79	**100.00**
Brazil	14.94	15.84	2.02	20.93	11.58	15.61	19.09	**100.00**
Paraguay	4.44	47.93	0.17	5.31	26.93	11.60	3.63	**100.00**
Uruguay	5.99	50.99	2.30	8.60	10.11	7.05	14.94	**100.00**
Chile	18.64	29.79	1.97	11.66	11.27	19.42	7.25	**100.00**
Latin America	**30.50**	**17.91**	**2.57**	**14.55**	**11.55**	**14.26**	**8.67**	**100.00**

Source: COMTRADE, 2008.

Note: Latin America represents 11 countries in the table.

Table 3. Structure of Intra-regional Exports by Partner (2008)

(a) Value of Exports

($million)

Origin \ Destination	Mexico	Bolivia	Colombia	Ecuador	Peru	Venezuela	Argentina	Brazil	Paraguay	Uruguay	Chile	**Latin America**
Mexico		54.5	2,925.5	715.1	1,024.8	1,943.9	1,480.7	2,894.6	64.8	108.6	1,649.5	**12,861.9**
Bolivia	49.1		199.4	41.6	200.6	350.8	137.6	2,515.9	50.3	3.0	67.2	**3,615.6**
Colombia	977.0	65.1		1,520.5	1,085.7	6,358.2	135.4	734.8	6.7	5.3	1,727.3	**12,615.9**
Ecuador	157.5	12.5	762.0		1,659.5	617.7	113.2	46.1	0.0	7.2	1,508.3	**4,884.1**
Peru	376.8	215.9	678.7	424.8		863.0	111.5	905.2	0.0	16.7	1,690.3	**5,282.9**
Venezuela	601.5	40.4	1,131.3	409.2	177.6		23.4	462.8	352.2	539.3	219.0	**3,956.5**
Argentina	1,312.9	551.4	754.6	470.5	1,144.1	983.4		12,410.4	1,210.2	2,038.8	4,398.6	**25,274.9**
Brazil	4,429.5	673.8	2,091.2	787.6	2,048.5	3,717.5	16,939.4		2,257.6	1,481.0	4,880.5	**39,306.7**
Paraguay	10.7	43.5	0.0	15.2	139.9	274.1	1,360.8	627.0		47.1	336.3	**2,854.6**
Uruguay	304.0	13.4	40.0	43.5	79.1	250.8	511.4	969.1	97.6		155.0	**2,464.0**
Chile	2,413.2	208.4	624.7	470.2	1,024.3	1,067.5	891.1	3,876.1	97.4	94.3		**10,767.2**
Latin America	**10,632.3**	**1,878.9**	**9,207.3**	**4,898.2**	**8,584.2**	**16,426.9**	**21,704.6**	**25,442.0**	**4,137.0**	**4,341.3**	**16,631.9**	123,884.4

(b) Aggregate Share by Main Destination

(percent)

Origin \ Destination	Mexico	Bolivia	Colombia	Ecuador	Peru	Venezuela	Argentina	Brazil	Paraguay	Uruguay	Chile	**Latin America**
Mexico		0.42	22.75	5.56	7.97	15.11	11.51	22.51	0.50	0.84	12.82	**100.00**
Bolivia	1.36		5.51	1.15	5.55	9.70	3.81	69.58	1.39	0.08	1.86	**100.00**
Colombia	7.74	0.52		12.05	8.61	50.40	1.07	5.82	0.05	0.04	13.69	**100.00**
Ecuador	3.22	0.26	15.60		33.98	12.65	2.32	0.94		0.15	30.88	**100.00**
Peru	7.13	4.09	12.85	8.04		16.34	2.11	17.14		0.32	32.00	**100.00**
Venezuela	15.20	1.02	28.59	10.34	4.49		0.59	11.70	8.90	13.63	5.53	**100.00**
Argentina	5.19	2.18	2.99	1.86	4.53	3.89		49.10	4.79	8.07	17.40	**100.00**
Brazil	11.27	1.71	5.32	2.00	5.21	9.46	43.10		5.74	3.77	12.42	**100.00**
Paraguay	0.38	1.52		0.53	4.90	9.60	47.67	21.96		1.65	11.78	**100.00**
Uruguay	12.34	0.54	1.62	1.77	3.21	10.18	20.76	39.33	3.96		6.29	**100.00**
Chile	22.41	1.94	5.80	4.37	9.51	9.91	8.28	36.00	0.90	0.88		**100.00**
Latin America	**8.58**	**1.52**	**7.43**	**3.95**	**6.93**	**13.26**	**17.52**	**20.54**	**3.34**	**3.50**	**13.43**	**100.00**

Source: IDB-INTRADE

Table 4. Bilateral Tariffs and Transport Costs in Latin America (percent)

Applied Tariff Rates: (2005/06)

(%)

		Destination										
		Mexico	Bolivia	Colombia	Ecuador	Peru	Venezuela	Argentina	Brazil	Paraguay	Uruguay	Chile
Origin	Mexico		7.40	9.82	9.01	7.19	10.27	12.63	12.55	14.74	16.63	0.05
	Bolivia	0.54		0.00	0.00	0.00	0.00	0.58	0.52	0.54	0.43	0.00
	Colombia	1.43	0.00		0.00	0.00	0.00	6.16	4.83	8.90	5.95	0.12
	Ecuador	8.87	0.00	0.00		0.00	0.00	4.89	4.41	5.74	3.84	0.13
	Peru	10.33	0.00	0.00	0.00		0.00	6.71	6.28	9.04	4.27	1.04
	Venezuela	3.90	0.00	0.00	0.00	0.00		6.29	5.16	8.73	6.30	6.00
	Argentina	10.21	1.45	7.93	13.84	9.64	13.54		0.00	0.00	0.00	0.11
	Brazil	11.17	1.45	5.96	9.40	5.76	11.95	0.00		0.00	0.00	0.11
	Paraguay	10.58	1.45	5.99	18.13	7.95	17.74	0.00	0.00		0.00	0.11
	Uruguay	2.07	1.45	6.48	7.26	4.83	17.09	0.00	0.00	0.00		0.11
	Chile	0.24	1.45	0.41	0.40	2.45	14.08	2.93	2.32	2.19	10.81	
	Aggregate	**5.94**	**1.47**	**3.66**	**5.80**	**3.78**	**8.47**	**4.02**	**3.61**	**4.99**	**4.82**	**0.78**

***Ad Valorem* Transport Costs (2005)**

(%)

		Destination										
		Mexico	Bolivia	Colombia	Ecuador	Peru	Venezuela	Argentina	Brazil	Paraguay	Uruguay	Chile
Origin	Mexico		10.58	8.91	9.00	8.63	9.00	10.87	11.74	13.69	9.05	8.18
	Bolivia	10.58		18.15	9.54	8.92	13.68	8.44	8.09	16.96	9.40	11.45
	Colombia	8.91	10.14		7.17	11.27	6.97	11.84	10.98	14.34	8.38	8.83
	Ecuador	8.73	9.54	7.17		7.33	7.54	14.53	11.41	14.26	13.39	12.27
	Peru	8.63	8.74	9.60	7.33		9.95	10.23	8.61	13.91	12.07	7.34
	Venezuela	8.73	13.68	6.97	7.33	9.95		11.48	12.05	13.69	6.74	10.02
	Argentina	10.87	7.87	16.47	14.53	15.23	11.48		6.69	6.66	5.37	10.72
	Brazil	11.74	7.27	11.56	11.41	12.85	12.05	8.66		6.19	8.12	10.77
	Paraguay	13.69	8.60	18.15	14.26	15.65	13.69	5.48	4.82		12.11	12.82
	Uruguay	9.05	9.79	12.69	13.39	16.18	6.74	7.08	5.13	9.43		11.90
	Chile	8.18	8.46	15.59	12.27	10.24	10.02	9.04	10.46	9.31	7.63	
	Aggregate	**10.09**	**9.18**	**12.06**	**10.59**	**11.60**	**10.03**	**9.42**	**8.71**	**10.41**	**8.87**	**10.35**

Source: IDB-INTRADE database for tariffs, and Moreira, Volpe and Blyde (2008) for transport costs.

Note: simple average on bilateral basis.

