

TECHNICAL REPORT

# Colombian Trade Liberalization

A Quantitative Assessment

**SUBMITTED TO**  
USAID/Peru  
USAID/Colombia

**SUBMITTED BY**  
CRECER Project

**UNDER CONTRACT NO.**  
PCE-I-802-00-00013-00 Task Order 802

February 2004



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Lima, Peru

**PREPARED BY**  
Miles K. Light

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This report was prepared as part of a trade diagnostic study to assess Colombia's trade capacity building needs and priorities in the context of upcoming free trade agreement negotiations with the United States and within the broader framework of the FTAA process. The study aims to define, prioritize, and articulate technical assistance needs related to strengthening the capacity to analyze issues that are likely to arise in the course of preparation for both bilateral and multi-lateral negotiations. These issues include: market access and import policy, agriculture, government procurement, services, investment, intellectual property, sanitary and phyto-sanitary standards, and customs administration. In addition, the study includes a series of quantitative exercises to assess the impact of trade liberalization on the Colombian economy at the macroeconomic and sectoral levels with a view to outlining recommendations for effective adjustment to integration and identifying measures to enhance competitiveness domestically and in international markets.

This study was carried out by a team of Colombian and international analysts under the auspices of the USAID/Bogotá Mission, in partnership with the Colombian Ministry of Trade, Industry, and Tourism.

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# Executive Summary

This report examines the bilateral trade negotiations between the United States and Colombia from a macroeconomic perspective. We identify economic themes relevant to trade liberalization and quantify the impact of each, describing where the largest potential gains exist for Colombian welfare and consumption. We also discuss some of the obstacles that Colombia must overcome in order to benefit from trade and investment liberalization.

Given the current environment of trade liberalization and global investment, the bilateral trade negotiations with the United States are opportune for Colombia. Such an arrangement can strengthen Colombia's institutions and help standardize Colombia's production structure so that producers can compete on the global market. Colombia would like to maintain its preferences in U.S. markets. These preferences contribute almost 1 percent to Colombia's annual GDP. A bilateral treaty would effectively make these preferences permanent. The pure gains accruing from preferential access to U.S. markets, however, may become less important if the United States negotiates free trade arrangements with several other countries that would then compete against Colombia's exports (e.g., Peru, Ecuador, Bolivia). Colombia, of course, can still enjoy a "first-mover" advantage by establishing a presence in the United States now rather than later.

As the role of goods trade attenuates, the impact of free trade on several service industries is likely to grow, and the institutional reform for trade and investment in the services sectors are likely to yield the largest gains in welfare. If Colombia correctly introduces competition and investment in several service sectors, annual consumption could rise by almost 5 percent in the short term and 7.5 percent in the long term. For these gains to be realized, the government must establish an enabling environment for private investment, while gradually shifting tariff revenues onto other tax streams. Such reforms can reduce Colombia's dependence on primary products and help it compete in the global market for high-skilled goods and services.

Most gains from trade are likely to arise from factor productivity in the services and manufacturing sectors. Services account for almost 80 percent of GDP in the United States and for 57 percent of GDP in Colombia. In addition, services are the largest intermediate input to production for manufactures. Clearly, services are an important component of any

industrialized country. But most studies of international trade fail to capture the gains from service sector liberalization or from foreign direct investment. Such gains cannot be realized using the standard Ricardian model and constant returns to scale. Many segments of the economy exhibit not constant returns to scale but increasing returns to scale (IRTS) technologies. IRTS effects can change the GDP and welfare effects dramatically.

We capture these productivity effects using an endogenous, Dixit-Stiglitz product variety approach which is standard in the industrial organization literature. We estimate that only 20 percent of gains to Colombia will arise from goods trade. About 35 percent will arise from product variety effects in intermediate inputs, and 45 percent from dismantling barriers to foreign direct investment. Of course, our calculations assume the existence of well-functioning capital markets, enforcement of the rule of law, and financial transparency.

# 1. Introduction

This report is part of a cooperative effort between the U.S. and the Colombian governments intended to expand the technical capacity of the Colombian government for understanding the potential ramifications of trade liberalization, in particular those agreements which involve the U.S. and Colombia. The focus here is upon the macroeconomic impacts of potential trade developments. In order to analyze these impacts, we utilize existing economic and trade data from the Colombian statistics office as well as the Global Trade Analysis Project (GTAP). These data are combined with standard economic theory into a quantitative general equilibrium model. This model is then used to conduct comparative statics exercises, where the current state of the world is compared against a state where certain trade and economic policy variables have been altered. We focus mostly upon welfare of society members, output levels for firms (GDP), trade volumes, prices, and fiscal impacts.

We have designed this study to help identify how the Colombian government can achieve its goal of welfare improvement through trade. The government's strategy is presented in a report by the Ministry of Trade, called "Colombia's strategy to strengthen institutions and export capacity."<sup>1</sup> In this document, the Colombian government specifies its strategy to actualize the potential gains from a free trade agreement. Two of the strategies mentioned in that report are particularly relevant here:

- Priority #2: Prepare the governmental agencies to assume additional responsibilities and improve their capacity to provide useful services to the population under a free trade agreement.
- Priority #3: To improve instruments that will increase factor productivity and elevate Colombian standards of production to international levels.

Part of this study develops economic analysis capacity at the Department of National Planning so that the government can provide useful analytical services to decision-makers (Priority #2); we also describe in detail how the bilateral trade agreement will improve factor productivity in Colombia (Priority #3).

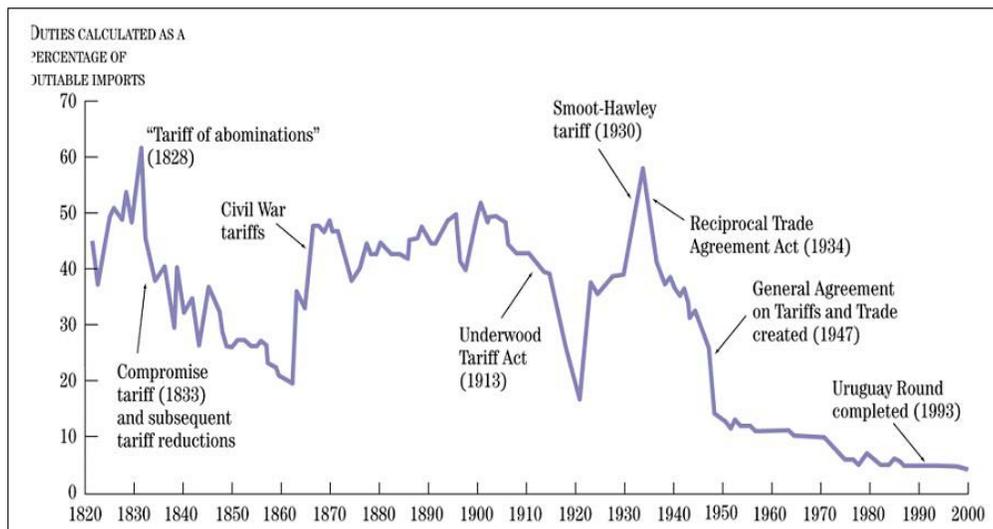
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<sup>1</sup> "Estrategia Nacional para el Fortalecimiento de las Capacidades de Comercio," Programa de Cooperación Hemisférica (PCH), Ministerio de Comercio, Industria y Turismo, Republic of Colombia, August, 2003.

## Developments in International Trade: Goods and Services

As Colombia proceeds in the negotiations of several trade agreements, the government and trade negotiators should consider the development of international trade over the past 20 years. Since 1983, the value of global trade has increased four times faster than the rate of global GDP. One cause of the increased trade has been a series of technological improvements in global shipping that have lowered the cost of transportation considerably. These falling transport costs have allowed exporters to arbitrage small differences in comparative advantage between countries, so that most production now occurs where costs are lowest. As transportation costs continue to fall, the only significant barriers to trade remaining are the tariff and non-tariff barriers themselves. These barriers have also fallen substantially. Even these barriers to trade have fallen significantly after development of the General Agreement on Tariffs and Trade (GATT), and more recently after Uruguay Round. Figure 1-1 shows the evolution of tariffs in the United States over the past two centuries.

**Figure 1-1**  
*Evolution of U.S. Tariffs over the Past 150 Years*



Source: Taylor, *Principles of Microeconomics 3/e* (2002)

Although shipping technology and lower tariffs have contributed to increased trade, they only account for part of the growth. Services trade, through various modes of delivery, has been the fastest-growing segment of international trade over the past 20 years. Interestingly, most of the growth in service trade has been driven by developing countries outside of the OECD. According to Table 1-1, the services portion of international trade for the non-OECD countries has increased from 9% in 1980 to 18% in 1995. McGuire (2001) estimates that services trade in 2000 was \$1,435 billion dollars and about 20% of total international trade. This trend has changed dramatically over the past 2-3 years, especially with the expansion of

internet bandwidth between Asia and the United States. Services trade for some countries, India in particular, has become the largest export.

**Table 1-1**  
*Global Trade in Services, 1980–1995*

	1980	1985	1990	1995
Total trade in services (billions of US Dollars)	361	387	861	1,234
OECD share	83%	83%	78%	73%
Rest of World share	17%	17%	22%	27%
Services share of goods and services trade	16%	17%	20%	20%
OECD share	19%	20%	21%	20%
Rest of World	9%	11%	17%	18%

Sources: IMF (1996a; 1996b).

Note: Data pertain only to countries reporting to the IMF.

## Goods and Services in Colombia

Colombia has taken advantage of its comparative advantage in primary and agricultural products to produce exports. Coffee, tropical fruits, flowers, coal and oil have all seen substantial development and Colombia now has a large export capacity for these goods. Naturally, we expect exports to continue to grow for these primary products as trade barriers are lowered even further. At the same time, we expect the primary impacts from further trade liberalization to arise from (1) reductions in imported input prices which lower the production and transport costs of both export and import-competing products; (2) changes in inter-sectoral relative prices which lead to a reallocation of investment resources away from sectors with little or no comparative advantage and towards sectors with significant comparative advantage; and (3) dynamic improvements in factor productivity resulting from service sector liberalization and enhanced integration into regional financial networks.

There still remains substantial growth potential for exports in primary products, but there exist larger potential gains for Colombia from trade liberalization. These new gains are driven by factor productivity in the services and manufacturing sectors. Services account for almost 80% of GDP in the United States and for 57% of GDP in Colombia. In addition, services are the largest intermediate input to production for manufactures. Clearly, this is an important component of any industrialized country. Most studies of international trade fail to capture all of the potential gains because they assume that all production exhibits constant returns to scale (CRTS) technology. However, we know that many segments of the economy are not characterized by CRTS technology. Instead, they exhibit increasing returns to scale (IRTS) technologies. Properly accounting for the IRTS effects can change GDP and welfare estimates dramatically.

## Basic Approach

In order to quantify the possible gains from a trade agreement, we use two different economic models. These are a multiregional model of production and international trade based upon the GTAP dataset, and an increasing returns to scale model based upon Colombian national accounts. Both models are used to quantify changes in production, trade and consumption under different scenarios, but each model brings a unique view to the trade debates. The multiregional model has a distinct advantage over a single, small open economy model because it has the ability to identify trade diversion and trade creation, and because each region is explicitly represented. The IRTS model has the drawback that it is not multiregional, but it can accommodate the presence of imperfectly-competitive firms using a Dixit-Stiglitz variety framework.

Several different trade possibilities are considered by calculating a counterfactual scenario using either the multiregional or IRTS model. The main idea is not only to *quantify* the expected impact of trade and investment liberalization, but also to *understand* the economics and driving factors behind the overall impact. We try to emphasize where we see the largest potential gains for Colombia, and also explain why certain aspects are important.

**Report Layout.** The next section describes the motivation and theory behind each model. These descriptions are largely non-technical. Section 5 presents the main findings of the paper, and section 6 concludes and offers useful directions for further investigation.

## 2. Model Formulation

For the bilateral trade analysis, we use two separate models:

1. A Multiregional Trade Model (MRT)
2. Increasing Returns to Scale model (IRTS)

Each model has a specific purpose. The multiregional model incorporates each country explicitly, allowing us to identify the effects of bilateral and multilateral agreements on trade flows and production for all of the relevant countries. The IRTS model captures important productivity effects which come from increased product variety and new firm types. We describe each model in detail, highlighting the strengths and weaknesses of each approach.<sup>2</sup>

### Multiregional Trade Model (MRT)

The multiregional model is based upon the GTAPinGAMS framework.<sup>3</sup> This framework provides a basic CGE model similar to the GTAP model (Hertel, et. al. (1997)). We aggregate 57 distinct regions into 10 regions that are relevant to the policy issue at hand. Outside of the Western Hemisphere, we combine all other countries into two regions, the European Union 15 and the Rest of the World. The general specification of this model follows earlier studies of trade agreements in South America, such as the model of trade policy options for Chile and Brazil (Harrison, Rutherford and Tarr, 2002), the FTAA analysis for the Andean Community (Light, 2003), and the FTAA analysis for Colombia (Rutherford and Light, 2002). The model incorporates 57 production sectors and 5 factors of production. Tables 2-1, 2-2, and 2-3 list the regions, sectors, and factors in the model.