Table 5. Aggregate Impact in Latin America

(Percentage changes from baseline)

			Exports				Imports			
	GDP (%)	Outputs (%)	Value ($million)		Percentage Change (%)		Value ($million)		Percentage Change (%)	
			Latin America	Total	Latin America	Total	Latin America	Total	Latin America	Total
Scenario 1: 10-Percent Tariff Reduction in Latin America										
Mexico	0.036	0.042	278.4	280.3	1.67	0.10	157.0	269.8	1.15	0.08
Bolivia	0.045	0.053	3.0	4.5	0.07	0.07	7.9	5.2	0.31	0.11
Colombia	0.044	0.047	4.4	31.3	0.03	0.07	122.3	37.8	1.00	0.08
Ecuador	0.052	0.051	10.6	15.4	0.19	0.08	44.4	16.4	0.80	0.09
Peru	0.084	0.091	30.0	66.2	0.44	0.17	108.8	69.7	0.88	0.19
Venezuela	0.075	0.073	14.5	82.7	0.36	0.07	167.4	88.2	0.83	0.18
Argentina	0.040	0.045	104.5	89.2	0.35	0.11	68.1	81.4	0.24	0.12
Brazil	0.043	0.046	301.6	267.8	0.64	0.12	161.5	249.3	0.48	0.12
Paraguay	0.047	0.067	9.4	9.4	0.28	0.18	11.6	9.6	0.24	0.09
Uruguay	0.031	0.032	7.1	7.1	0.24	0.09	9.0	7.1	0.17	0.07
Chile	0.016	0.026	53.7	40.6	0.40	0.04	30.0	36.0	0.13	0.04
Latin America	**0.034**	**0.048**	**817.1**	**894.6**	**0.55**	**0.10**	**888.0**	**870.7**	**0.55**	**0.10**
Scenario 2: Complete Tariff Elimination within Latin America										
Mexico	0.243	0.276	1447.2	1803.3	8.67	0.63	1719.3	1770.8	12.59	0.51
Bolivia	0.427	0.507	30.8	46.9	0.74	0.74	81.5	54.0	3.23	1.19
Colombia	0.339	0.367	-19.2	230.3	-0.12	0.51	1033.2	291.3	8.47	0.60
Ecuador	0.438	0.445	108.3	153.9	1.96	0.81	407.4	164.1	7.37	0.92
Peru	0.747	0.828	323.3	654.2	4.77	1.65	1017.3	683.9	8.23	1.83
Venezuela	0.590	0.574	178.5	523.6	4.40	0.46	1595.7	619.4	7.91	1.24
Argentina	0.353	0.410	1168.7	950.7	3.97	1.21	538.3	845.6	1.93	1.23
Brazil	0.395	0.435	3479.4	2884.3	7.38	1.27	1250.0	2627.9	3.71	1.23
Paraguay	0.440	0.668	100.4	100.1	3.07	1.96	114.2	101.9	2.38	0.93
Uruguay	0.264	0.301	77.6	75.2	2.57	0.99	79.5	73.9	1.55	0.71
Chile	0.144	0.244	568.4	427.2	4.23	0.47	294.6	378.1	1.27	0.47
Latin America	**0.299**	**0.403**	**7463.4**	**7849.7**	**4.99**	**0.85**	**8131.2**	**7610.8**	**5.04**	**0.86**
Scenario 3: 10-Percent Reduction of Ad Valorem Trade Transport Costs in Latin America										
Mexico	0.865	0.843	4,383	4,961	26.25	1.73	3,836.7	4,804.5	28.08	1.39
Bolivia	6.148	4.908	682	650	16.37	10.28	574.3	599.7	22.75	13.19
Colombia	3.035	2.889	2,794	2,827	17.60	6.28	3,215.7	2,741.6	26.37	5.60
Ecuador	3.666	2.700	908	815	16.40	4.31	1,226.8	750.8	22.19	4.23
Peru	3.333	3.312	1,467	1,851	21.67	4.66	2,382.8	1,735.6	19.28	4.64
Venezuela	2.669	2.059	878	1,780	21.62	1.57	3,486.8	1,798.2	17.28	3.61
Argentina	4.702	4.323	7,161	6,987	24.30	8.91	6,831.6	6,503.6	24.44	9.43
Brazil	2.536	2.465	11,027	10,828	23.40	4.78	8,958.4	10,086.6	26.57	4.71
Paraguay	6.598	4.955	514	519	15.71	10.16	746.6	537.6	15.55	4.93
Uruguay	5.383	4.511	704	724	23.35	9.49	889.0	693.6	17.29	6.71
Chile	3.249	3.218	3,298	3,585	24.54	3.93	4,154.3	3,157.0	17.93	3.89
Latin America	**2.221**	**2.295**	**33,817**	**35,526**	**22.63**	**3.86**	**36,302.9**	**33,408.8**	**22.52**	**3.75**

Source: Authors' CGE model simulations.

Table 6. Impact on Intra-regional Exports in Latin America

(Percentage changes from baseline)

Scenario 1: 10-Percent Tariff Reduction in Latin America

Destination / Origin	Mexico	Bolivia	Colombia	Ecuador	Peru	Venezuela	Argentina	Brazil	Paraguay	Uruguay	Chile	**Latin America**
Mexico		-0.17	1.40	2.31	1.94	1.37	2.46	2.46	2.83	2.71	0.02	**1.67**
Bolivia	0.15		-0.17	-0.29	-0.06	-0.25	0.26	0.10	0.97	1.69	0.23	**0.07**
Colombia	0.37	-0.08		-0.06	0.03	-0.18	1.28	0.87	1.64	1.76	0.14	**0.03**
Ecuador	1.68	-0.09	-0.20		0.02	-0.16	0.55	0.98		1.36	0.50	**0.19**
Peru	2.21	-0.10	-0.10	-0.11		-0.14	1.78	1.18		1.73	0.19	**0.44**
Venezuela	0.28	-0.02	-0.07	-0.06	0.06		1.52	0.70	1.63	0.34	0.93	**0.36**
Argentina	1.74	0.21	1.68	1.87	1.26	2.56		0.03	-0.04	0.00	0.05	**0.35**
Brazil	1.85	0.26	1.78	2.23	1.57	2.23	0.01		0.04	0.05	0.05	**0.64**
Paraguay	1.38	0.96		1.21	1.20	1.02	0.07	0.04		0.02	0.46	**0.28**
Uruguay	0.36	0.91	1.34	0.40	0.43	0.81	0.05	0.07	-0.03		0.40	**0.24**
Chile	0.07	1.43	-0.15	-0.14	0.50	1.24	0.56	0.36	1.71	1.44		**0.40**
Latin America	**1.14**	**0.32**	**1.00**	**0.79**	**0.87**	**0.82**	**0.24**	**0.48**	**0.24**	**0.17**	**0.13**	**0.55**

Scenario 2: Complete Tariff Elimination within Latin America

Destination / Origin	Mexico	Bolivia	Colombia	Ecuador	Peru	Venezuela	Argentina	Brazil	Paraguay	Uruguay	Chile	**Latin America**
Mexico		-1.47	6.53	11.31	9.70	5.20	14.07	13.97	16.23	15.22	0.40	**8.67**
Bolivia	1.16		-1.67	-2.89	-0.50	-3.08	2.87	1.14	10.30	18.93	2.40	**0.71**
Colombia	3.45	-0.84		-0.60	0.27	-2.74	14.05	9.47	18.04	19.62	1.43	**-0.12**
Ecuador	18.20	-0.92	-1.86		0.19	-2.36	5.92	10.79		15.03	5.22	**1.94**
Peru	25.13	-1.10	-0.99	-1.09		-2.33	20.22	12.84		19.84	1.88	**4.77**
Venezuela	3.13	0.38	0.04	0.33	0.86		17.92	8.13	18.65	3.77	10.49	**4.39**
Argentina	18.78	1.92	18.97	21.54	13.81	29.77		0.47	-0.51	-0.09	0.37	**3.96**
Brazil	20.66	2.44	20.85	26.52	17.50	25.73	0.35		0.28	0.63	0.35	**7.38**
Paraguay	14.62	10.26		13.15	13.07	10.57	0.78	0.63		0.27	4.70	**3.02**
Uruguay	3.39	9.76	14.85	4.23	4.64	8.22	0.95	0.89	-0.27		4.14	**2.57**
Chile	0.29	15.74	-1.33	-1.23	5.31	12.86	6.24	3.92	19.37	16.28		**4.23**
Latin America	**12.50**	**3.24**	**8.35**	**7.25**	**8.11**	**7.83**	**1.90**	**3.72**	**2.32**	**1.53**	**1.28**	**4.99**

Scenario 3: 10-Percent Reduction of Ad Valorem Trade Transport Costs in Latin America

Destination / Origin	Mexico	Bolivia	Colombia	Ecuador	Peru	Venezuela	Argentina	Brazil	Paraguay	Uruguay	Chile	**Latin America**
Mexico		25.77	27.49	23.16	26.73	21.13	26.19	28.59	25.86	23.30	25.94	**26.25**
Bolivia	21.61		12.82	9.05	12.52	7.50	15.74	18.23	7.49	23.10	13.99	**16.37**
Colombia	24.22	18.86		22.82	17.04	17.42	23.29	19.32	7.89	12.21	9.67	**17.60**
Ecuador	21.39	15.04	31.44		10.38	17.72	17.07	25.70		12.36	15.40	**16.40**
Peru	26.85	22.97	25.93	22.25		18.27	28.39	29.92		14.32	15.07	**21.67**
Venezuela	30.49	20.92	27.41	22.66	2.33		28.47	21.63	10.08	13.56	21.77	**21.62**
Argentina	31.44	20.54	23.65	16.87	19.88	20.13		29.34	12.87	15.84	17.96	**24.30**
Brazil	28.87	24.30	26.02	24.41	23.29	16.13	24.95		17.83	19.88	20.64	**23.40**
Paraguay	35.07	26.87		14.37	16.38	10.56	12.18	24.14		19.22	13.35	**15.71**
Uruguay	24.65	21.24	29.36	23.33	15.21	10.27	30.12	24.00	14.55		20.72	**23.35**
Chile	27.36	24.02	24.14	21.32	24.07	15.02	27.89	25.24	16.30	20.24		**24.54**
Latin America	**28.10**	**22.79**	**26.54**	**22.23**	**19.33**	**17.19**	**24.51**	**26.77**	**15.63**	**17.28**	**18.18**	**22.63**

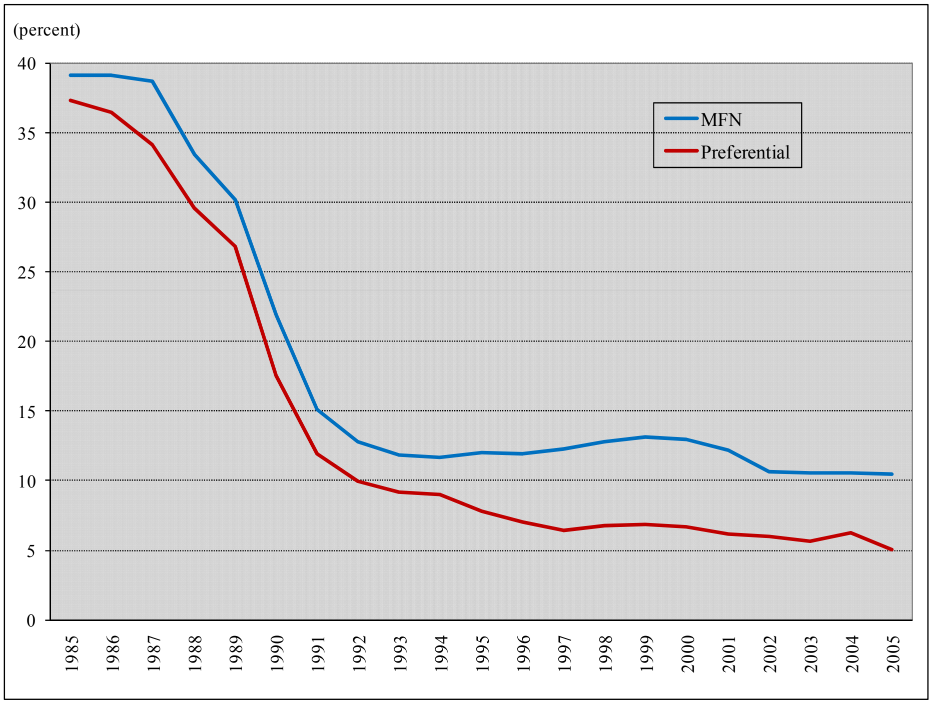
Source: Authors' CGE model simulations.

Table 7. Impact on Factor Market
(percentage change from baseline)

Counties	Factor Returns						Employment			
	Labor			Capital	Land	Natural				
	Low	Mid	High			Resources	Low	Mid	High	Total
Scenario 1: 10-Percent Tariff Reduction in Latin America										
Mexico	0.02	0.02	0.02	0.02	0.04	0.02	0.02	0.01	0.01	0.01
Bolivia	0.03	0.03	0.03	0.04	0.02	0.09	0.03	0.02	0.01	0.03
Colombia	0.02	0.02	0.03	0.02	0.02	0.09	0.02	0.02	0.01	0.02
Ecuador	0.03	0.03	0.04	0.05	0.09	0.12	0.03	0.03	0.02	0.03
Peru	0.04	0.05	0.06	0.06	0.03	0.11	0.05	0.04	0.02	0.04
Venezuela	0.05	0.05	0.05	0.07	-0.07	0.12	0.05	0.04	0.02	0.04
Argentina	0.02	0.02	0.03	0.02	0.05	0.02	0.02	0.02	0.01	0.02
Brazil	0.02	0.02	0.02	0.03	0.04	0.03	0.02	0.02	0.01	0.02
Paraguay	0.04	0.04	0.04	0.04	0.21	0.15	0.04	0.03	0.02	0.04
Uruguay	0.02	0.02	0.02	0.02	0.07	0.06	0.02	0.01	0.01	0.01
Chile	0.01	0.02	0.02	0.01	0.05	0.05	0.01	0.01	0.01	0.01
Latin America							***0.02***	***0.02***	***0.01***	***0.02***
Scenario 2: Complete Tariff Elimination within Latin America										
Mexico	0.11	0.12	0.13	0.15	0.22	0.15	0.10	0.08	0.05	0.09
Bolivia	0.25	0.28	0.30	0.38	0.15	0.94	0.25	0.19	0.12	0.24
Colombia	0.18	0.20	0.21	0.21	0.04	0.84	0.17	0.14	0.08	0.14
Ecuador	0.28	0.31	0.33	0.53	0.76	1.19	0.27	0.21	0.13	0.25
Peru	0.40	0.47	0.52	0.53	0.17	1.02	0.40	0.33	0.21	0.33
Venezuela	0.34	0.37	0.42	0.57	-0.65	1.15	0.33	0.25	0.16	0.28
Argentina	0.22	0.23	0.24	0.19	0.34	0.12	0.20	0.16	0.12	0.17
Brazil	0.19	0.21	0.22	0.26	0.23	0.17	0.21	0.17	0.13	0.19
Paraguay	0.36	0.41	0.43	0.39	2.21	1.51	0.37	0.29	0.17	0.34
Uruguay	0.14	0.15	0.16	0.15	0.61	0.44	0.14	0.10	0.06	0.12
Chile	0.15	0.15	0.17	0.13	0.41	0.50	0.12	0.09	0.06	0.10
Latin America							***0.20***	***0.17***	***0.11***	***0.18***
Scenario 3: 10-Percent Reduction of Ad Valorem Trade Transport Costs in Latin America										
Mexico	0.35	0.38	0.41	0.45	0.87	0.49	0.33	0.27	0.17	0.29
Bolivia	3.13	3.40	3.70	2.98	6.44	7.95	3.11	2.35	1.45	2.92
Colombia	1.48	1.63	1.76	1.39	2.13	2.32	1.44	1.11	0.68	1.18
Ecuador	2.03	2.22	2.40	2.35	2.03	3.71	2.01	1.53	0.94	1.81
Peru	1.63	1.88	2.09	1.85	1.94	2.75	1.70	1.36	0.86	1.38
Venezuela	1.55	1.68	1.82	1.91	-2.75	2.31	1.49	1.13	0.70	1.28
Argentina	2.29	2.41	2.54	2.08	1.40	3.48	2.13	1.71	1.25	1.85
Brazil	1.12	1.22	1.30	1.49	0.87	0.10	1.22	1.01	0.75	1.14
Paraguay	3.07	3.46	3.65	3.41	7.58	8.29	3.13	2.45	1.46	2.91
Uruguay	2.46	2.68	2.87	2.73	5.36	6.71	2.53	1.91	1.16	2.13
Chile	1.76	1.89	2.05	1.61	-0.83	3.12	1.50	1.12	0.69	1.22
Latin America							***1.28***	***1.00***	***0.70***	***1.13***

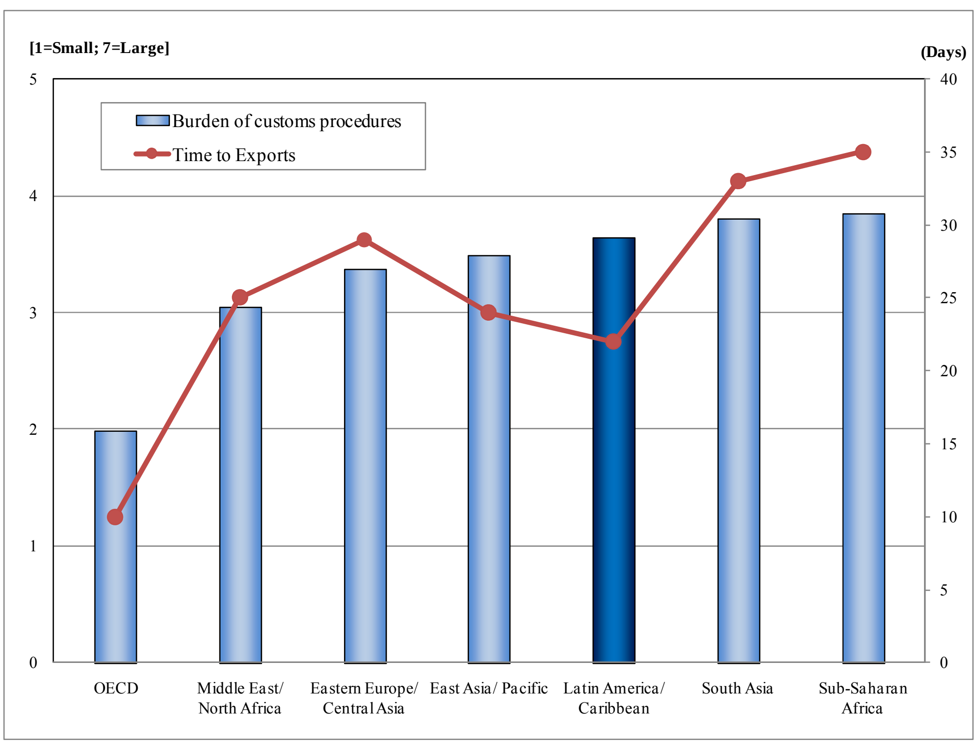
Source: Authors' CGE model simulations.