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<sup>2</sup> The algebraic formulation of the model is presented in Appendix A.

<sup>3</sup> See the GTAPinGAMS homepage at: <http://debreu.colorado.edu/gtap5/>.

**Table 2-1**  
*Regions in the Multiregional Trade Model*

Identifier	Region
COL	Colombia
VEN	Venezuela
XAP	Rest of Andean Pact (Ecuador, Perú, and Bolivia)
XSM	Rest of South America
BRA	Brazil
MSR	MERCOSUR Countries except Brazil
MEX	Mexico
XCM	Central America and Caribbean
CAN	Canada
USA	United States of America
EUR	European Union (15)
ROW	Rest of World

The general specification of the model follows earlier work by Rutherford and Tarr (1999) on the Uruguay Round, Chile, and Brazil. We concentrate here on the “base” model, which is static and assumes constant returns to scale (CRTS). Apart from the fact that imports and exports are distinguished by many regions, the structure of the model within any country is very close to the basic GTAPinGAMS model.

**Table 2-2**  
*Sectors in the Multiregional Model*

Identifier	Sector
CRO	Paddy rice, Wheat, Sugar cane, plant fibers, wool, forestry, fishing
GRO	Cereal grains nec
V_F	Vegetables - fruit - nuts
OSD	Oil seeds
OCR	Other Crops
MET	Bo horses, animal product, Bo meat, meat prod, dairy
COL	Coal
OIL	Oil
ONR	Gas - Other Natural Resources, minerals
SGR	Sugar
OFD	Food products nec
TEX	Textiles
WAP	Wearing apparel

Identifier	Sector
SFT	Leather products, wood, paper, publishing
P_C	Petroleum - coal products
CRP	Chemical - rubber - plastic products
NMM	Mineral products not elsewhere classified
IND	Heavy Industry: Ferrous metals, other metals, manufactures, electricity
FMP	Metal products
MVH	Motor vehicles and parts
OTN	Transport equipment nec
ELE	Electronic equipment
OME	Machinery and equipment nec
SER	Gas distribution, Water, Construction, trade, recreation, public
TRN	Transportation: Air, Water, Other
CMN	Communications
BSR	Business Services: Financial, Insurance, Other
DWE	Ownership of dwellings
CGD	Savings good

Production entails the use of intermediate inputs and the primary factors (labor, capital and land). Primary factors are mobile across sectors within a region, but are internationally immobile. We assume Constant Elasticity of Substitution (CES) production functions for value added, and Leontief production functions for intermediates and the value added composite (i.e., we allow for substitution between capital and labor in the production of value added, but impose a constant relation between intermediate inputs and value added, which imposes a less flexible structure to the economic system). Output is differentiated between domestic output and exports, but exports are not differentiated by country of destination.

**Table 2-3**  
*Factors of Production in the Multiregional model*

Identifier	Description
LND	Land
SKL	Skilled labor
LAB	Unskilled labor
CAP	Capital
RES	Natural resources

Changes to welfare are measured using the representative agent's utility. We use the equivalent variation measure to combine the effect of simultaneous price and income effects. This measure computes the percentage change in income that is equivalent to the change in consumption the representative agent can afford in the counterfactual.

The GTAPinGAMS framework allows us to explicitly evaluate the importance to Colombia of improved market access for the United States (and to other regions), as well as potentially detrimental trade-diversion effects upon neighboring countries like Venezuela, Ecuador, and Brazil.

The base year data in both models comes from national accounting data for 1997.<sup>4</sup> In order to reconcile several trade agreements signed since 1997, we adjust the model and tariff structure to reflect the current trade regimes. Relevant agreements are the Andean Trade Pact, where there is a free trade zone within the Andean Community, and MERCOSUR, which is a free trade area between Brazil, Argentina, and Uruguay. We also assume that NAFTA operates as an effective free trade area with zero tariffs between the U.S., Canada and Mexico, but that each of the three countries has its own external tariff. Although there are many other regional preferential trading arrangements in the Americas that are implemented at different levels of effectiveness, the GTAP dataset does not incorporate several of these preferential tariff rates. Therefore, we use a combination of tariff rates taken from the GTAP5 dataset, as well as more recent statistics from the FTAA trade database. These figures are presented in Table 3-1 and in Appendix C. Several detailed reports are available from the GTAP website<sup>5</sup> that describes how tariff and non-tariff barriers are calculated.

It has been postulated by Colombian economists that the true barriers to agricultural imports are much higher than those reported in the GTAP data. In order to accommodate these beliefs, some of the scenarios incorporate a broadly-based 26% import tariff on goods coming from the United States into the base year data. The results from these scenarios are listed separately, so that the reader can compare the results between the modified GTAP rates, and the rates of 26% (see section 3).

Like any tool, there are times when its use is appropriate, and other times when it is not. We itemize some of the strengths and limitations of using the Multiregional Trade model for bilateral trade policy analysis.

- Strengths
  - Multiregional framework: A multiregional approach has two advantages in particular. First, it explicitly accounts for changes in all foreign countries (i.e., not only in the countries signing the agreement, but also in the rest of the world). Changes to

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<sup>4</sup> A new database will be released in February, 2004. This database will be based upon the 2001 national accounts.

<sup>5</sup> The GTAP homepage is: <http://www.gtap.agecon.purdue.edu/>.

comparative-advantage in foreign countries are important to determine trade-diversion and trade-creation. Second, the multiregional framework describes the importance of the agreements to *other* country's welfare. For example, it is possible to identify key exports for Brazil – which will help Colombia to understand the motivation behind some policies for key trading partners.

The multiregional framework allows us to see the strategic complementarities between countries, identifying possible trading partners and the effects of trade agreements upon non-participating nations, so that policy makers can take into account the effects not only of their one policies, but also of policies imposed by other countries.

- Globally consistent and comparable: The GTAP dataset and GTAPinGAMS model is a consistent and comparable dataset across a large number of countries. That is, the GTAP consortium is careful to consistently define the nature of each commodity. Because the sectoral definitions are consistent, output and consumption can be compared across different sectors and different countries. Before this, sectoral production across countries was not comparable because each sector had been defined slightly differently.

- Limitations

- Single-agent framework: We cannot address the distributional impacts of the trade agreements because only one agent exists. Since the representative agent (RA) framework represents welfare for the *average* citizen, it misses any changes to the poverty rate. The RA approach is reasonable for northern countries like the U.S. and Canada, which have a large middle-class, but it is less representative for countries with a polar income distribution.
- Constant Returns to Scale: The new economic geography contends that most gains are found in *services* rather than in *goods* trade. This important component is not captured by the MRT model. Benefits from the transfer of technology and expertise are likely to be larger than tariff-distortion elimination.
- Broad Sectoral Definition: The GTAP model distinguishes 57 production sectors. While this is a large number of sectors when considering the computability of a multi-regional trade model and the difficulties of acquiring the data, it is not specific enough for particular industries to use. An accompanying partial-equilibrium or sectoral analysis should help to bridge the micro-macro gap.
- Potential Exports and Economic Structure: The multiregional trade model does not include sectors which were not traded during the base year, 1997. This effectively precludes the possibility of future exports from sectors that have a potential comparative advantage but that are not currently traded. More generally, the model is tied to the base-year data and does not reflect some potentially important economic changes.

- Current Account Balance Constraint: In a static framework, the current-account balance is held constant. The current account balance constraint will necessarily introduce changes in the terms of trade for a country. In this environment, the elimination of large tariffs in the U.S. will induce exports of Colombian goods to the U.S. However, given the fixed current account balance constraint referenced above, this will necessarily be counterbalanced by a large and permanent increase in U.S. imports into Colombia (primarily for those import-competing sectors that faced relatively large tariff barriers in Colombia prior to the agreement). This result is required in order to ensure that the current account balance does not change as a result of the agreement. Of course, in a dynamic sense the expectation would be that the liberalization process would trigger secular changes in investment patterns and productivity across a range of critical product and service sectors which would significantly improve GDP and export growth performance over time and, accompanied by sound macroeconomic and structural policies, improve the external balance situation. This feature is not included in a static model because it constitutes borrowing funds from the future without the opportunity cost of repayment.

The constant current account constraint (the current account deficit during the model's base year, 1997, was approximately 5% of GDP) limits the degree to which these impacts can be fully reflected in the results of the model; and underscores the importance of viewing the result—particularly at detailed sectoral level—with caution. In a sense it constrains the positive dynamic impacts which a trade liberalization can have over time on the external balance position of the economy.

This limitation can be overcome by using a forward-looking dynamic analysis. A dynamic model can permit account fluctuations year by year, so long as balance is satisfied in the terminal conditions.

- A simplistic view of labor markets is assumed in this study. The wage gap between skilled, unskilled, formal, and informal workers is an important social consideration in Colombia and should be taken into account. A model could be specifically designed in order to spotlight labor markets in light of the proposed regulatory changes.
- Data Limitations: A common complaint about the GTAP trade database is their limited approach to non-tariff barriers. Many countries, South American countries in particular, believe that domestic policy in the US generates relatively large distortions in the agricultural sector that are not captured in the GTAP database. Grain subsidies (domestic price support programs) are one such example. Subsequent analyses by the government of Colombia should buttress our GTAP-based estimates with estimates that are more closely-aligned with Colombian beliefs.

## IRTS Model

Some of the biggest benefits from a trade agreement cannot be captured using the GTAPinGAMS model. First, the multiregional model cannot capture improvements in factor productivity that come about from new firm entry and from foreign direct investment.

Jensen et. al. (2002) show that total gains of this type are 4-5 times larger than the standard (CRTS) gains from improved terms of trade and lower distortions. Gains are even larger over the long run as investment adjusts given higher capital returns.

Other benefits which were not considered are technology transfers and corporate knowledge. These transfers typically occur through on-the-job training by multinational corporations. In order to capture these gains, we use a model recently developed by Rutherford and Tarr (2002). The IRTS model presented here incorporates imperfect competition and productivity effects using theory originally taken from the industrial organization literature, but more recently used in the “new trade theory”. By using accepted theory in the CGE model, we are able to elaborate upon previous trade papers that recognized the importance of improved productivity, but were constrained to using “proxy” measures of the productivity effects.<sup>6</sup> The structure of the IRTS model is depicted below.<sup>7</sup>

## IRTS CONCEPTUAL FRAMEWORK

We model Colombia as a *small open economy* based upon 1997 national accounting data and include increasing returns to scale technology (IRTS) using the Dixit-Stiglitz product variety framework and Chamberlanian large-group monopolistic competition. There are 17 sectors in the model. These are listed in Table B-3. This model can also be applied to a more detailed, 57-sector dataset for Colombia. However we found that the nature of the gains and the trade effects are likely to be similar between the 17-sector and the 57-sector aggregations. For computational simplicity and logical transparency, we use the 17-sector aggregation during this analysis.

The 17 sectors are listed in three separate categories. One category of sectors is composed of those goods or services that are produced under constant returns to scale and perfect competition. In these sectors, competitive domestic firms face price competition from foreign producers where imported goods are differentiated in final demand functions for Colombian consumers and firms. This is the standard Armington formulation for CRTS sectors.

A second category of sectors is composed of those goods that are produced under increasing returns to scale and imperfect competition. These goods are characterized as Dixit-Stiglitz

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<sup>6</sup> See, for example, de Melo and Robinson (1992) or MaMonteagudo and Watanuki (2001), who use reduced-form external effects as scaling parameters to increase the value exports or imports.

<sup>7</sup> A formal presentation is made in Appendix A

composites of domestic and import varieties with firm-level product differentiation. The efficiency gains associated with an increased number of varieties accrue to both consumers and firms using these goods as intermediate inputs. Foreign firms supply the Colombian market via **Mode 1**, the sale of foreign goods in Colombia. Goods that fall into this second category are typically high-technology and branded goods, such as computers, internet routers, and industrial machinery. The number of foreign firms that are willing to compete in the Colombian market depends on the expected quasi-rents available in the Colombian market, which in turn depends on the tariff rate.

**Table 2-4**  
*Sectoral Definitions for the IRTS Model*

Identifier	Description
C O N S T A N T R E T U R N S S E C T O R S	
COF	Coffee
CRO	Other crops
LVS	Livestock
FFH	Forestry, Fishing and hunting
OIL	Oil
MIN	Other Minerals
THR	Coffee Threshing
FOD	Foodstuffs
NRI	Natural Resources Intensive Industries
NSI	Non-skilled Labor Intensive Industries
CON	Construction
ELE	Electricity Gas and Water
COM	Communications
GOV	Government Services
I N C R E A S I N G R E T U R N S G O O D S	
HTC	Capital and High Technology Industries
I N C R E A S I N G R E T U R N S S E R V I C E S	
COM	Communications
TRN	Transport
SER	Private Services

The third category of sectors contains *services* which are produced under increasing returns to scale and imperfect competition. For these services, two types of firms operate: domestic and

multinational. Multinational service providers must establish a domestic presence in order to compete in the Colombian market.<sup>8</sup> They must import some of their technology or management expertise. They cannot supply the Colombian market from abroad as goods providers can do. Thus, their cost structure differs from goods providers. They incur costs related to imported inputs, domestic goods, and factor inputs. Domestic service providers do not import foreign technology or management expertise. Hence, domestic service firms incur costs related to domestic goods and factor inputs only. These services are characterized by firm-level product differentiation. Restrictions on foreign direct investment, right of establishment, the movement of business personnel, and lack of intellectual property protection and contract enforcement have major, direct impacts on multinational firms providing services to the market.