Figure 1. Average MFN and Preferential Tariffs in Latin America: 1985-2005



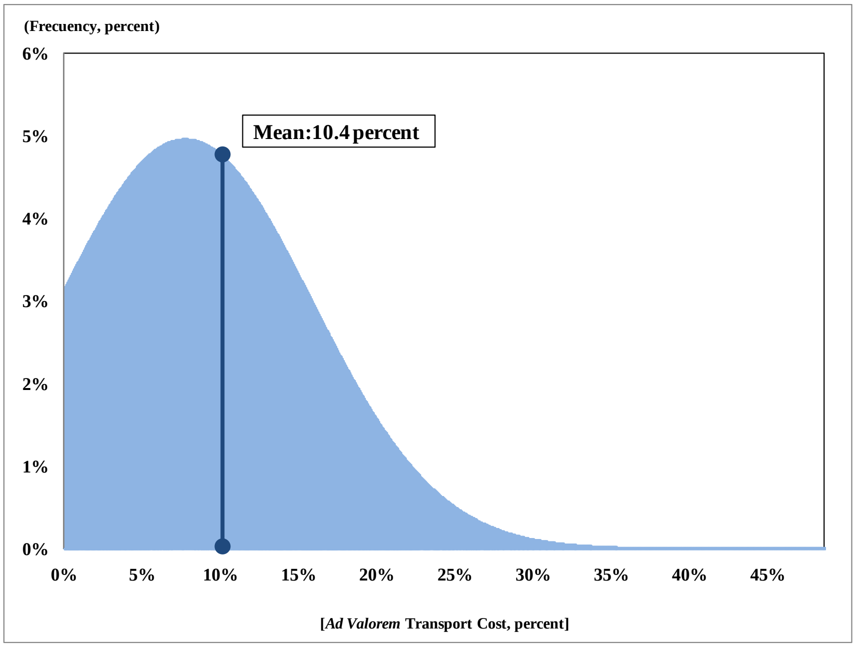
Source: Estevadeordal, Volpe and Ando (2009).
Note: MFN and preferential tariffs are averaged at the 5-digit SITC levels.

Figure 2. Global Comparison of Some forms of Trade-related Costs



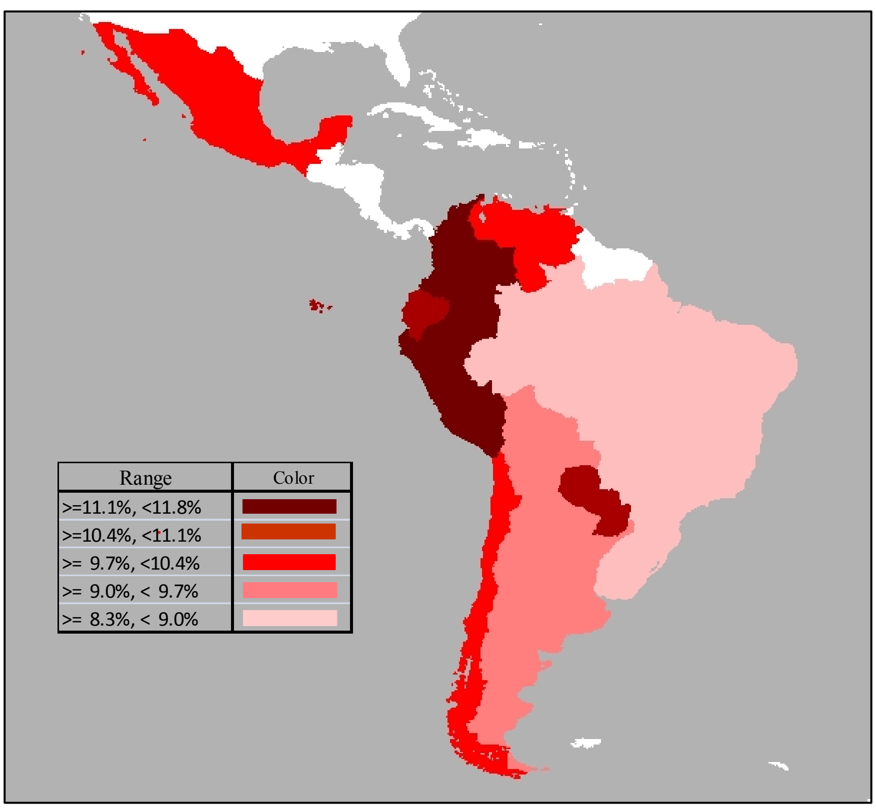
Source: World Economic Forum (2007) and World Bank (2008).

Figure 3. Distribution of *Ad Valorem* Transport Costs in Latin America



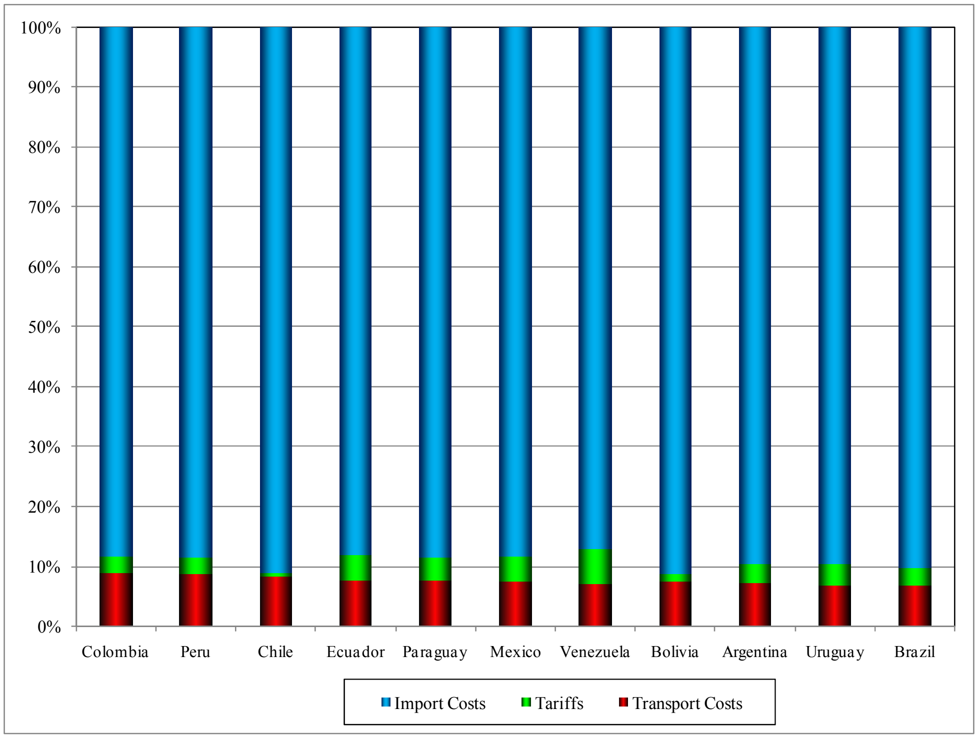
Source: Authors' estimations based on Mauricio, Volpe and Blyde (2008).

Figure 4. Aggregate *Ad Valorem* Transport Costs in Latin America



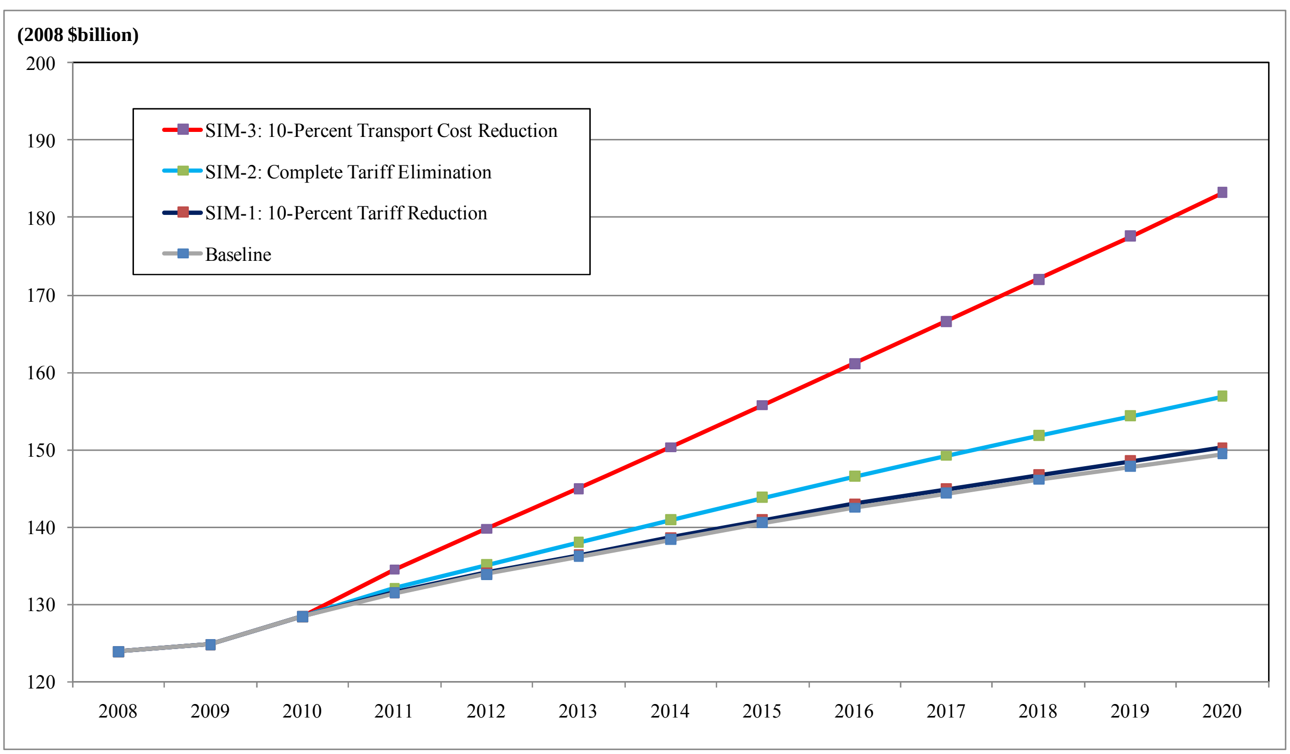
Source: Authors' estimations based on Mauricio, Volpe and Blyde (2008).

Figure 5. Decomposition of Prices of Imports at Porty of Entry in Latin America



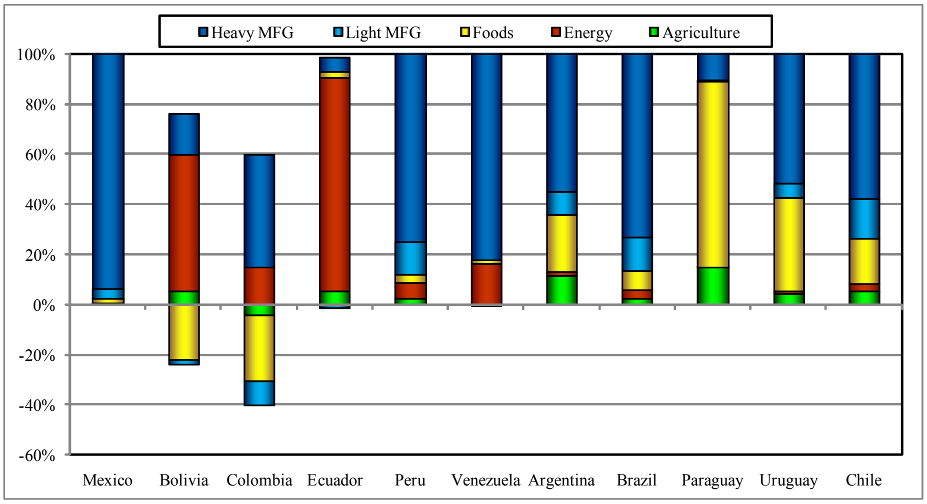
Source: Authors' estimations based on Mauricio, Volpe and Blyde (2008).

Figure 6. Trajectory of Intra-LAC Exports: 2008-2020

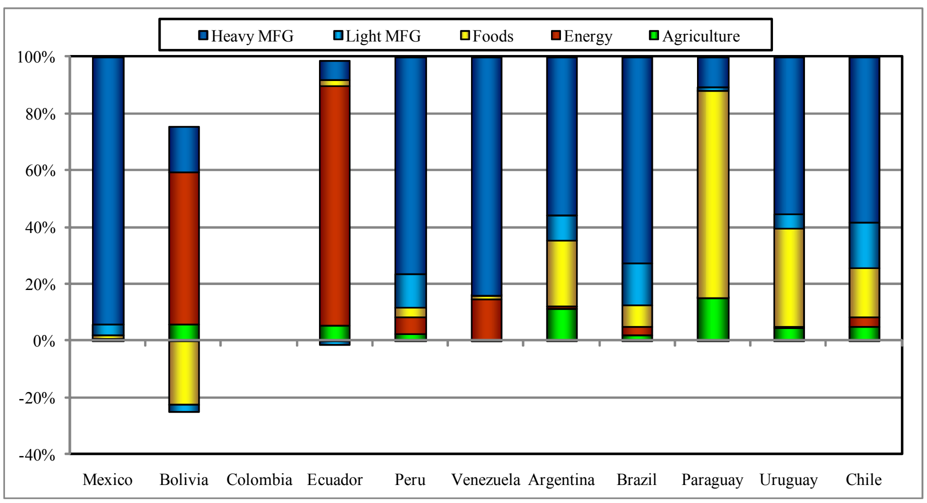


Source: Authors' CGE model estimations.

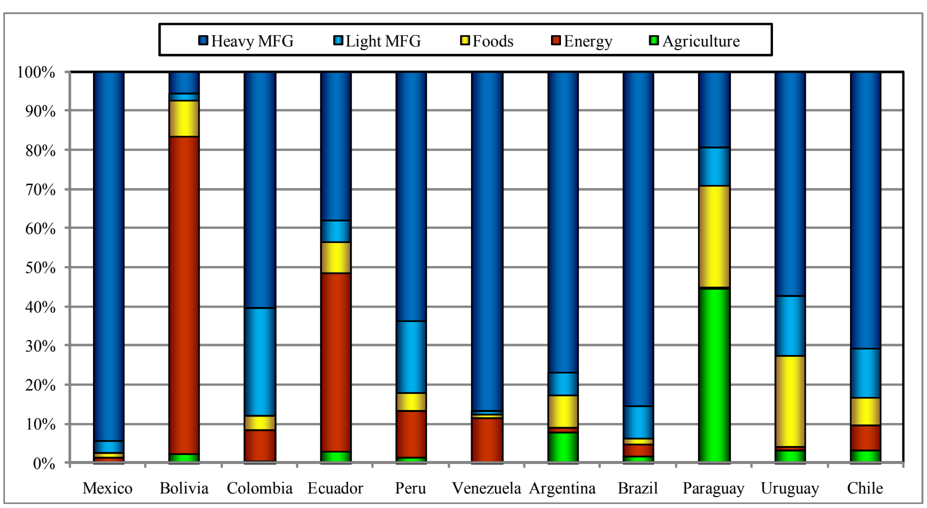
Figure 7. Composition of New Aggregate Intra-regional Exports in Latin America



Scenario 2: 10-Percent Tariff Reduction in Latin America



Scenario 3: 10-Percent Reduction of Ad Valorem Trade Transport Costs in Latin America



Source: Authors' CGE model estimations.

Annex 1. Countries and Regions in the Model

Nos.	**Country/Region**	
1.	Canada	
2.	United States	
3.	Mexico	
4.	Central America	
5.	Bolivia	
6.	Colombia	
7.	Ecuador	
8.	Peru	
9.	Venezuela	
10.	Argentina	
11.	Brazil	
12.	Paraguay	
13.	Uruguay	
14.	Chile	
15.	EU27	Austria, Belgium, Bulgaria, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxemburg, Malta, the Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden and the United Kingdom.
16.	Japan	
17.	China	
18.	India	
19.	Rest of Asia	Afghanistan, Bangladesh, Bhutan, Brunei Darussalam, Cambodia, Hong Kong, Indonesia, Iran, Iraq, Kazakhstan, Korea, Laos, Macao, Malaysia, Myanmar, Nepal, Pakistan, Papua New Guinea, Philippines, Singapore, Sri Lanka, Thailand, Vietnam
20.	Rest of World	

Note: The highlighted are the countries in Latin America in this study.

Annex 2. Sectoral Classification in the Model

No.	Transport Model		GTAP		
	Commodities	Description		Commodities	Description
I.	**AGR**	**Agriculture**			
1	CRLGR	Cereal grains	1	PDR	Paddy rice
			2	WHT	Wheat
			3	GRO	Corn, Cereal grains, maize, sorghum
2	VGFRT	Vegetables and fruits	4	V_F	Vegetables, fruit, nuts
3	LVSTK	Livestock	9	CTL	Bovine cattle, sheep and goats, horses
			10	OAP	Animal products nec*
4	OTHAG	Other agriculture	5	OSD	Oil seeds and Soybeans, sunflower
			6	C_B	Sugar cane, sugar beet
			7	PFB	Plant-based fibers, cotton, jute
			8	OCR	Coffee, cocoa
			11	RMK	Raw milk
			12	WOL	Wool, silk-worm cocoons
			13	FOR	Forestry
			14	FSH	Fishing
II.	**ENRGY**	**Energy**			
5	COLGS	Coal, crude oil and gas	15	COL	Coal
			16	OIL	Oil (crude)
			17	GAS	Gas
6	MNRLS	Minerals	18	OMN	Minerals (iron, tin, copper)
			34	NMM	Mineral products (china, glass, cement)
III.	**FOOD**	**Processed Foods**			
7	MEAT	Meat	19	CMT	Bovine meat products
			20	OMT	Pork and poultry meat
8	DAIRY	Dairy products	22	MIL	Dairy products
9	OTHFD	Other food products	21	VOL	Vegetable oils and fats
			23	PCR	Processed rice
			24	SGR	Sugar (processed)
			25	OFD	Food products nec*
			26	B_T	Beverages and tobacco products
IV.	**LMFG**	**Light Manufactures**			
10	TXTIL	Textiles	27	TEX	Textiles
11	WAPRL	Wearing apparel	28	WAP	Wearing apparel
12	LTHFW	Leather products and footwear	29	LEA	Leather products, footwear, shoes
13	OLMFG	Other light manufactures	30	LUM	Wood products (furniture)
			31	PPP	Paper products, publishing, books, magazines
			42	OMF	Manufactures nec, toys, jewels
V.	**HMFG**	**Heavy Manufactures**			
14	CHMCL	Chemical and plastic products	32	P_C	Petroleum, coal products
			33	CRP	Chemical, rubber, plastic products, fertilizers, tires
15	METAL	Metals and metal products	35	I_S	Ferrous metals, iron, steel
			36	NFM	Metals nec*
			37	FMP	Metal products, cutlery, tools
16	VEHCL	Motor vehicles	38	MVH	Motor vehicles and parts
			39	OTN	Transport equipment (aircraft, trains, ships)
17	MCHNY	Machinery and Electric equipment	40	ELE	Electronic equipment
			41	OME	Machinery and equipment nec*
VI.	**UTLCST**	**Utility-Construction**			
18	UTLTY	Utilities	43	ELY	Electricity
			44	GDT	Gas manufacture, distribution
			45	WTR	Water
19	CNSTR	Construction	46	CNS	Construction
VII.	**SRVC**	**Services**			
20	TRADE	Trade, Restaurants and Dwellings	47	TRD	Trade
			55	ROS	Recreational and other services
			57	DWE	Dwellings
21	TRSPT	Transport and Communications	48	OTP	Transport nec
			49	WTP	Water transport
			50	ATP	Air transport
			51	CMN	Communication
22	FISRG	Financials and Other Services	52	OFI	Financial services nec
			53	ISR	Insurance
			54	OBS	Business services nec
			56	OSG	Public Administration, Defense, Education, Health

Note: The sectoral classifications follow GTAP sectors.