### *Comparative Steady-State Formulation*

To capture the effects of long-run investment and changes to the capital stock, we have developed a comparative steady-state model. In this version of our model, we allow the capital stock to adjust to its steady-state equilibrium along with all of the model features we employ in our reference case (i.e., we allow for tariff and FDI liberalization with endogenous productivity effects as above). We call this the comparative steady-state model. In the comparative static model, we assume that the capital stock is fixed and the rental rate on capital is endogenously determined. In the comparative steady-state model, the logic is reversed. We assume that the capital stock is in its initial steady-state equilibrium in the benchmark dataset, but that the capital stock will adjust to a new steady-state equilibrium based on a fixed rate of return demanded by investors. That is, if the trade policy shock happens to induce an increase in the rate of return on capital so that it exceeds the initial rate of return, investors will invest and expand the capital stock. Expansion of the capital stock drives down the marginal product of capital (i.e., it drives down the rental rate on capital) until the rate of return on capital falls back toward the long-run rental rate. To analyze trade policy, this comparative steady-state approach has been employed by many authors, including Harrison, Rutherford and Tarr (1997) and Francois et. al. (1997). The approach, however, dates back to the 1970s, when both Koopmans and Manne used it.

## **TAXES IN THE IRTS MODEL**

A common oversight by trade economists is the assumption of lump-sum tariff replacement. This assumption may be an acceptable approximation in countries such as the United States where tariffs are only 1% of total government revenues, but the lump-sum replacement assumption is clearly not valid in developing countries. In the 1997 data, Colombian tariff collections accounted for about 8% of total government revenues (see Table 2-5). To assume

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<sup>8</sup> The establishment of domestic presence to provide services is called *Mode 4* under the GATS nomenclature.

lump-sum presents a biased evaluation of overall welfare gains. The share of tariff revenues has fallen to approximately 6% of central government revenues since 2002, but it remains a substantive source of revenues. Tariffs on imports from the United States constitute about 40% of total tariffs in the 1997 data (approximately US\$439 million).

**Table 2-5**  
*Summary Statistics for Major Revenue Streams*

	Revenues		Base (T)	Tax Rates	
	(B)	(%)		Collected	Posted
VAT	5,600	33.3	86.0	6.5	5-45
Corporate Taxes	4,340	25.8	19.7	22.0	35
Excise Taxes	2,090	12.4	45.9	4.6	30
Import Tariffs	1,390	8.3	22.4	6.2	5-200
Payroll Taxes	970	5.8	57.9	1.7	
Indirect Output Taxes	910	5.4	139.3	0.6	
Local / State Taxes	810	4.8	139.3	0.5	
Individual Income Taxes	740	4.4	57.9	1.3	17-35
Total	16,826	100.0			
Social Security Payments	6,554		139.3	4.7	
Central Government Income:	20,140				
Local Government Income:	12,500				
Social Security Outlays	9,509				

*Note: Based upon 1997 social accounts from the Colombian Ministry of Finance. (B) indicates billions of 1997 Colombian Pesos. (T) indicates trillions of Pesos.*

In order to consider tariff-replacement effects, we have adopted the data and tax structure from the Department of National Planning *Mega Tax* model, which has a rich characterization of taxes. In particular, the treatment of value-added taxes (VAT), corporate taxes, and individual firm output taxes is well-considered in this model. The VAT structure includes an invoice-rebate system, where producers can claim a refund upon VAT taxes paid on intermediate inputs to production. This tax structure is distinctly different from most applied models, where the VAT tax is an aggregate over all goods, or is applied as a tax directly on labor and capital. See Light, Rutherford, and Barrera (2003b) for a detailed review of the Colombian tributary system. With this formulation we can quantify the welfare effects of replacing the public income lost by the trade agreement applying new VAT rates that are changed until the original level of public expenditure is attained.

The strengths and limitations of the framework of the IRTS model are:

- Strengths

- Tax structure: The model incorporates Colombia's tax structure, allowing the analysis of government's tax policy in order to evaluate a tariff replacement.
- Productivity effects: Increasing returns allow incorporating the effects of productivity increases due to FDI and product diversity.
- Steady state analysis: Though being a static model, one can approximate the long-run effects using the steady-state closure of the model.
- Limitations:
  - Tariff structure: Given that there is only one external agent (rest of the world), elimination of tariff and non-tariff barriers for one country or for all is exactly the same in this model. Thus, an agreement between Colombia and the U.S. or Colombia and all of the Americas is modeled in the same way in this model, so that most results overstate the effect of any agreement. This has a major impact on the results of the model, especially in the tax replacement analysis, given that all} tariff revenues have to be replaced by VAT.

## The Steady-State Formulation

A major drawback of static analysis is the presence of a fixed capital stock that does not align with investment. Logically, the level of investment depends upon depreciation, interest rates, and capital stock. Static CGE models usually fail to address the possible changes to investment and the capital stock the counterfactual. We remedy this drawback by including the *Steady-State* option. The Steady-State feature allows capital and investment to change in response to policy directives, as would happen in a long-run analysis. The adjustment process is consistent with the following complementarily condition:

$$(P_{inv} = rk) \perp k$$

The scale parameter,  $K$ , is complementary to the steady-state investment equation above, so when  $rk$  rises relative to  $P_{inv}$ ,  $k$  scales up government and private investment to reflect the arbitrage condition. Thus, in the steady-state equilibrium,  $k$  adjusts investment so that investment is consistent with the return to capital.

The results in the steady-state formulation can be considered to be the long-term effects after full adjustment. We caution the reader to consider these results as an *upper-bound* for the results. In a fully-dynamic model, the capital stock adjustment may be slightly smaller because it would incorporate the opportunity cost of investment. The steady-state formulation here does not incorporate the opportunity cost of investment and is therefore typically considered an upper bound estimate.



### 3. Quantifying the Barriers to Trade, Tariffs, Services, and FDI

First we describe barriers to goods trade, which are mostly tariff related. Then we describe the process of estimating non-tariff barriers. These barriers will be the most important policy instruments used in our trade agreements simulations.

#### TARIFF BARRIERS

Colombia's situation is unique since this country enjoys benefits from the Andean Trade Preference Act (ATPA).<sup>9</sup> Before 2002, a significant portion of goods imported to the U.S. from Colombia enjoyed nominal tariff rates between 0% and 3%. The spectrum of goods was expanded in 2002 to include most textiles, and virtually all remaining export categories not previously covered, including oil, shoe products, and fish products. As a result, textile industry exports to the United States have doubled. In our calculations, we describe the impact of the ATPA upon Colombian exports and production to the United States. We then consider various bilateral scenarios.

Table 3-1 reports tariff barriers between Colombia and major trading partners in the model. As can be easily checked, the tariff rates in table 3-1 differ from the rates posted by the Colombian or U.S. governments. The difference arises mainly from the fact that the rates shown in the table were calculated as tariffs paid as a proportion from the value of imports for the sector, and represent the effective rate imposed on importers after exemptions and evasion (which can be high in some countries, including Colombia). Under these settings, any change in tariff rates arising from an agreement is supposed to take effect on the effective rate, not only on the posted rate. We describe the U.S. barriers before and after major ATPA preferences were granted for Colombia/U.S. trade. Tables 3-2 and C-3 provide an overview of the major exports and imports for Colombia in the multiregional model.

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<sup>9</sup> Now called the Andean Trade Promotion and Drug Eradication Act (ATPDEA).

Significant import tariffs posted by the U.S. were levied upon fruits and vegetables, other agriculture (including cut flowers), textiles and wearing apparel, oil seeds, milk, sugar, and some types of machinery and industrial equipment. Under the ATPA, most of these tariffs were eliminated, leaving only a few textiles, sugar, milk, and highly-lobbied goods with tariff barriers.

Colombia's import structure places large tariffs upon automobiles, agricultural goods, textiles, wearing apparel, meats, processed foods, and to a lesser extent, industrial products. The tariff structure is substantially less restrictive than it was before 1992, when barriers to imports often exceeded 40%. Although tariffs have fallen substantially under the open-trade policy called "Aperatura," there remain potentially large *price-bands* for agricultural goods. These are variable tariffs intended to stabilize Colombian agricultural goods. The price band is raised when world agriculture prices are low, and it falls when prices rise. In 1997, world prices were high, so many of the price bands were low or zero.

## NON-TARIFF BARRIERS

Unlike tariffs, there is no simple measure of the barriers to foreign direct investment (FDI) and service provision by foreigners. Often, these barriers are vaguely defined in the law and are imposed differently across sectors, often on a case-by-case basis. The non-standard nature of non-tariff barriers (NTBs) clearly causes problems when attempting to quantify the restrictiveness for a country.

Despite these challenges, economists have developed several means to identify the restrictiveness of trade, at least to a certain order of magnitude. So far, the following methods have been popular:

- *Frequency measures.* Counting the number of restrictions in each sector.
- *Price Differences.* Attributing the difference in the price of services to non-tariff barriers.
- *Indices.* Applying weights to various trade and investment restrictions in order to calculate a "restrictiveness index."

The most popular measure, illustrated in Figure 3-1, appears to be the "Trade Restrictiveness Index" (TRI), which applies weights to various barriers to investment in order to synthesize the barriers into a single number. Prior research resulting from the GATS negotiations can be used here to define the major barriers to FDI. Table 3-3 lists common barriers and classifies them into three main categories: *restrictions on entry, ownership and control restrictions, and operational restrictions.*

A 38-country study of the trade restrictiveness in services was conducted by the Australian Productivity Commission, and the resulting research findings were presented in an edited volume by Findlay and Warren (2000). Although the particular focus was trade impediments

in Asian Pacific countries, Colombia was included as one of the 38 countries. Some of the findings from this research have been consolidated into Table 3–4.

**Table 3-1**  
*Tariff Structure for Colombia and Major Trading Partners*

From:	USA	COLOMBIA		XSM	EUR	XSM	COL	COL
	COL	USA97	USA02	USA	COL	COL	EUR	XSM
Sugar	18.0	53.0	53.0	53.0	18.0	0.0	76.0	11.1
Milk products	19.0	42.0	42.0	42.0	19.0	19.0	88.0	3.0
Other Crops	9.0	22.0	3.0	22.0	9.0	9.0	3.0	10.0
Oil seeds	11.0	18.0	0.0	18.0	0.0	0.0	0.0	0.0
Wearing apparel	20.0	15.0	3.0	13.2	20.0	18.4	13.0	11.0
Textiles	16.0	12.0	6.0	16.0	16.8	20.0	11.0	11.0
Other Food products	18.0	11.0	0.0	11.0	18.0	18.0	29.0	11.7
Leather Products	13.0	6.0	0.0	5.7	16.3	10.0	5.0	11.0
Chemical, rubber, plastic	8.0	5.0	0.0	2.0	7.0	12.0	7.0	11.0
Vegetables and Fruits	14.0	5.0	0.0	5.0	14.0	14.0	15.0	0.0
Natural Gas and Minerals	5.0	4.0	0.0	0.0	5.0	5.0	0.0	11.0
Metal products	14.0	3.0	0.0	2.0	13.8	14.8	4.0	11.6
Other Machinery	9.0	3.0	0.0	2.0	8.4	14.0	2.0	10.7
Electronic equipment	6.0	2.0	0.0	1.8	6.6	6.0	4.5	11.0
Petroleum Products	10.0	2.0	0.0	1.5	9.3	9.0	0.2	0.0
Other Transport Equipment	3.0	2.0	0.0	0.9	3.7	20.0	1.0	11.0
Other Mineral product	14.0	2.0	0.0	6.0	15.0	14.0	7.0	11.7
Major Crops	14.7	2.0	0.0	1.7	17.6	17.1	18.2	17.6
Heavy Industry	13.8	1.5	0.0	0.9	10.5	5.8	0.1	11.0
Bo Meats	16.4	1.5	0.0	2.0	13.2	10.8	46.8	15.0
Wood, Paper, Publishing	13.6	1.2	0.0	1.3	11.6	10.5	1.5	10.0
Cereal Grains	12.0	1.0	0.0	1.0	12.0	12.0	39.0	0.0
Motor vehicles, parts	15.0	1.0	0.0	1.2	23.4	30.0	4.1	11.0
Finance and Other Services	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Communication	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Savings Good	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Dwelling Ownership	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Coal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	11.0
Oil	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Transportation: All Modes	0.4	0.0	0.0	0.0	0.5	0.6	0.0	0.0
Services: Public and Private	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

*Note:*

*USA97 United States as reported in 1997 data*

USA02 United States tariffs reported in IADB/FTAA database for 2001, plus textile exemptions