Annex 3. List of Model Parameters, Variables and Equations

A. List of Model Parameters and Variables

A.1. Set

$i \in I$	:	Sectors or commodities
$r \in R$	:	Regions or countries
$f \in F$	:	Factors of production
$lab \in LAB(\subset F)$	:	Aggregate labor
$l \in L(\subset F)$	:	Labor by skill category
$cap \in CAP(\subset F)$	:	Capital
$fln \in f(\subset F)$	:	Non-labor factors of production
$ff \in FF(\subset F)$	:	Non-labor mobile factors
$ins \in INS$	:	Domestic institutions (households, firms and government)
$h \in H(\subset INS)$	:	Households
$firm \in FIRM(\subset INS)$	:	Firms
$t \in T$	:	Time periods (2008 to 2020)

Alias : (i, j), (r, s), (f, fp), $(ins, inst)$

A.2. Parameters

$pwtx_i^r$	:	Price index weight for output
$pwts_i^r$	:	Price index weight for domestic sales
$pwtc_i^r$	:	Price index weight for composite goods
$IO_{i,j}^r$	:	Input-output coefficients
$fshr_{ins,f}^r$	:	Factor income share parameter
tx_i^r	:	Output tax rate
tva_i^r	:	Value-added tax rate
th_h^r	:	Household income tax rates by household category
$tent^r$	:	Enterprise tax rate
ts_{ins}^r	:	Social security tax rate
tcz_i^r	:	Commodity tax rate on intermediate input
tch_i^r	:	Commodity tax rate on private consumption
tcg_i^r	:	Commodity tax rate on government demand
tcv_i^r	:	Commodity tax rate on investment demand
$te_i^{r,s}$	:	Export tax rate
$tm_i^{r,s}$	:	Import tariff rate
$tr_i^{r,s}$	:	*Ad Valorem* international transport cost rate

$\omega_{i,h}^{r}$: Marginal household consumption share in LES function

$frisch_{h}^{r}$: Frisch parameter

AX_{i}^{r} : CES production function shift parameter

AV_{i}^{r} : CES value-added function shift parameter

AL_{i}^{r} : CES aggregate labor function shift parameter

AC_{i}^{r} : Upper-level CES function shift parameter

AM_{i}^{r} : Lower-level CES function shift parameter

AT_{i}^{r} : Upper-level CET function shift parameter

AE_{i}^{r} : Lower -level CET function shift parameter

AI^{r} : Cobb-Douglas investment function shift parameter

$TADJ_{i}^{r,s}$: Transport cost technical adjustment coefficient

a_{i}^{r} : CES production function share parameters

$\beta_{i,f}^{r}$: CES value-added function share parameters

γ_{i}^{r} : Upper-level CET function share parameters

γe_{i}^{r} : Lower -level CET function share parameters

δ_{i}^{r} : Upper-level CES function share parameters

δm_{i}^{r} : Lower -level CES function share parameters

$\beta l_{i,l}^{r}$: CES aggregate labor function share parameters

μ_{i}^{r} : Investment demand share parameters

$\varphi 1_{i}^{r}$: Polynomial investment demand coefficient (second degree)

$\varphi 2_{i}^{r}$: Polynomial investment demand coefficient (first degree)

σp_{i}^{r} : CES production function elasticity

σva_{i}^{r} : CES value-added function elasticity

σc_{i}^{r} : Upper-level CES function elasticity

σm_{i}^{r} : Lower-level CES function elasticity

σt_{i}^{r} : Upper-level CET function elasticity

σe_{i}^{r} : Lower-level CET function elasticity

σl_{i}^{r} : CES aggregate labor function elasticity

ηl_{l}^{r} : Labor supply elasticity

δ^{r} : Capital depreciation rate

$g_{POP}{}_{t}^{r}$: Population growth rate

$g_{LAB}{}_{l,t}^{r}$: Labor force growth rate

g_{t}^{r} : Real GDP growth rate (2008-2020)

$g_{FS}{}_{f}^{r}$: Long-term factor supply growth rate (land and natural resource)

A.3. Endogenous Variables

(1) Price Indices

CPI^r : Consumer price index
PID^r : Normalized price index
$PINDEX^r$: Average net output price index (PP)
$PINDOM^r$: Domestic good price index (PD)
$GDPDEF^r$: GDP deflator
ER^r : Exchange rate

(2) Output

PP_i^r : Average net output price (producer price)
PX_i^r : Gross output price including output tax
PVA_i^r : Value added price
PD_i^r : Domestic good price
PZ_i^r : Aggregate intermediate input price
PQ_i^r : Composite good price
X_i^r : Domestic Output
VA_i^r : Aggregate value-added (composite primary factor)
XD_i^r : Domestic sales of domestic output
XZ_i^r : Aggregate intermediate demand
Q_i^r : Composite good (absorption)
INT_i^r : Intermediate demand

(3) Factor Price and Factor Demand

WF_f^r : Average factor price (non-labor)
WA_i^r : Sectoral aggregate labor wage
WL_l^r : Aggregate labor wages by skill category
$QF_{i,f}^r$: Sectoral factor demand (non-labor)
$QL_{i,l}^r$: Sectoral labor demand by skill category
$WDIST_{i,f}^r$: Factor price differentials (non-labor)
$WLDIST_{i,l}^r$: Labor wage differentials by skill category
$LADJ_l^r$: Labor supply adjustment factor (free for baseline, fixed for simulation)
FS_f^r : Aggregate factor supply

(4) International Trade

$PWE_i^{r,s}$: World price of exports

$PWM_i^{r,s}$	:	World price of imports
PXE_i^r	:	Average price of exports
PXM_i^r	:	Average price of imports
$PE_i^{r,s}$	:	Domestic price of exports
$PM_i^{r,s}$	:	Domestic price of imports
XE_i^r	:	Aggregate sectoral exports
XM_i^r	:	Aggregate sectoral imports
$E_i^{r,s}$	:	Sectoral export supply
$M_i^{r,s}$	:	Sectoral import demand

(5) Institutional Income and Expenditures

YF_f^r	:	Factor income
YH^r	:	Household income
YHD^r	:	Household disposable income
CD_i^r	:	Sectoral household consumption demand
$YENT^r$	:	Firm income

(6) Government Account

$HTAX^r$	:	Household income tax
$ENTAX^r$	:	Enterprise tax
$OUTAX^r$	:	Output tax
$VATAX^r$	:	Value-added tax
$COMTAX^r$	:	Commodity tax
$SSTAX^r$	:	Social security tax
$EXPTAX^r$	:	Export tax
$TARIFF^r$	:	Import tariff duty
GR^r	:	Government revenue
GDE^r	:	Gross government consumption expenditures

(7) Saving and Investment

$IADJ^r$	:	Investment scaling factor
$HSAV^r$	:	Aggregate household savings
$ENTSAV^r$	:	Enterprise savings
$GSAV^r$	:	Government savings
SAV^r	:	Total savings
PK^r	:	Price of capital
RK_i^r	:	Sectoral capital return
INV^r	:	Aggregate investment
ID_i^r	:	Investment demand by sector of origin

DK_i^r	:	Investment demand by sector of destination
K_i^r	:	Sectoral capital stock
KT^r	:	Aggregate capital stock

(8) Trade-related Endogenous Productivity

$EPROD^r$	:	Aggregate exports over output (market openness on exports)
$MPROD^r$	:	Aggregate imports over composite good (market openness on imports)
TFP^r	:	Total factor productivity (endogenous for baseline, fixed for simulation)
$ITFP_i^r$	:	Sectoral factor productivity

(9) National Account and Miscellaneous Variables

$RGDP^r$	:	Real gross domestic product at market prices
$RGDPVA^r$	:	Real gross domestic product at factor costs
$TB^{r,s}$	:	Net bilateral trade balance with partners
$WALRAS^r$	:	Walras law on saving-investment balance

A.4. Exogenous Variables

$CMIN_i^r$	:	Subsistence minima for household consumption
GD_i^r	:	Government sectoral consumption demand
IR^r	:	Real interest rate
MPS^r	:	Household saving rate (marginal propensity to save)
TRH^r	:	Domestic inter-household transfer
DIV^r	:	Firms' distributed profits
$GSUB_{ins}^r$	:	Government subsidy to domestic institutions
$REMIT^r$	:	Remittances
$REPAT^r$	:	Firms' repatriated profit
$FBOR^r$	:	Government foreign borrowing
$FSAV^r$	:	Foreign saving
$FTRH^r$	:	Households overseas transfer
$FDIV^r$	:	Firms' foreign dividends
$AMORT^r$	:	Government foreign amortization payment
BOP^r	:	Balance of payment

B. Model Equations (Static Module)

B.1. Price Indices

(1) Consumer price index: $$CPI^r = \prod_i \left[\left(PQ_i^r\right)^{cles_i^r} \cdot \left(PID^r\right)^{MPS^r} \right]$$

(2) Normalized price index: $PID^r = \sum_i PQ_r^r \cdot CD_i^r \Big/ \sum_i PQ0_i^r \cdot CD_i^r$

(3) Average net output price index: $PINDEX^r = \sum_i pwtx_i^r \cdot PP_i^r$

(4) Domestic good price index: $PINDOM^r = \sum_i pwts_i^r \cdot PD_i^r$

(5) GDP deflator: $GDPDEF^r = RGDPVA^r / RGDP^r$

B.2. Output

(6) Average net output price:

$$PP_i^r = \frac{1}{AX_i^r} \cdot \left[\left(\alpha_i^r\right)^{\sigma p_i^r} \cdot \left[\left(1 + tva_i^r\right) \cdot PVA_i^r\right]^{1-\sigma p_i^r} + \left(1-\alpha_i^r\right)^{\sigma p_i^r} \cdot \left[\left(1 + tcz_i^r\right) \cdot PZ_i^r\right]^{1-\sigma p_i^r} \right]^{\frac{1}{1-\sigma p_i^r}}$$

(7) Gross output price: $PX_i^r = \left(1 + tx_i^r\right) \cdot PP_i^r$

(8) Value added price:

$$PVA_i^r = \left(\frac{1}{ITFP_i^r \cdot AV_i^r}\right) \cdot \left[\left(\beta_{i,lab}^r\right)^{\sigma va_i^r} \cdot \left(WA_i^r\right)^{1-\sigma va_i^r} + \sum_{fln} \left(\beta_{i,fln}^r\right)^{\sigma va_i^r} \cdot \left(WDIST_{i,fln}^r \cdot WF_{fln}^r\right)^{1-\sigma va_i^r} \right]^{\frac{1}{1-\sigma va_i^r}}$$

(9) Aggregate intermediate input price: $PZ_i^r = \sum_j IO_{i,j}^r \cdot PQ_j^r$

(10) Aggregate value-added (composite primary factor):

$$VA_i^r = \left(\frac{1}{AX_i^r}\right)^{1-\sigma p_i^r} \cdot \left[\frac{\alpha_i^r \cdot PP_i^r}{\left(1 + tva_i^r\right) \cdot PVA_i^r} \right]^{\sigma p_i^r} \cdot X_i^r$$

(11) Domestic sales with respect to output:

$$XD_i^r = \left(\frac{1}{AT_i^r}\right)^{1+\sigma t_i^r} \cdot \left[\frac{PD_i^r}{\left(1 - \gamma_i^r\right) \cdot PX_i^r} \right]^{\sigma t_i^r} \cdot X_i^r$$

(12) Domestic sales with respect to composite goods:

$$XD_i^r = \left(\frac{1}{AC_i^r}\right)^{1-\sigma c_i^r} \cdot \left[\frac{\left(1 - \delta_i^r\right) \cdot PQ_i^r}{PD_i^r} \right]^{\sigma c_i^r} \cdot Q_i^r$$

(13) Aggregate intermediate demand:

$$XZ_i^r = \left(\frac{1}{AX_i^r}\right)^{1-\sigma p_i^r} \cdot \left[\frac{\left(1 - \alpha_i^r\right) \cdot PP_i^r}{\left(1 + tcz_i^r\right) \cdot PVA_i^r} \right]^{\sigma p_i^r} \cdot X_i^r$$

(14) Intermediate demand: $INT_i^r = \sum_j IO_{i,j}^r \cdot XZ_i^r$

B.3. Factor Price and Factor Demand

(15) Sectoral aggregate labor wages: $WA_i^r = \frac{1}{AL_i^r} \cdot \left[\sum_l \left(\beta l_{i,l}^r\right)^{\sigma l_i^r} \cdot \left(WLDIST_{i.l}^r \cdot WL_l^r\right)^{1-\sigma l_i^r} \right]^{\frac{1}{1-\sigma l_i^r}}$

(16) Sectoral aggregate labor demand: $QF_{i,lab}^{r} = \left(\frac{1}{ITFP_i^r \cdot AV_i^r}\right)^{1-\sigma va_i^r} \cdot \left[\frac{\beta_{i,lab}^r \cdot PVA_i^r}{WA_i^r}\right]^{\sigma va_i^r} \cdot VA_i^r$

(17) Sectoral non-labor demand: $QF_{i,nfl}^{r} = \left(\frac{1}{ITFP_i^r \cdot AV_i^r}\right)^{1-\sigma va_i^r} \cdot \left[\frac{\beta_{i,nfl}^r \cdot PVA_i^r}{WDIST_{i,nfl}^r \cdot WF_{nfl}^r}\right]^{\sigma va_i^r} \cdot VA_i^r$

B.4. International Trade

(18) Domestic prices of exports: $PE_i^{r,s} = \left(1 - te_i^{r,s}\right) \cdot PWE_i^{r,s} \cdot ER^r$

(19) Domestic prices of imports: $\frac{PM_i^{r,s}}{TADJ_i^{r,s}} = \left(1 + tm_i^{r,s}\right) \cdot PWM_i^{r,s} \cdot ER^r$

(20) Aggregate output price with export sector:

$$PX_i^r = \frac{1}{AT_i^r} \cdot \left[\left(\gamma_i^r\right)^{-\sigma t_i^r} \cdot \left(PXE_i^r\right)^{1+\sigma t_i^r} + \left(1-\gamma_i^r\right)^{-\sigma t_i^r} \cdot \left(PD_i^r\right)^{1+\sigma t_i^r}\right]^{\frac{1}{1+\sigma t_i^r}}$$

(21) Composite good price with import sector:

$$PQ_i^r = \frac{1}{AC_i^r} \cdot \left[\left(\delta_i^r\right)^{\sigma c_i^r} \cdot \left(PXM_i^r\right)^{1-\sigma c_i^r} + \left(1-\delta_i^r\right)^{\sigma c_i^r} \cdot \left(PD_i^r\right)^{1-\sigma c_i^r}\right]^{\frac{1}{1-\sigma c_i^r}}$$

(22) Aggregate price of exports: $PXE_i^r = \frac{1}{AE_i^r} \cdot \left[\sum_s \left(\gamma e_i^{r,s}\right)^{-\sigma e_i^r} \cdot \left(PE_i^{r,s}\right)^{1+\sigma e_i^r}\right]^{\frac{1}{1+\sigma e_i^r}}$

(23) Aggregate price of imports: $PXM_i^r = \frac{1}{AM_i^r} \cdot \left[\sum_s \left(\delta m_i^{r,s}\right)^{\sigma m_i^r} \cdot \left(\frac{PM_i^{r,s}}{TADJ_i^{r,s}}\right)^{1-\sigma m_i^r}\right]^{\frac{1}{1-\sigma m_i^r}}$

(24) Aggregate sectoral exports: $XE_i^r = \left(\frac{1}{AT_i^r}\right)^{1+\sigma t_i^r} \cdot \left[\frac{PXE_i^r}{\gamma_i^r \cdot PX_i^r}\right]^{\sigma t_i^r} \cdot X_i^r$

(25) Aggregate sectoral imports: $XM_i^r = \left(\frac{1}{AC_i^r}\right)^{1-\sigma c_i^r} \cdot \left[\frac{\delta_i^r \cdot PQ_i^r}{PXM_i^r}\right]^{\sigma c_i^r} \cdot Q_i^r$

(26) Export supply to different destinations:

$$E_i^{r,s} = \left(\frac{1}{AE_i^r}\right)^{1+\sigma e_i^r} \cdot \left(\frac{PE_i^{r,s}}{\gamma e_i^{r,s} \cdot PXE_i^r}\right)^{\sigma e_i^r} \cdot XE_i^r$$

(27) Import demand from different sources:

$$TADJ_i^{r,s} \cdot M_i^{r,s} = \left(\frac{1}{AM_i^r}\right)^{1-\sigma m_i^r} \cdot \left(\frac{\delta m_i^{r,s} \cdot PXM_i^r}{PM_i^{r,s}}\right)^{\sigma m_i^r} \cdot XM_i^r$$

(28) Domestic good price with non-export sector: $PD_i^r = PX_i^r$

(29) Composite good price with non-output and non-import sector: $PQ_i^r = PD_i^r$

(30) Composite good price with non-output but import sector: $PQ_i^r = PXM_i^r$

(31) Domestic sales of non-export sector: $XD_i^r = X_i^r$

(32) Composite goods for non-import sector: $Q_i^r = XD_i^r$

(33) Composite goods for non-domestic outputs: $Q_i^r = XM_i^r$

B.5. Institutional Income and Expenditures

(34) Labor income: $YF_l^r = \sum_i WLDIST_{i,l}^r \cdot WL_l^r \cdot QL_{i,l}^r$

(35) Non-labor income: $YF_{fln}^r = \sum_i WDIST_{i,fln}^r \cdot WF_{fln}^r \cdot QF_{i,fln}^r$

(36) Household income:

$$YH^r = \sum_f fshr_{h,f}^r \cdot YF_f^r + TRH^r + DIV^r + GSUB_h^r + ER^r \cdot REMIT^r$$

(37) Household disposable income:

$$YHD^r = (1 - MPS^r) \cdot (1 - th^r - ts_h^r) \cdot YH^r - (TRH^r + ER^r \cdot FTRH^r)$$

(38) Sectoral household consumption demand:

$$CD_i^r = CMIN_i^r + \frac{\varpi_i^r}{(1 + tch_i^r) \cdot PQ_i^r} \cdot \left[YHD_i^r - \sum_j (1 + tch_i^r) \cdot PQ_j^r \cdot CMIN_i^r \right]$$

(39) Enterprise income:

$$YENT^r = \sum_f fshr_{firm,f}^r \cdot YF_l^r + GSUB_{firm}^r + ER^r \cdot REPAT^r$$