COL Colombia

EUR European Union 15

XSM Other South American Countries

**Table 3-2**  
*Structure of Key Export Sectors for Colombia*

	X-U.S.	X	%-X	LAB/VA	SKL/VA	CAP/VA	RES/VA
Oil	1641.3	2143.5	53.7	10.2	2.1	48.1	39.6
Other Crops	980.0	2802.9	82.0	46.5	0.6	25.1	27.8
Transportation: All Modes	383.0	1851.7	16.7	71.1	13.5	15.3	0.0
Wearing apparel	305.5	495.9	18.7	53.5	7.7	38.8	0.0
Finance and Other Services	206.4	1462.1	10.8	28.5	22.8	48.7	0.0
Heavy Industry	189.8	515.9	10.5	29.2	7.7	63.1	0.0
Other Food products	179.9	576.8	9.9	33.5	7.2	59.2	0.0
Petroleum Products	177.5	339.2	14.8	57.2	10.4	32.3	0.0
Vegetables and Fruits	152.5	480.7	14.6	46.5	0.6	25.1	27.8
Chemical, rubber, plastic	118.6	1210.6	15.0	33.4	7.8	58.9	0.0
Services: Public and Private	111.5	512.3	0.9	41.4	28.4	30.2	0.0
Coal	98.2	902.5	90.1	15.4	1.3	41.7	41.6
Other Mineral product	50.7	198.8	10.9	41.0	6.7	52.3	0.0
Leather Products	44.6	146.5	14.4	42.8	6.2	51.0	0.0
Textiles	42.5	310.0	14.8	45.5	6.8	47.7	0.0
Sugar	39.2	254.1	17.1	37.2	8.0	54.8	0.0
Wood, Paper, Publishing	33.3	288.4	6.9	43.7	7.5	48.8	0.0
Metal products	13.0	123.6	10.3	46.1	8.1	45.8	0.0
Other Machinery	12.6	387.6	15.9	49.7	12.2	38.0	0.0
Bo Meats	11.8	47.4	0.4	49.0	2.4	26.6	22.1
Major Crops	11.3	92.8	1.3	41.5	3.0	42.6	12.8
Motor vehicles, parts	3.2	118.9	7.7	59.8	11.9	28.3	0.0
Electronic equipment	2.3	14.8	3.5	52.0	12.4	35.6	0.0
Communication	0.9	10.3	0.4	21.5	17.2	61.3	0.0
Other Transport Equipment	0.9	15.9	5.4	60.5	11.3	28.2	0.0
Milk products	0.5	8.2	0.4	35.6	5.2	59.2	0.0
Cereal Grains	0.1	1.0	0.3	46.6	0.5	25.1	27.8
Natural Gas and Minerals	0.1	5.9	0.8	47.9	7.0	30.6	14.6
Oil seeds	0.0	1.1	0.4	46.6	0.5	25.1	27.8

Note:

X-US Colombian export value to the United States

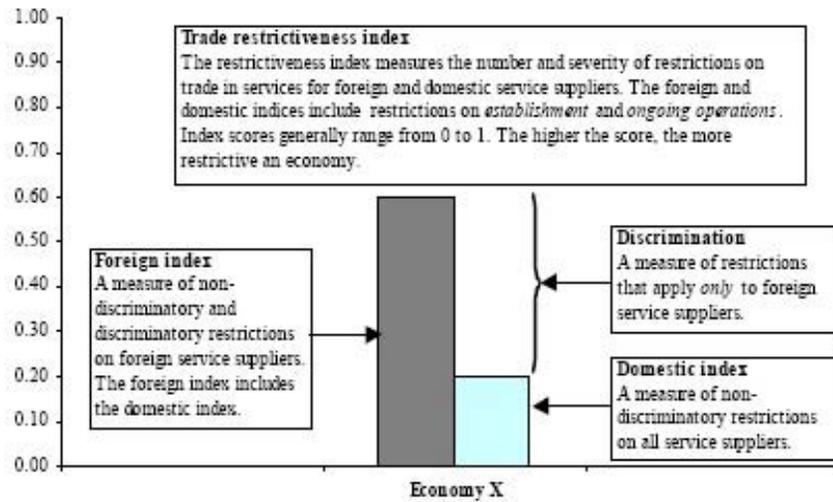
X Total Colombian Exports by Sector

%-X Percentage of Colombian production that is sold as exports. (Exports/(Exports+Domestic))

LAB/VA Unskilled labor's value share in total value-added

- SKL/VA *Skilled labor's value share in total value-added*
- CAP/VA *Capital value share in total value-added*
- RES/VA *Natural resource value share in total value-added*

**Figure 3-1**  
*Illustration of Results from Trade Restrictiveness Index*



Source: McGuire (2000).

**Table 3-3**  
*Common Barriers to FDI*

<b>Restrictions</b>	
<i>Restrictions on market entry</i>	<ul style="list-style-type: none"> <li>• Bans on foreign investment in certain sectors</li> <li>• Quantitative restrictions (e.g. limit of 25 percent foreign ownership in a sector)</li> <li>• Screening and approval (sometimes involving national interest or net economic benefits tests)</li> <li>• Restrictions on the legal form of the foreign entity</li> <li>• Minimum capital requirements</li> <li>• Conditions on subsequent investment</li> <li>• Conditions on location</li> <li>• Admission taxes</li> </ul>
<i>Ownership and control restrictions</i>	<ul style="list-style-type: none"> <li>• Compulsory joint ventures with domestic investors</li> <li>• Limits on the number of foreign board members</li> <li>• Government appointed board members</li> <li>• Government approval required for certain decisions</li> <li>• Restrictions on foreign shareholders' rights</li> <li>• Mandatory transfer of some ownership to locals within a specified time (e.g. 15 years)</li> </ul>

<i>Operational restrictions</i>	<ul style="list-style-type: none"> <li>• Performance requirements (e.g. export requirements)</li> <li>• Local content restrictions</li> <li>• Restrictions on imports of labor, capital and raw materials</li> <li>• Operational permits or licenses</li> <li>• Ceilings on royalties</li> <li>• Restrictions on repatriation of capital and profits</li> </ul>
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Source: UNCTAD (1996)

The second step in the process is to *quantify* the ad-valorem equivalent of the TRI for each sector. We use TRI estimates for 38 other countries in each of the service and FDI sectors, then regress price against the TRI in order to compute a %-change in price related to the restrictiveness. Obviously, this method is somewhat arbitrary. The index weights have been chosen based upon personal judgment, only certain countries have been included in the regression due to data limitations, and the explanatory power of the regressions is necessarily low because market structure is not captured in the regression model. Despite these difficulties, we notice that the regression results are reasonable. As a defense against spurious calculations, we also compute a sensitivity analysis to the central ad-valorem estimates in the model. We calculate a range of scenarios that consider the upper and lower bound estimates of the ad-valorem TRI equivalent estimates.

**Table 3-4**  
*Colombia Trade Restrictiveness and Price-Effect Indices*

Trade Restrictiveness			Price Effects		
<i>Sector</i>	<i>Domestic</i>	<i>Foreign</i>	<i>Domestic1</i>	<i>Domestic2</i>	<i>Foreign</i>
Banking	0.2850	0.3997	3.54%	24.78%	18.35%
Distribution	0.1238	0.1904			
Maritime	0.1805	0.4690			
Telecommunications	0.2000	0.4600	10.55%	32.4%	24.26%

Definitions:

**Distribution:** Wholesale and retail trade (except motor vehicles and motorcycles) including commission trade and repair of personal and household goods. (622,63,51-2)

**Banking:** Financial intermediation services, except insurance and pension funds.(811)

**Maritime:** Water transportation.

**Telecommunications:** Telecommunications, including fixed line, mobile, and internet communications.

Source: McGuire/UNCTAD (2002). Domestic2 taken from Niño (2003).

Barriers to foreign direct investment have been estimated in a few Colombian service sectors, namely in telecommunications, banking, external maritime transportation services, and retail and wholesale distribution services. The methodology employed is an application of the methodology and data work of Christopher Findlay and Tony Warren. Findlay and Warren have employed cross-country data sets in several service sectors where the price and quantity of services in the sector is regressed on measures of regulatory barriers. Findley and Warren

then infer from these regressions the impact of changes in any of the regulatory barriers on the price or quantity of the service.

In another study, Niño (2003) used the methodology of Warren (2000) and estimated a different set of values of the ad-valorem equivalent, which we present in Table 3-4 based on more recent data. These values are somewhat higher (3-8 times) than the estimates from the Findlay and Warren (2000) study, but we consider them quite acceptable given other recent calculations made by other researchers for other sectors of the Colombian economy which are in the range between 27% and 120% (Balcázar, Orozco and Samacá).

We use the estimated coefficients listed in Table 3-4 as the domestic and foreign barriers to FDI in Colombia.

**Table 3-5**  
*IRTS Market Participation of Foreign Firms in Colombia*

Sector	Market Share ( $\theta$ )		Import Share for FDI ( $\theta_M$ )
	Domestic	Foreign	Foreign
Banking	82%	18%	10%
Distribution	91%	9%	--
Maritime	97%	3%	--
Telecommunications	85%	15%	10%

*Source: Colombian Department of National Planning*

Table 3-5 reports the market share controlled by domestic and foreign firms in services. For foreign firms, the last column in Table 3-5 lists the share of production that is imported from outside Colombia. This captures the amount of services and goods that the foreign firm that come from headquarters. Barriers that limit the use of these imported goods, such as limitations on foreign residence, taxes upon special machinery, or the ban on foreign-purchased cellular handsets, will limit the degree of new firm entry as well.

For particular agricultural sectors (rice, cereal grains, milk, oil seeds, sugar cane) we have also estimated the average ad-valorem equivalent of non-tariff barriers. We use the differential between the international price and the domestic price to calculate these estimates. The average estimate over the sectors covered for the years 1997-2002 is 26%.

Using the ad-valorem equivalents we recalibrate our base model in order to introduce these non-tariff barriers as tariff equivalents into the model. Our basic approach here is to treat tariffs and non-tariff barriers in the same way (i.e., only as tariffs that increase the cost of imports). Obviously, this is not the best approach, but it is the only one available to us.



## 4. Experiments

In this section we present and explain the basic scenarios we run in both models. It must be remembered that all the policy experiments in this approach have to be converted into tariff variations.

### MULTIREGIONAL MODEL

We used four basic scenarios for the CRTS model:

1. ATPA: Simulate the Andean Trade Preference Act (i.e., we implement a policy in the U.S. that puts a zero tariff on all the goods coming from the Andean countries (Bolivia, Colombia, Ecuador and Perú)).

This experiment allows us to assess the possible losses that these countries, particularly Colombia, might have if the ATPA is removed in the future. This isn't really a counterfactual experiment, given that the Act is already in force. But it could be helpful in evaluating the accuracy of model predictions (up to a certain point) and the effects of losing the preferences and not signing an agreement with the U.S..

2. BILAT: In this scenario we implement a bilateral free trade agreement between Colombia and the U.S. and maintain the ATPA preferences for the rest of the Andean countries. Thus, both Colombia and the U.S. eliminate all their tariff and non-tariff barriers and export subsidies for trade in goods and services between the two countries,<sup>10</sup> while the U.S. allows preferential access to Andean countries.

This scenario allows us to see the competitive and welfare effects for Colombia in contrast to the ATPA scenario (i.e. how much does Colombia gain or lose if the ATPA stands in place forever and Colombia signs a free trade agreement with the U.S.?).

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<sup>10</sup> The reader should remember that we only included Colombian non-tariff barriers in the model.

The quantitative difference between the results of this scenario and the ATPA scenario shows how much Colombia might gain or lose if it signs an agreement in the current economic context.

3. USCOL: In this scenario we simulate a bilateral free trade agreement between the U.S. and Colombia and eliminate the ATPA preferences for the other Andean countries.

This experiment is quite similar to the BILAT, though it allows us to see the competitive gains Colombia might have *vis-à-vis* the other Andean countries, once the ATPA is eliminated. This is an important scenario for we cannot expect the ATPA to stand forever and it allows us to quantify the effects of Colombia being the first country to sign an agreement with the U.S.

4. UNIUS: In this scenario we impose a unilateral elimination of tariff and non-tariff barriers in Colombia to imports from the U.S.

This experiment allows us to have a comparison with the IRTS model, where elimination of tariff and non-tariff barriers takes place only in Colombia. It also allows us to quantify the impact on Colombia's competitiveness due to access to cheaper inputs from the U.S., though losing preferential access for its products into the U.S.

5. FTAA: We simulate the Free Trade Area of the Americas, eliminating all tariff and non-tariff barriers within the Americas having ATPA as a starting point. Thus, this scenario combines ATPA and multilateral liberalization.

For all the scenarios we make a sensitivity analysis running simulations using a low and a high value of the substitution elasticities and using two types of aggregation at the sectoral level (57 and 10 sectors).

## IRTS MODEL EXPERIMENTS

The experiments using the IRTS model are designed to quantify the “behind the border” effects from increased competition and improved product variety. Under the “IRTS” and “CRTS” headings, three identical scenarios are conducted, one set where we assume that all sectors are perfectly competitive (the CRTS scenarios) and one set where we identify four of the 17 sectors to be *imperfectly* competitive (the IRTS scenarios). In these scenarios, two sets of barriers are removed: tariff barriers that raise the cost of imports into Colombia, and non-tariff barriers to investment and foreign presence.