B.6. Government Account

(40) Household income tax: $HTAX^r = th^r \cdot YH^r$

(41) Enterprise tax: $ENTAX^r = tent^r \cdot YENT^r$

(42) Output tax: $OUTAX^r = \sum_i tx_i^r \cdot PP_i^r \cdot X_i^r$

(43) Value-added tax: $VATAX^r = \sum_i tva_i^r \cdot PVA_i^r \cdot VA_i^r$

(44) Commodity tax:

$$COMTAX^r = \sum_i tcz_i^r \cdot PZ_i^r \cdot XZ_i^r + \sum_i tch_i^r \cdot PQ_i^r \cdot CD_i^r + \sum_i PQ_i^r \cdot (tcg_i^r \cdot GD_i^r + tcv_i^r \cdot ID_i^r)$$

(45) Social security tax: $SSTAX^r = ts_h^r \cdot YH^r + ts_{firm}^r \cdot YENT^r$

(46) Export tax: $EXPTAX^r = ER^r \cdot \sum_s \sum_i te_i^{r,s} \cdot PWE_i^{r,s} \cdot E_i^{r,s}$

(47) Import tariff duty: $TARIFF^r = ER^r \cdot \sum_s \sum_i tm_i^{r,s} \cdot PWM_i^{r,s} \cdot M_i^{r,s}$

(48) Government revenue:

$$GR^r = HTAX^r + ENTAX^r + OUTAX^r + VATAX^r + SSTAX^r + COMTAX^r + EXPTAX^r + TARIFF^r + ER^r \cdot FBOR^r$$

(49) Gross government consumption expenditures:

$$GDE^r = \sum_i \left(1 + tcg_i^r\right) \cdot PQ_i^r \cdot GD_i^r$$

B.7. Saving and Investment

(50) Aggregate household savings:

$$HSAV^r = MPS^r \cdot \left(1 - th^r - ts_h^r\right) \cdot YH^r$$

(51) Enterprise savings:

$$ENTSAV^r = \left(1 - tent^r - ts_{firm}^r\right) \cdot YENT^r - \left(DIV^r + ER^r \cdot FDIV^r\right)$$

(52) Government savings: $GSAV^r = GR^r - \left(\sum_{ins} GSUB_{ins}^r + GDE^r + ER^r \cdot AMORT^r\right)$

(53) Total savings: $SAV^r = HSAV^r + ENTSAV^r + GSAV^r + ER^r \cdot FSAV^r$

(54) Price of capital: $PK^r = \dfrac{1}{AI^r} \cdot \prod_i \left[\dfrac{\left(1 + tcv_i^r\right) \cdot PQ_i^r}{\mu_i^r}\right]^{\mu_i^r}$

(55) Investment demand by sector of origin: $\left(1 + tcv_i^r\right) \cdot PQ_i^r \cdot ID_i^r = \mu_i^r \cdot INV^r$

(56) Aggregate Investment: $INV^r = IADJ^r \cdot PK^r \cdot \sum_i DK_i^r$

(57) Sectoral capital return: $RK_i^r = WDIST_{i,cap}^r \cdot WF_{cap}^r$

(58) Investment demand by sector of destination:

$$\frac{DK_i^r}{K_i^r} = \varphi 1_i^r \cdot \left(\frac{RK_i^r}{PK_i^r \cdot IR_i^r}\right)^2 + \varphi 2_i^r \cdot \left(\frac{RK_i^r}{PK_i^r \cdot IR_i^r}\right)$$

(59) Sectoral capital stock: $K_i^r = QF_{cap}^r$

(60) Aggregate capital stock: $KT^r = \sum_i K_i^r$

B.8. Trade-related Endogenous Productivity

(61) Aggregate exports over output: $EPROD^r = \sum_i XE_i^r \Big/ \sum_i X_i^r$

(62) Aggregate imports over composite good: $MPROD^r = \sum_i XM_i^r \Big/ \sum_i Q_i^r$

(63) Sectoral factor productivity:

$$ITFP_i^r = TFP^r \cdot \left[\frac{EPROD^r}{EPROD0^r}\right]^{\eta e_i^r} \cdot \left[\frac{MPROD^r}{MPROD0^r}\right]^{\eta m_i^r}$$

B.9. National Account

(64) Real gross domestic product at market prices:

$$RGDP^r = \sum_i \left(1+tch_i^r\right)\cdot PQ0_i^r \cdot CD_i^r + \sum_i \left(1+tcg_i^r\right)\cdot PQ0_i^r \cdot GD_i^r + \sum_i \left(1+tcv_i^r\right)\cdot PQ0_i^r \cdot iD_i^r$$
$$+ ER^r \cdot \left[\sum_s \sum_i \left(PWE0_i^{r,s} \cdot E_i^{r,s} - PWM0_i^{r,s} \cdot TADJ_i^{r,s} \cdot M_i^{r,s}\right)\right]$$

(65) Real gross domestic product at factor costs:

$$RGDPVA^r = \sum_i PVA0_i^r \cdot VA_i^r + \sum_i tx_i^r \cdot PP0_i^r \cdot X_i^r + \sum_i tva_i^r \cdot PVA0_i^r \cdot VA_i^r + \sum_i tcz_i^r \cdot PZ0_i^r \cdot VZ_i^r$$
$$+ \sum_i tch_i^r \cdot PQ0_i^r \cdot CD_i^r + \sum_i tcg_i^r \cdot PQ0_i^r \cdot GD_i^r + \sum_i tcv_i^r \cdot PQ0_i^r \cdot ID_i^r$$
$$+ ER0^r \cdot \left(\sum_i te0_i^{r,s} \cdot PWE0_i^{r,s} \cdot E_i^{r,s} + \sum_i tm0_i^{r,s} \cdot PWM0_i^{r,s} \cdot TADJ_i^{r,s} M_i^{r,s}\right)$$

B.10. Trade Consistencies

(66) Export-import symmetry conditions: $TADJ_i^{r,s} \cdot M_i^{r,s} = E_i^{s,r}$

(67) World price consistency conditions: $PWM_i^{r,s} = \left(1+tr_i^{s,r}\right)\cdot PWE_i^{s,r}$

B.11. Market Equilibrium Conditions

(68) Material balance (commodity market equilibrium):

$$Q_i^r = INT_i^r + CD_i^r + GD_i^r + ID_i^r$$

(69) Labor market equilibrium: $FS_l^r = \sum_i QL_{i,l}^r$

(70) Non-labor market equilibrium: $FS_{ff}^r = \sum_i QF_{i,ff}^r$

(71) Endogenous Labor supply: $FS_l^r = LADJ_l^r \cdot FS0_l^r \cdot \left[\dfrac{WL_l^r / CPI^r}{WL0_l^r / CPI0^r}\right]^{\eta l_l^r}$

(72) Foreign saving equilibrium: $FSAV^r = BOP^r - \left(REMIT^r + REPAT^r + FBOR^r\right)$

(73) Net bilateral trade balance: $TB^{r,s} = \sum_i PWM_i^{r,s} \cdot M_i^{r,s} - \sum_i PWE_i^{r,s} \cdot E_i^{r,s}$

(74) Balance of payment equilibrium:

$$BOP^r = FTRH^r + FDIV^r + AMORT^r + \sum_s TB^{r,s}$$

(75) Walras' law for saving and investment equality:

$$INV^r = SAV^r + WALRAS^r$$

C. Inter-temporal Dynamic Equations (Recursive Dynamic Module)

(1) Capital stock accumulation: $KT_t^r = KT_{t-1}^r \cdot \left(1-\delta^r\right) + \sum_i DK_{i,t-1}^r$

(2) Labor supply: $FS_{l,t}^{r} = FS_{l,t-1}^{r} \cdot \left(1 + gLAB_{l,t}^{r}\right)$

(3) Factor supply (land and natural resources): $FS_{fln,t}^{r} = FS0_{fln}^{r} \cdot \left(1 + gFS_{fln}^{r}\right)^{t-1}$

(4) Subsistence Minima: $CMIN_{i,t}^{r} = CMIN_{i,t-1}^{r} \cdot \left(1 + gPOP_{t}^{r}\right)$

(5) Government sectoral consumption demand: $GD_{i,t}^{r} = GD_{i,t-1}^{r} \cdot \left(1 + g_{t}^{r}\right)$

(6) Domestic inter-household transfer: $TRH_{t}^{r} = TRH_{t-1}^{r} \cdot \left(1 + gPOP_{t}^{r}\right)$

(7) Firms' distributed profits: $DIV_{t}^{r} = DIV_{t-1}^{r} \cdot \left(1 + g_{t}^{r}\right)$

(8) Government subsidy to domestic institutions: $GSUB_{t}^{r} = GSUB_{t-1}^{r} \cdot \left(1 + g_{t}^{r}\right)$

(9) Firms' repatriated profits: $REPAT_{t}^{r} = REPAT_{t-1}^{r} \cdot \left(1 + gPOP_{t}^{r}\right)$

(10) Public foreign borrowings: $FBOR_{t}^{r} = FBOR_{t-1}^{r} \cdot \left(1 + gPOP_{t}^{r}\right)$

(11) Firms' foreign dividends: $FDIV_{t}^{r} = FDIV_{t-1}^{r} \cdot \left(1 + gPOP_{t}^{r}\right)$

(12) Government foreign amortization payment: $AMORT_{t}^{r} = AMORT_{t-1}^{r} \cdot \left(1 + gPOP_{t}^{r}\right)$