In all of the scenarios, the government budget is held constant. Most scenarios use lump-sum replacement of revenues, except for the VAT scenario, which raises the level the national value-added tax collections to hold the government budget constant. The nature of each scenario is described in the itemized list below.

### *Detailed Scenario Descriptions*

- **FULL:** In this scenario, all pre-existing import tariffs are removed. In addition, all non-tariff barriers to foreign direct investment are removed. This is the central scenario intended to capture *both* the Harberger triangle trade distortions, as well as the Dixit-Stiglitz variety effects. The assumed pre-existing barriers to foreign entry are listed in Table 4.1 below. These barriers are fully-eliminated in this scenario.
- **VAT:** All pre-existing tariffs and non-tariff barriers are removed. In this scenario, the lost tariff revenues are replaced using the VAT system instead of a lump-sum replacement system. The difference between the VAT scenario and the FULL scenario is the difference between using a non-distortionary system (lump sum taxation) and one that introduces some distortions (the VAT system). The uninitiated may ask why the VAT scenario should be considered if we already have the results from the FULL scenario. The answer is: a lump-sum taxation system does not exist in any country, so the VAT system is the most likely means that the government will replace revenues.
- **SS:** As in the FULL scenario, all pre-existing tariffs and non-tariff barriers are removed. The difference is that the long-run capital stock is allowed to adjust to the new rate of return. This is called the steady-state scenario, and it is described in detail in section steady-state.

Finally, there are two "decomposition" scenarios. These scenarios were conducted so that the reader can identify the relative magnitude of the gains coming from the two policies: tariff elimination and non-tariff barrier elimination. Like the "IRTS" heading scenarios, these scenarios assume that four of the 17 sectors are characterized by increasing returns to scale technology.

- **TM:** Elimination of tariff barriers, but non-tariff barriers to foreign direct investment remain in place. This scenario identifies the *distortionary* effects.
- **FDI:** Elimination of non-tariff barriers (i.e., there are no barriers on FDI and foreign firm presence, but tariffs remain in place). This scenario identifies the *productivity* effects.

**Table 4-1**  
*Non-Tariff Barrier Levels for IRTS*

Sector	Current Level
Services	24.78%
Communications	32.4%
Transportation	25.0%

Source: Nino (2003)



## 5. Results

Here we analyze our basic findings and show some of the results in more detail in the following two subsections. We emphasize welfare and political issues, and leave the explanation of economic and sectoral results for the subsections.

The results of the model under a range of trade liberalization scenarios are illustrated in the following sections, under low and high elasticity assumptions. In general terms and as expected, the adoption of a bilateral trade agreement with the U.S. results in a modest increase in welfare and production under the CRST model (under low elasticity assumptions), and a larger though still modest increase of about 1% in both under high elasticity assumptions. The benefits are slightly higher under the assumption that the bilateral agreement occurs within a context in which the current ATPDEA benefits of the other Andean countries expire. In essence, the bilateral trade agreement locks in the trade benefits now existing under ATPDEA.

A peculiar result, presumably arising from the constraining assumptions of the model, is that the benefits of an ongoing ATPDEA agreement actually exceed those of a bilateral agreement under the model. As will be referenced later, this relates to the assumption in the model that the existence of “modest” tariff barriers between trading partners shifts the terms of trade in favor of the partner imposing the barriers. It does this by artificially decreasing imports into that country and increasing the supply of that good sold on the international market, thereby effectively lowering the CIF price of the commodity. Of course, in reality it is hard to imagine a scenario under which Colombian tariff policies would affect the international price of an import item.

This effectively illustrates that this counterintuitive outcome essentially reflects internal consistency requirements of the model, but not the reality of international trading and price formation relationships. Moreover, the constant returns to scale and overall comparative statics orientation of the model effectively exclude perhaps the most important set of impacts which an agreement would be expected to have on economic performance—the dynamic impact on information and technology transfer, private investment and factor productivity. As a result, the results in this sense appear to represent a conservative lower-bound

simulation of the impact of a trade agreement on welfare and output. (In a subsequent section, we will attempt to at least partially incorporate the dynamic impacts of trade liberalization on economic performance through the innovative introduction of increasing returns to scale assumptions in a scaled-down (sectorally speaking) variant of the model).

It should be noted that a significant advantage of the agreement, which could not be effectively captured in this type of modeling, is the security which it will provide investors (both local and foreign) that the trade benefits now being provided under ATPDEA will be extended into perpetuity. This could prove critical in stabilizing investor expectations and encouraging long-term investments in sectors which are either reliant on imported inputs from the U.S.; and/or focused on penetrating U.S. markets. Overall, an agreement would be expected not to create a more stable and positive set of expectations regarding the Colombian investment environment; and to improve (*ceteris paribus*) the overall perception of international financial markets regarding the stability and potential profitability of investing in Colombia.

Of course, reaping the full benefits of trade liberalization and taking advantage of the opportunities provided by a bilateral trade agreement (and eventually incorporation into an ALCA agreement), will depend on other policy and institutional reforms not directly related to an agreement. This includes, among other key factors, stable macroeconomic policies, increased and better targeted infrastructure investments, and improvement in the enabling environment for business formation and operation, and of course further consolidation of recent improvements in security. In short, the trade integration is not a cure-all, but must be complemented by economic policy and institutional reforms that maximize the supply response of the private sector to enhanced trade and investment opportunities.

## **DETAILED RESULTS FROM THE MULTIREGIONAL TRADE (MRT) MODEL**

In this subsection we present the results for the experiments run in the multiregional ten-sector model. In Appendix D we show the results for the 57-sector version of the model. We made simulations using high and low values of the elasticities in the model; here we report only the basic results for both high and low elasticities, with the more detailed results shown only for the low elasticity values.  $\sigma_{DM}$  represents the elasticity between domestic and imported intermediate goods in the production of Armington goods;  $\sigma_{MM}$  represents the elasticity of substitution between the imports from different countries; and  $\eta_{DX}$  represents the elasticity of transformation between domestic goods and exports.

**Table 5-1***Multiregional trade model summary results for Colombia (10-sector aggregation)*

	ATPA	BILAT	USCOL	UNIUS	FTAA
<b>LOW ELASTICITY RESULTS: <math>\sigma_{DM} = 2</math>, <math>\eta_{DX} = 2</math>, <math>\sigma_{MM} = 4</math></b>					
Equivalent Variation	0.79	0.52	0.54	-0.25	0.28
Dollar value of EV (\$B)	0.51	0.34	0.35	-0.16	0.18
• Production	0.38	0.17	0.17	-0.48	0.19
• Tariff Revs.(\$M)	55.33	-635.86	-637.54	-622.35	-1107.57
Real Exchange Rate	-1.21	0.38	0.36	1.68	1.80
• U.S. Imports	3.42	31.36	31.05	26.73	20.27
• Exports to U.S.	20.41	27.09	27.91	2.94	22.48
<b>HIGH ELASTICITY RESULTS: <math>\sigma_{DM} = 6</math>, <math>\eta_{DX} = 6</math>, <math>\sigma_{MM} = 12</math></b>					
Equivalent Variation	1.28	1.03	1.07	-0.28	0.65
Dollar value of EV (\$B)	0.83	0.67	0.69	-0.18	0.42
• Production	1.40	1.26	1.24	-1.62	0.92
• Tariff Revs.(\$M)	223.03	-693.51	-700.24	-753.93	-1138.97
Real Exchange Rate	-1.30	-0.01	-0.03	1.61	1.50
• U.S. Imports	11.22	115.10	112.69	89.96	62.21
• Exports to U.S.	106.03	144.79	150.42	8.12	104.61

*Note: Values are reported as percentage change (%), millions of USD (\$M), or as billions of USD (\$B).*

As noted above, a constraining factor which must be taken into account in interpreting model results – particularly at the sectoral level – is that the current account deficit is kept constant at the base year 1997 level (approx. 5% of GDP). This has a significant impact on sectoral results because it effectively forces a rise in imports equivalent to any increase in exports in order to ensure that the current account balance does not change. Base case results indicate that Colombia would gain modestly from a bilateral agreement (under the assumption that in its absence ATPDEA benefits eventually expire).

In terms of specific outcomes (analyzed for the aggregated 10-sector variant of the model), the real exchange rate depreciates slightly under a bilateral agreement, which reflects that Colombia is a net importer and that its tariff barriers are higher on average than those of the U.S. (excluding ATPDEA benefits). It also reflects the consistency condition that increased exports need to be compensated under the model by increasing imports in order to leave the current account balance unaffected.

**Table 5-2**  
*Change in Terms of Trade (Percent, Low Elasticity Results)*

	ATPA	BILAT	USCOL	UNIUS	FTAA
Cereals	0.93	19.69	19.80	18.34	22.36
Oil Seeds	5.08	17.20	17.81	12.24	18.02
Other Ag.	1.60	5.15	5.52	3.34	11.03
Energy and mining	1.30	2.03	2.03	0.61	7.62
Protected Manufactures	1.41	3.02	3.02	1.48	8.99
Food products	2.47	6.04	6.56	3.30	12.35
Textiles and Apparel	4.50	15.46	15.83	6.06	18.62
Other manufacturing	1.45	4.61	4.54	3.00	6.65
Services	0.86	0.33	0.33	-0.60	-0.05

At the sectoral level results are primarily driven by changes in the terms of trade. As can be seen in Table 5-2, a bilateral agreement results in a major improvement in the terms of trade, primarily driven through a decrease in the price of imports. As can be gleaned by reviewing the relative price effects associated with ATPDEA, these effects swamp the impact of increased net prices of exports to the U.S. This is not surprising given the relative size of the trading partners. These effects underscore the critical importance of trade liberalization in reducing consumption costs; an issue of critical importance given the high percentage of the Colombian population which is under the poverty line (approx. 65% in 2003).

**Table 5-3**  
*Colombian Import Volume (Percentage Change, Low Elasticity Results)*

	ATPA	BILAT	USCOL	UNIUS	FTAA
Cereals	6.00	142.06	141.26	128.50	120.12
Oil Seeds	3.12	156.18	153.55	160.52	134.21
Other Ag.	7.16	72.93	71.69	60.99	47.40
Energy and mining	3.68	37.36	37.14	32.12	17.46
Protected Manufactures	2.84	38.58	38.23	34.50	19.21
Food products	6.71	84.15	82.01	72.24	57.18
Textiles and Apparel	5.02	64.26	62.70	56.50	41.65
Other manufacturing	2.88	25.71	25.56	21.85	16.50
Services	4.79	1.89	1.82	-3.24	-0.77

Imports rise significantly in all sectors. Again this is not surprising given the significant shifts in relative prices. Export sector response is generally strong and along the lines expected (in both the agriculture and manufacturing sectors), other than the counterintuitive slight reduction in exports for energy and services. Production results are very mixed (and even more so for the disaggregated 57-sector variant of the model). While the food products, oil

seeds, and textiles/apparel sectors move significantly and in the expected direction, results for a number of other sectors appear counterintuitive. Some of these sectors experience a major spike in exports, yet a reduction in overall production. This again reflects the restrictive assumptions behind the model, which ensure that imports in major sectors (again most particularly in those that previously had significant protective barriers) will rise sufficiently to ensure that the current account balance does not change. This underscores the fact that the CGE model production results at the sectoral level are of limited relevance—and must be interpreted with considerable caution. The key advantage of the model is in capturing the interactive effects of relative price changes and resource flows on overall GPD and social welfare in a snapshot; and these are the results which warrant attention and analysis. Detailed sectoral results can be more effectively analyzed in a partial equilibrium context; and a detailed review of these potential impacts will be carried out in a separate analysis.

**Table 5-4**  
*Colombian Export Volume (Percentage Change, Low Elasticity Results)*

	ATPA	BILAT	USCOL	UNIUS	FTAA
Cereals	11.01	9.12	9.33	-1.27	9.18
Oil Seeds	77.19	81.89	84.55	2.94	61.59
Other Ag.	11.78	13.91	14.36	2.26	13.57
Energy and mining	-4.05	-1.33	-1.19	3.25	1.43
Protected Manufactures	11.12	13.95	14.29	2.95	7.77
Food products	32.38	35.86	37.01	3.02	33.71
Textiles and Apparel	42.47	99.16	99.90	3.18	83.27
Other manufacturing	5.09	7.36	7.81	2.57	5.68
Services	-3.23	-1.23	-1.17	2.38	0.70

**Table 5-5**  
*Colombian Production (Percentage Change, Low Elasticity Results)*

	ATPA	BILAT	USCOL	UNIUS	FTAA
Cereals	-0.09	-6.35	-6.38	-6.04	-6.99
Oil Seeds	6.35	7.29	7.52	0.88	6.16
Other Ag.	0.37	0.05	0.03	-0.22	-0.49
Energy and mining	-2.38	-1.14	-1.19	1.54	-0.52
Protected Manufactures	-1.62	-1.59	-1.65	0.25	-2.17
Food products	0.52	0.32	0.30	-0.09	-0.06
Textiles and Apparel	2.47	6.36	6.27	-0.22	8.89
Other manufacturing	-1.70	-2.38	-2.43	-0.52	-1.55
Services	-0.34	-0.25	-0.25	0.10	-0.13
Ownership of dwellings	0.26	-0.50	-0.50	-0.68	-1.02

**Table 5-6**  
*Price of Consumer Goods, Low Elasticity Results*

	<b>ATPA</b>	<b>BILAT</b>	<b>USCOL</b>	<b>UNIUS</b>	<b>FTAA</b>
Cereals	0.14	-2.37	-2.38	-2.47	-2.40
Oil Seeds	-1.60	-2.46	-2.54	-0.96	-2.13
Other Ag.	0.61	0.70	0.70	0.04	0.45
Energy and mining	0.03	0.35	0.36	0.28	-0.25
Protected Manufactures	-0.69	-0.72	-0.72	-0.01	-1.97
Food products	0.13	-0.01	-0.03	-0.20	-0.14
Textiles and Apparel	-0.79	-2.76	-2.80	-0.90	-3.33
Other manufacturing	-0.60	-1.12	-1.10	-0.51	-1.26
Services	0.21	0.73	0.75	0.44	1.04
Ownership of dwellings	0.46	1.06	1.07	0.51	1.41

**Table 5-7**  
*Real Exchange Rate, Low Elasticity Results*

	<b>ATPA</b>	<b>BILAT</b>	<b>USCOL</b>	<b>UNIUS</b>	<b>FTAA</b>
Colombia	-1.21	0.38	0.36	1.68	1.80
United States	-0.05	0.03	0.01	0.08	0.11
Venezuela	0.21	0.08	0.08	-0.15	2.14
Brazil	-0.16	0.01	0.01	0.18	3.55
Other Andean Pact	-0.65	-0.52	0.09	0.14	2.79
Mexico	0.10	0.03	0.03	-0.07	0.01
Central America	-0.21	0.08	0.06	0.30	0.06
Other South America	-0.05	0.02	0.02	0.07	1.95
Canada	0.06	0.02	0.02	-0.04	0.10
European Union	0.01	0.00	0.00	-0.01	0.03
Rest of World	0.03	0.00	0.00	-0.02	0.03
Other MERCOSUR	-0.08	0.01	0.01	0.09	-0.40

## IRTS Model Results

As shown in Table 5-8, the potential gains from tariff and FDI liberalization are substantial. Full elimination of tariff and non-tariff barriers increases overall consumption by 5.0%. The role of service liberalization and increasing returns to scale is important because services are widely used as an intermediate input to production. The gains from service liberalization are larger than the traditional gains from a CRTS model for two reasons:

1. Production costs are lowered because of pro-competitive and efficiency effects. These cost-savings translate directly into lower prices for households and they do not require lower input prices in order to lower the costs, as is the case for CRTS technologies.
2. There is a stronger response to tariff elimination in sectors that exhibit increasing returns to scale. Lower input prices not only allow for increased output, but the higher level of profitability also increases the number of firms (varieties) operating in the market.

Each of the scenarios are each described in Table 5-9. We identify the role of FDI and IRTS technology, then compare these effects with the standard CRTS technology.

At this point, we will discuss each result in Table 5-8 in detail. First, compare the results for full liberalization under the IRTS and CRTS headings. The FULL scenario under the CRTS heading only captures the import price distortions that arise from import tariffs. The total deadweight loss from these distortions is only 0.2% of initial income. These small gains were standard results for trade economists before it was possible to include imperfect competition in empirical economic models.

It also appears that the distortionary cost of moving from lump-sum taxation (FULL) to a distortionary tax (VAT) is not as costly as previously thought. Welfare falls only by 0.1% when moving to the VAT scenario from FULL.

A comparison between FDI and TM in Table 5-8 shows that welfare improvements arise mostly from increased FDI, and less so from tariff elimination. Tariff elimination increases the number of varieties for IRTS sectors producing goods (the high-technology and manufacturing sectors in particular). But, in a comparison between the FDI and TM scenarios, the results differ substantially. Welfare in the FDI scenario increases 3.1% versus 1.9% in the TM scenario. This is partly because tariff elimination requires a revenue-replacement requirement, whereas the FDI scenario allows tariffs to remain intact. However, the revenue replacement cost is not overly burdensome, about of income is linked to the balanced-budget constraint.

The Colombian government (Department of National Planning) believes that bilateral trade reform will also have substantial pro-competitive effects in the domestic market. They believe that the barriers to entry for domestic firms are as large as those for foreign firms. If this is actually the case, that *all* firms face barriers to entry in the domestic market, and that the bilateral trade agreement will create perfectly-competitive markets, then the gains could be very large in the near- and long terms. We present the results from this scenario in Appendix E of this report. To summarize, if barriers to entry for all firms are 15-32%, then the removal of these barriers, together with full trade liberalization could increase Colombian consumption by 8.7% (5.8% in GDP terms) in the medium term, and in the long-run, overall welfare could be as much as 30-40% higher. The extremely large long-run estimates reflect the possibility to attract FDI as well as domestic investment. In the long-run scenario, the Colombian capital stock is twice as large under full liberalization as it is now. As we mentioned before, however,

these results assume that there exist substantial barriers to entry for all firms, not just foreign firms. To place things in perspective, a 30% increase in average per-capita consumption is currently equal to a USD\$600 increase in annual income (at market exchange rates). In the long-run (i.e., 10 years) such improvements are not un-reasonable.

Additional IRTS results assuming different levels of *domestic* barriers to entry are listed in Appendix E.

**Table 5-8**  
Summary Results Table

	FULL	VAT	SS	CRTS	CRTSYLD	SSCRTS	TM	FDI
EV	5.03	2.24	15.36	1.56	0.17	2.19	1.90	3.08
EV_GDP	3.32	1.48	10.14	1.03	0.11	1.45	1.26	2.04
R-PFX	5.60	4.65	6.19	1.19	0.75	1.09	1.51	3.86
VAT_PORC	0.00	18.92	0.00	0.00	12.69	0.00	0.00	0.00

**Table 5-9**  
Scenario Definitions

Scenarios:	
<b>I R T S</b>	Under this heading, some sectors are assumed to exhibit increasing returns to scale. The sectors exhibiting IRTS technology are described in Table B-3. The nature of the non-tariff barriers inhibiting investment are described in Table 3-3.
<b>C R T S</b>	Under this heading, all sectors are assumed to have constant returns to scale technology.
<b>F U L L</b>	Complete elimination of import tariffs together with elimination of non-tariff barriers to FDI. This is the central scenario in the study. Revenues are replaced in lump-sum fashion.
<b>V A T</b>	Equal-yield tax calculation using value-added taxes to replace lost revenues from tariff elimination. This scenario allows a comparison between lump-sum replacement in the full scenario and a more realistic scenario where the revenues are collected using an alternative distortionary tax.
<b>S S</b>	Steady-state (long-run) impact of eliminating tariff and non-tariff barriers. The steady-state concept is described in section 2.3.
<b>T M</b>	Elimination of import tariffs only. This scenario considers the role of tariff elimination when some sectors, namely high-technology and manufacturing, are characterized as imperfectly competitive.
<b>F D I</b>	Elimination of FDI barriers only; import tariffs remain.

Finally, the steady-state impacts are potentially very large. Our long-term, steady-state results reflect a significant increase in investment as barriers to FDI are removed. In the SS scenario for the IRTS and CRTS scenarios, future capital stock ( $k$ ) is expected to be 27% and 4% higher than it would be if no liberalization policy is undertaken. As we mentioned in section 2.3, the estimates represent an *upper-bound* of the gains and the change in capital stock because we do not include the opportunity cost of investment.<sup>11</sup> The estimates also assume that the rest of the economy is functioning correctly, and that no outside deterrents to FDI exist.<sup>12</sup>

<sup>11</sup> In a forward-looking infinite horizon growth model, the opportunity cost of investment is present consumption.

<sup>12</sup> The overall impact of these *externals* can be evaluated and quantified in a consistent manner. Indeed, this calculation (the impact of violence upon economic performance) has been considered in Light and Rutherford (2004).

## FACTOR MARKET IMPACTS

Table 5-10 reports the change in real factor returns for each of the scenarios using the IRTS (Dixit Stiglitz) model. The real return for each factor of production (Six labor types and capital) is calculated to be the nominal factor price divided by the national price index.

In almost all of the scenarios, real wages and capital returns rise. The relative increase in wages across labor types, however, is very different depending upon whether IRTS technology is assumed.

Urban formal, salaried workers (representing skilled labor) rise the most in the FULL scenario when there are increasing returns to scale. This is not surprising, since most services, such as accounting, finance, and computer programming, utilize skilled labor intensively. According to the Stolpher-Samuelson theorem, the factor used intensively in a sector that expands will appreciate compared to other factors. In our case, UFS is the factor used intensively in the production of services.

**Table 5-10**

*Factor Returns under Various Bilateral Trade Scenarios*

	FULL	VAT	SS	CRTS	CRTSYLD	SSCRTS	TM	FDI
UFS	9.33	8.21	22.93	0.11	-0.14	1.31	0.41	8.86
UFN	12.63	8.49	31.18	1.85	-0.32	3.73	2.07	10.35
UTC	13.23	9.03	31.61	1.98	-0.24	3.88	2.21	10.76
UMC	5.90	7.46	16.30	-1.27	0.15	-0.30	-0.89	6.90
RSW	6.03	5.09	10.02	1.38	0.98	1.35	1.78	4.03
RNW	6.75	4.71	10.32	2.16	1.02	2.03	2.53	3.89
K	11.52	8.36	2.45	1.70	0.21	-0.52	2.08	9.51

Notice that this result is *reversed* when we assume that all sectors are perfectly competitive (the CRTS scenarios). In this case, full liberalization increases wages the most for RSW and RNW, rural workers. These workers gain because traditional export industries in the primary resource sectors and in some agricultural sectors (e.g., coffee) see improved terms of trade -- partly because the elimination of import tariffs increased imports and decreased the exchange rate so that global currencies are more valuable for these basic exporters.

Overall, however, real wages can be expected to improve substantially as a result of trade liberalization. Although slightly more gains go to high-skill workers, the gains for the poor are substantially higher (6.75%) after liberalization. Next, we consider the production and trade effects of full trade liberalization.

## SECTORAL IMPACTS

Briefly, we describe some of the changes in production and costs in the FULL scenario using the IRTS model. The EXPORTS heading represents production and sales of exports; not just the volume of exports, SUPPLY represents the combination domestic production plus IMPORTS -- this is the amount of a given good supplied to the Colombian market. So for high-technology goods (HTC), we see imports fall by 2.8%, export production rise by 10.3%, and domestic supply rises by 1.5%. Market prices for HTC fall by 6.1%, which reflects the lower cost of intermediate inputs.

The most striking results are dramatically lower prices in the communications and services sectors. Prices fall 16% in telephone, cellular phone and internet communications as a result of trade and investment liberalization. This price drop is also commensurate with a large influx of foreign competition – outside firms such as *Telefónica* from Perú may be able to compete to serve cellular and fixed-line customers.

Those IRTS sectors that are service-oriented, such as communications and services, import more foreign varieties and there are more foreign firms serving the Colombian market. The IRTS sector that is goods-oriented (HTC) sees a large increase in *exports*. This happens because productivity in the high-tech and manufacturing sector is higher, so this sector can export substantially more on the world market at constant prices. Market supply typically increases for goods from perfectly competitive sectors, with prices in most sectors falling from lower import prices and from lower cost of services.

**Table 5-11**  
*Parameter Sectoral Percent Changes*

	IMPORTS(%)	EXPORTS(%)	EXPORT(\$)	IMPORTS(\$)	DSUPPLY	P-REAL	P-NOMINAL
COF	-12.9	-12.9	-335.9		-19.7	6.3	-4.7
CRO	19.5	2.1	53.2	232	2.2	1.1	-9.4
LVS	6	0.6	0.1	1.8	0.6	5	-5.9
FFH	14.1	1.6	0.2	7.8	1	3.4	-7.3
OIL	18.8	38.2	1241.8	123.7	16.2	-12.4	-21.5
MIN	9.7	-12.7	-70.9	13.2	-0.2	-10.8	-20
THR	10.7	-9	-17	0.1	-1.3	6.3	-4.7
FOD	11.9	4.3	39.2	207	1.5	3	-7.7
NRI	39.3	-31.1	-304.2	0.4	2.6	-36.5	-43
NSI	5.9	7.1	108.3	210.3	1.8	1.1	-9.4
HTC	5.7	10.6	312.5	808.2	1.9	-1	-11.2
CON			-		0.3	5.4	-5.5
TRN	-48.1	70.2	561.3	-159.1	19.7	-21.7	-29.8
ELE	2.2	-3.6			0.3	6.6	-4.4

	IMPORTS(%)	EXPORTS(%)	EXPORT(\$)	IMPORTS(\$)	DSUPPLY	P-REAL	P-NOMINAL
COM	-18.5	15	40.7	-13.3	23	-31.6	-38.7
SER	34.9	-1.5	-3.5	295.1	1.4	4.6	-6.3
GOV					-5.5	5.6	-5.3

Note:

Imports: Value of imports for sector.

Exports: Colombian production sold to consumers outside of the country (export production).

Supply: Total supply of products in Colombia (domestics plus imports).

Price: Domestic market price for a good

Finally, in table 5-12, we show how the number of firm *varieties* changes as barriers to entry are removed. These results reflect our base scenario which only considers non-tariff barriers to *foreign* entry. For this reason, we see some contraction in domestic firm varieties, but large growth in foreign firm varieties. An increase in the number of firm types reflects increased competition in the IRTS case. And it simply reflects an increase in production for the CRTS case. Foreign firms in service provision increase by the largest percentage, but since these firms represent only 5% of total firms in the sector, this is not a large total change. Domestic firms expand in the IRTS model as well, this comes about because the cost of intermediate inputs falls.

**Table 5-12 (A)**

*Change in Number of Domestic Firms (%)*

	FULL	VAT	SS	CRTS	CRTSYLD	SSCRTS	TM	FDI
HTC	-3.00	-5.02	7.61	-2.74	-3.88	-1.06	-4.86	1.81
TRN	14.13	12.31	21.17	1.11	-0.02	2.58	0.86	12.58
COM	14.96	12.44	23.17	0.18	-1.30	1.39	0.15	14.63
SER	-5.09	-6.07	2.01	0.65	-0.19	1.98	0.51	-5.56

**Table 5-12 (B)**

*Change in Number of Domestic Firms (%)*

	FULL	VAT	SS	CRTS	CRTSYLD	SSCRTS	TM	FDI
HTC	5.33	5.24	16.21	4.18	3.71	6.71	5.54	-0.16
TRN	17.35	15.08	26.17	1.25	-0.02	2.89	1.05	15.43
COM	18.59	15.16	28.12	0.14	-1.57	1.39	0.04	18.42
SER	131.13	127.78	153.87	0.71	-0.28	2.20	0.56	130.01

## 6. Conclusions

Colombia faces the near-term prospect of a bilateral trade agreement with the United States, as well as enhanced regional integration through the ALCA process. We have attempted in this study to provide an analytical prism through which aggregate impacts of integration can be understood. In interpreting the results of the model used in our study, readers must take into account its comparative statics nature, along with restrictive underlying assumptions that ensure the model's internal consistency and closure (as with any model of this nature).

Our use of the IRTS variant of the model is an innovative attempt to incorporate the spillover impact of dynamic factors arising from integration (e.g., enhanced information and technology transfer, increased foreign investment, improved service sector performance) on factor productivity and economic growth potential in a manner not possible with earlier variants of the model. This variant is associated with an annual increase in Colombia's consumption and GDP of approximately 5 percent and 3 percent, respectively, in relation to consumption and GDP in the absence of an agreement. Under steady-state assumptions, annual consumption and GDP would increase by approximately 7.5 percent and 5 percent, respectively. These results assume that any decrease in tax revenue resulting from an agreement is reflected in an equivalent decrease in government expenditure, rather than an increase in the tax burden on individuals or businesses. Assuming the latter, as seen in earlier results, will reduce the welfare impact of the agreement modestly. But this reduction is likely to be exaggerated, given that under most realistic trade adjustment scenarios the government and economy will have a lengthy period of time to adjust to revenue replacement needs arising from a trade agreement.

This study does not purport to have direct predictive value for or relevance to the condition of the Colombian economy five or ten years after an agreement is signed. It is intended to help readers understand how the relative price impacts of trade liberalization filter through an economy, and how their direct and indirect effects on investment, production, and consumption decisions can affect aggregate economic and social welfare. As an analytical device for grasping the potential impact of trade liberalization on socioeconomic variables, the model used in our study provides a means for examining how an agreement could affect the behavior of consumers and producers. Ultimately, policy and institutional adjustment factors

will determine how much Colombia benefits from trade and investment opportunities that arise from integration, while minimizing short-term transition costs at the sectoral level.

## **Directions for Further Research**

### **MULTIPLE HOUSEHOLDS AND POVERTY REDUCTION**

A key concern for developing countries is the effect of free trade on poverty. A microsimulation analysis that combines the IRTS (macro) effects with a standard household living survey (microeffects) would improve understanding of the trade-poverty interaction substantially. The Trade Research Division of the World Bank is developing this technique.

### **SERVICE EXPORT POTENTIAL**

Colombian export data show very limited services exports. The surge in services trade between OECD countries and developing countries, such as India and China, suggests a large potential export market for Colombian services. An analysis of Colombia's comparative advantage in professional services could help identify how Colombia can take advantage of technological improvements for transporting information.

### **DATA IMPROVEMENTS FOR THE SERVICES SECTOR**

Lack of concrete data hinders assessment of potential welfare and production gains for Colombia in the services sectors. For the most part, standards for accounting and tracking service provision and trade are lacking. Any advances in the understanding of service provision and trade by the Government of Colombia will improve the precision of economic analysis dramatically. The Government of Colombia should implement many of the standards that have been proposed under the General Agreement for Trade in Services (GATS) to better understand Colombia's position in services trade.

# Appendix A. Algebraic Description of Colombia's FDI Regime

The model algebra is very similar to the Jensen, Tarr, Rutherford (2003) model for Russia's accession into the World Trade Organization. Naturally, the model structure was altered in order to reflect special characteristics within the Colombian economy.

Primary factors include capital, skilled and unskilled labor, and sector-specific workers. Twenty-five percent of the labor in all IRTS sectors is assumed to be sector specific.

Goods produced subject to increasing returns to scale are differentiated at the firm level; firms in these industries set prices such that marginal cost equals marginal revenue; and there is free entry, which drives profits to zero. We employ the standard Chamberlinian large group monopolistic competition assumption, which results in constant markups over marginal cost.

Aggregate productivity is affected by the number of varieties using the standard Dixit-Stiglitz formulation. The effective cost function for users of goods produced subject to increasing returns to scale declines in the total number of firms in the industry.

For simplicity we assume that the composition of fixed and marginal cost is identical in all increasing returns to scale sectors. This implies that the ratio of fixed to marginal cost is a constant. This assumption in a large-group model assures that output per firm for all firm types remains constant, i.e., the model does not produce rationalization gains or losses.

*Consumer Behavior* Private consumption in the model arises from budget-constrained utility maximization. Preferences are represented as a Cobb-Douglas aggregate of goods and services:

$$U(C) = \sum \theta_i \log(c_i)$$

in which  $\theta_i \geq 0$  and  $\sum_i \theta_i = 1$ . Associated demand functions are defined in terms of goods prices  $p_i$  consumption tax rates  $t_i^C$  and aggregate income,  $M$ :

$$c_i = \frac{\theta_i M}{p_i(1 + t_i^C)}$$

Income is defined in terms of sources of factor income:

$$M = \sum_l w_l L_l + \sum_i w_{li}^S L_{li}^S + k(rk\bar{K} - p^I \bar{I}) - T_{LS}$$

The right side of the budget constraint includes wage income from both mobile and sector-specific labor, and capital earnings. Investment demand is fixed when  $k = 1$ . In a steady-state equilibrium, both the capital stock and the level of investment adjust to a level  $k > 1$  which equates the cost of capital formation and the discounted present value return to a unit of new capital. The final term on the right-hand side is the level of lump-sum tax adjusts which is used to balance the government budget and hold public output constant (see below).

**Domestic Supply** Goods and services are produced for sale in the domestic and international markets. A constant elasticity of transformation (CET) function shows the transformation possibilities in a given period between domestic ( $D_i$ ) and export ( $E_i$ ) sales for a given composite output level ( $Y_i$ ). The shares of sales at home and abroad are determined by relative prices given that firms produce the final good to maximize profit subject to the CET constraint:

$$Y_i = \left[ \theta_D \left( \frac{D_i}{\bar{D}_i} \right)^{\frac{1+\eta}{\eta}} + (1 - \theta_D) \left( \frac{E_i}{\bar{E}_i} \right)^{\frac{1+\eta}{\eta}} \right]^{\frac{\eta}{1+\eta}} \quad (1)$$

In this equation parameters  $\bar{D}_i$  and  $\bar{E}_i$  are the base year output for the domestic and export markets, respectively, and  $\theta_D$  is the baseline value share of domestic sales in total sales (the base year production level is scaled to unity) and is the elasticity of transformation.

Production is associated with a nested production function of intermediate inputs  $x_{ji}$ , labor services ( $L_{li}$  and  $L_{li}^S$ ), and capital ( $K_i$ ). Given prices of intermediate goods and labor, the aggregate production sector operates so to minimize the costs of producing a given output subject to the constraint:

$$Y_i = \min \left[ \frac{a_{ji}}{\bar{a}_{ji}}, V_i(L_{li}, L_{li}^S, K_i) \right]$$

in which  $a_{ji}$  represents the intermediate input of good  $j$  to sector  $i$ . In this function, skilled and unskilled labor (both mobile and sector-specific) and capital enter in a Cobb-Douglas aggregate with value shares determined by base year demands.

**Differentiated Goods** Goods produced subject to increasing returns to scale are characterized as differentiated products of domestic and foreign firms. Effective supply of all firms in a given sector is described by:

$$\begin{aligned} X_i &= \left( \sum_{i=1}^{n_i} \chi_i^\rho \right)^{1/\rho} \\ &= \left( \sum_{i=1}^{n_i^D} (\chi_i^D)^\rho + \sum_{i=1}^{n_i^F} (\chi_i^F)^\rho \right)^{1/\rho} \end{aligned} \quad (2)$$

$$= (\chi_i^D)^\rho + (\chi_i^F)^\rho)^{1/\rho}$$

$n_i^D$  and  $n_i^F$  are the numbers of domestic and foreign firms/varieties and  $X_i^D$  and  $X_i^F$  represent composites of domestic and foreign goods:

$$X_i^K = \left( \sum_{k=1}^{n_i^k} (\chi_i^k)^\rho \right)^{1/\rho} = (n_i^k (\chi_i^k)^\rho)^{1/\rho} = (n_i^k)^{\frac{1-\rho}{\rho}} \tilde{X}_i^k \quad k \in \{D, F\} \quad (3)$$

In the final expression  $X_i^K$  is output of a representative type  $k$  firm, and  $\tilde{X}_i^k = n_i^k \chi_i^k$  is resource inputs at marginal cost of all type  $k$  firms. The output of domestic firms, characterized by (3), is therefore equal to domestic supply less fixed costs of domestic firms, i.e.

$$\tilde{X}_i^D = n_i^D X_i^D = D_i - n_i^D f_i^D \quad (4)$$

and the output of importing firms is defined by imported resource less the fixed cost of those firms:

$$\tilde{X}_i^F = n_i^F X_i^F = F_i - n_i^F f_i^F$$

Holding total output constant, the *effective supply* of either domestic or foreign varieties of commodity  $i$  increases with  $(n_i^k)^{\frac{1-\rho}{\rho}}$ , which is the "variety effect multiplier." The multiplier increases with  $n_i^k$  and increases as the elasticity of substitution decreases toward 1.

The supply of good  $i$  equals aggregate demand, the sum of intermediate demand, consumer demand, investment demand and government demand:

$$X_i = \sum_j a_{ij} + c_i + I a_i^I G g_i \quad (5)$$

The number of domestic and foreign varieties determine the *effective supply index*,  $X_i$ , and we thereby assume that the Dixit-Stiglitz productivity has an symmetric impact on both intermediate and final demand. Changes in the number of domestic and foreign varieties are reflected through changes in the price index of the commodity associated with  $X_i$ .

**Differentiated Services** Services supplied under conditions of increasing returns to scale are characterized as the differentiated products of domestic and *multinational* firms. Effective supply of all firms in a given sector is described by:

$$\begin{aligned} X_i &= \left( \sum_{i=1}^{n_i} x_i^p \right) \\ &= \left( \sum_{i=1}^{n_i^D} (X_i^D)^p + \sum_{i=1}^{n_i^M} (X_i^M)^p \right)^{1/p} \end{aligned} \quad (6)$$

$$= \left( (X_i^D)^p + (X_i^M)^p \right)^{1/p}$$

$n_i^D$  and  $n_i^M$  are the numbers of domestic and multinational firms/ varieties, and  $X_i^D$  and  $X_i^M$  are output per firm of those two types of firms. In the final equation  $X_i^D$  and  $X_i^M$  represent composites of domestic and multinational services, i.e.:

$$X_i^K = \left( \sum_{k=1}^{n_i^k} (X_i^k)^p \right)^{1/p} = \left( n_i^k (X_i^k)^p \right)^{1/p} = \left( n_i^k \right)^{\frac{1-p}{p}} \tilde{X}_i^k \quad k \in \{D, M\} \quad (7)$$

In the final expression  $X_i^k$  is output of a representative type  $k$  firm, and  $\tilde{X}_i^k = n_i^k X_i^k$  are resource inputs at marginal cost of all type  $k$  firms.

The crucial distinction between differentiated goods and differentiated services is that in the case of goods, domestic supply, characterized by (1), equals the value of domestic goods while for services this quantity is split between resources used in producing domestic services and

resources employed by multinational firms. In the case of services, we may then define:

$$D_i = D_i^D + D_i^M \quad (8)$$

where  $D_i^D$  represents domestic resources used in the supply of services by domestic firms:

$$D_i^D = n_i^D (X_i^D + f_i^D)$$

while  $D_i^M$  represents domestic resources used in the supply of services by multinational firms.

We assume that multinational firms use domestic inputs in fixed proportion to imported inputs. Hence,

$$M_i = \theta_i^M n_i^M (X_i^M + f_i^M)$$

and

$$D_i = (1 - \theta_i^M) n_i^M (X_i^M + f_i^M)$$

in which  $\theta_i^M$  represents the benchmark value share of imported inputs to multinational service supply.

As in the case of differentiated goods, holding total output of either domestic or multinational services constant, *effective supply* of either domestic or multinational varieties of service commodity  $i$  increases with  $\left( n_i^k \right)^{\frac{1-p}{p}}$ , which is the "variety effect multiplier." The multiplier increases with and increases as the elasticity of substitution decreases toward 1.

Likewise, the supply of differentiated service  $i$  equals aggregate demand, the sum of intermediate demand, consumer demand, investment demand and government demand:

$$X_i = \sum_j a_{ij} + c_i + Ia_i^l Gg_i \quad (9)$$

The number of domestic and multinational varieties determine the *effective supply index*,  $X_i$ , and we thereby assume that the Dixit-Stiglitz productivity has a symmetric impact on both intermediate and final demand. Changes in the number of domestic and foreign varieties are reflected through changes in the price index of the commodity associated with  $X_i$ .



# Appendix B. Regions, Sectors, and Factors

**Table B-1**  
*Regions and Factors in the Colombian Bilateral Trade Study*

Identifier	Description
<b>R E G I O N S</b>	
COL	Colombia
VEN	Venezuela
XAP	Rest of Andean Pact (Ecuador, Perú, and Bolivia)
XSM	Rest of South America
BRA	Brazil
MSR	MERCOSUR Countries except Brazil
MEX	Mexico
XCM	Central America and Caribbean
CAN	Canada
USA	United States of America
EUR	European Union 15
ROW	Rest of World
<b>F A C T O R S   O F   P R O D U C T I O N</b>	
LND	Land
SKL	Skilled labor
LAB	Unskilled labor
CAP	Capital
RES	Natural resources

**Table B-2**

*Disaggregate Sectors Available for the Bilateral Analysis: Most Results Use More Aggregated Datasets*

Identifier	Sector
CRO	Paddy rice, Wheat, Sugar cane, plant fibers, wool, forestry, fishing
GRO	Cereal grains nec
V_F	Vegetables - fruit - nuts
OSD	Oil seeds
OCR	Other Crops
MET	Bo horses, animal product, Bo meat, meat product, dairy
COL	Coal
OIL	Oil
ONR	Gas - Other Natural Resources, minerals
SGR	Sugar
OFD	Food products nec
TEX	Textiles
WAP	Wearing apparel
SFT	Leather products, wood, paper, publishing
P_C	Petroleum - coal products
CRP	Chemical - rubber - plastic products
NMM	Mineral products nec
IND	Heavy Industry: Ferrous metals, other metals, manufactures electricity,
FMP	Metal products
MVH	Motor vehicles and parts
OTN	Transport equipment nec
ELE	Electronic equipment
OME	Machinery and equipment nec
SER	Gas distribution, Water, Construction, Trade, Recreation, Public goods
TRN	Transportation: Air, Water, Other
CMN	Communication
BSR	Business Service: Financial, Insurance, Other
DWE	Ownership of dwellings
CGD	Savings good

**Table B-3**  
*Sectoral Definitions for the IRTS Model*

Identifier	Description
C O N S T A N T R E T U R N S S E C T O R S	
COF	Coffee
CRO	Other crops
LVS	Livestock
FFH	Forestry fishing and hunting
OIL	Oil
MIN	Other Minerals
THR	Coffee Threshing
FOD	Foodstuffs
NRI	Natural Resources Intensive Industries
NSI	Non-skilled Labor Intensive Industries
CON	Construction
ELE	Electricity Gas and Water
COM	Communications
GOV	Government Services
I N C R E A S I N G R E T U R N S G O O D S	
HTC	Capital and High Technology Industries
I N C R E A S I N G R E T U R N S S E R V I C E S	
COM	Communications
TRN	Transport
SER	Private Services

**Table B-4**  
*Labor Categories*

Identifier	Description
UFS	Urban formal salaried work
UFN	Urban formal non-salaried work
UTC	Urban traditional contract work
UMC	Urban modern contract work (consulting)
RSW	Rural salaried work (organized farming work)
RNW	Rural non-salaried work (farming)



# **Appendix C. Benchmark Trade Statistics**

**Table C-1**  
*Colombian Production (Millions of U.S. Dollars)*

	X0	X-U.S.	%X-U.S.	Y0	%	%X
Other Crops	2990.0	980.0	35.0	3648.0	2.0	82.0
Oil	2320.2	1641.3	76.6	4319.0	2.3	53.7
Transportation: All Modes	1851.7	383.0	20.7	11058.6	6.0	16.7
Finance and Other Services	1462.1	206.4	14.1	13598.7	7.3	10.8
Chemical, rubber, plastic	1261.8	118.6	9.8	8386.3	4.5	15.0
Coal	1107.1	98.2	10.9	1228.2	0.7	90.1
Vegetables and Fruits	611.0	152.5	31.7	4177.9	2.3	14.6
Other Food products	599.1	179.9	31.2	6047.7	3.3	9.9
Heavy Industry	532.7	189.8	36.8	5087.2	2.7	10.5
Wearing apparel	514.5	305.5	61.6	2748.5	1.5	18.7
Services: Public and Private	512.3	111.5	21.8	54746.7	29.5	0.9
Other Machinery	401.0	12.6	3.3	2517.5	1.4	15.9
Petroleum Products	356.1	177.5	52.3	2404.5	1.3	14.8
Textiles	324.1	42.5	13.7	2185.9	1.2	14.8
Wood, Paper, Publishing	305.7	33.3	11.5	4401.4	2.4	6.9
Sugar	275.8	39.2	15.4	1616.7	0.9	17.1
Other Mineral product	225.2	50.7	25.5	2069.4	1.1	10.9
Leather Products	152.4	44.6	30.4	1060.6	0.6	14.4
Metal products	130.0	13.0	10.5	1266.5	0.7	10.3
Motor vehicles, parts	122.5	3.2	2.7	1592.0	0.9	7.7
Major Crops	99.3	11.3	12.1	7503.1	4.0	1.3
Bo Meats	49.8	11.8	24.9	11271.3	6.1	0.4
Other Transport Equipment	15.9	0.9	5.4	293.0	0.2	5.4
Electronic equipment	14.8	2.3	15.8	425.4	0.2	3.5
Communication	10.3	0.9	9.1	2431.9	1.3	0.4
Milk products	8.2	0.5	6.1	2240.1	1.2	0.4
Natural Gas and Minerals	5.9	0.1	1.0	709.6	0.4	0.8
Oil seeds	1.1	0.0	0.0	326.8	0.2	0.4
Cereal Grains	1.0	0.1	13.2	350.6	0.2	0.3
Savings Good	0.0	0.0	0.0	16110.9	8.7	0.0
Dwelling Ownership	0.0	0.0	0.0	9778.9	5.3	0.0
TOTAL	16261.6	4811.2	0.0	185603.0	100.0	0.0

**Table C-2**  
*Colombian Consumption (Millions of U.S. Dollars)*

	%	AO	%M	%M-U.S.	TM-U.S.
Services: Public and Private	31.8	55125.0	1.6	27.9	0.0
Finance and Other Services	7.9	13737.3	11.7	14.3	0.0
Bo Meats	6.5	11337.8	1.0	44.6	16.4
Transportation: All Modes	5.9	10262.5	10.3	21.7	0.4
Chemical, rubber, plastic	5.9	10190.7	30.1	38.2	8.0
Dwelling Ownership	5.6	9778.9	0.0	0.0	0.0
Major Crops	4.8	8276.3	10.6	28.4	14.7
Other Food products	3.4	5855.2	7.0	11.9	18.0
Heavy Industry	3.3	5749.1	20.8	15.8	13.8
Other Machinery	3.3	5720.1	63.0	43.6	9.0
Wood, Paper, Publishing	2.7	4757.2	13.9	30.9	13.6
Vegetables and Fruits	2.2	3764.4	5.2	11.0	14.0
Motor vehicles, parts	1.9	3231.9	54.5	14.5	15.0
Communication	1.4	2442.1	0.8	19.0	0.0
Textiles	1.4	2428.5	23.3	25.2	16.0
Wearing apparel	1.4	2402.8	7.0	67.2	20.0
Milk products	1.3	2321.3	3.8	15.3	19.0
Petroleum Products	1.3	2291.1	10.6	14.6	10.0
Other Mineral product	1.3	2216.0	16.8	26.0	14.0
Oil	1.2	1998.8	0.0	0.0	0.0
Electronic equipment	1.1	1865.9	78.0	57.1	6.0
Metal products	0.9	1504.9	24.5	34.1	14.0
Sugar	0.8	1346.8	0.4	4.1	18.0
Leather Products	0.6	1001.2	9.3	9.8	13.0
Other Transport Equipment	0.5	871.8	68.2	44.1	3.0
Natural Gas and Minerals	0.4	750.9	6.3	18.0	5.0
Other Crops	0.4	699.7	6.0	16.3	9.0
Cereal Grains	0.4	681.3	48.7	67.4	12.0
Oil seeds	0.2	411.0	20.8	55.6	11.0
Coal	0.1	121.1	0.0	0.0	0.0
TOTAL	100.0	173141.5	0.0	0.0	0.0

**Table C-3**  
*U.S. Imports and the Colombian Share*

	<b>%M</b>	<b>M-COL</b>	<b>M</b>	<b>%-COL</b>	<b>TM-COL</b>
Oil	52.1	1641.3	55396.5	3.0	0.0
Other Crops	34.6	980.0	6925.0	14.2	22.0
Transportation: All Modes	11.7	383.0	60470.6	0.6	0.0
Wearing apparel	37.7	305.5	36967.7	0.8	15.0
Finance and Other Services	1.6	206.4	43308.6	0.5	0.0
Heavy Industry	15.4	189.8	75766.4	0.3	1.5
Other Food products	7.1	179.9	14423.0	1.2	11.0
Petroleum Products	5.2	177.5	7853.9	2.3	2.0
Vegetables and Fruits	17.2	152.5	5000.2	3.1	5.0
Chemical, rubber, plastic	12.6	118.6	66076.6	0.2	5.0
Services: Public and Private	0.8	111.5	42316.5	0.3	0.0
Coal	1.2	98.2	294.5	33.3	0.0
Other Mineral product	15.2	50.7	12825.9	0.4	2.0
Leather Products	71.4	44.6	19893.5	0.2	6.0
Textiles	19.0	42.5	19611.3	0.2	12.0
Sugar	24.0	39.2	1220.3	3.2	53.0
Wood, Paper, Publishing	8.8	33.3	41645.2	0.1	1.2
Metal products	7.8	13.0	16407.3	0.1	3.0
Other Machinery	24.7	12.6	147719.3	0.0	3.0
Bo Meats	2.7	11.8	5567.0	0.2	1.5
Major Crops	7.0	11.3	10628.4	0.1	2.0
Motor vehicles, parts	26.9	3.2	109116.5	0.0	1.0
Electronic equipment	46.2	2.3	151114.4	0.0	2.0
Communication	2.9	0.9	8912.3	0.0	0.0
Other Transport Equipment	14.1	0.9	17662.3	0.0	2.0
Milk products	2.5	0.5	1206.6	0.0	42.0
Cereal Grains	1.6	0.1	548.5	0.0	1.0
Natural Gas and Minerals	28.1	0.1	9878.3	0.0	4.0
Oil seeds	4.8	0.0	477.8	0.0	18.0

# Appendix D. Detailed Results Listings

## Multiregional (CRTS) model: 57 Sector Disaggregation

**Table D-1**  
*Summary Low Elasticity Results for Colombia*

	<b>ATPA</b>	<b>BILAT</b>	<b>USCOL</b>	<b>UNIUS</b>	<b>FTAA</b>
Equivalent Variation	0.81	0.53	0.54	-0.28	0.25
Dollar value of EV (\$B)	0.53	0.34	0.35	-0.18	0.16
• Production	-0.51	-0.94	-0.97	-0.43	-1.01
• Tariff Revs.(\$M)	52.65	-588.26	-589.02	-628.58	-1065.98
Real Exchange Rate	-1.39	-0.02	-0.05	1.40	1.41
• U.S. Imports	3.09	28.77	28.59	24.87	18.99
• Exports to U.S.	19.17	23.22	24.15	2.88	18.95

Note: Low Elasticity Results:  $\sigma_{DM}=2$ ,  $\eta_{DX}=2$ ,  $\sigma_{MM}=4$

**Table D-2**  
*Summary High Elasticity Results for Colombia*

	<b>ATPA</b>	<b>BILAT</b>	<b>USCOL</b>	<b>UNIUS</b>	<b>FTAA</b>
Equivalent Variation	1.19	0.84	0.88	-0.34	0.47
Dollar value of EV (\$B)	0.77	0.55	0.57	-0.22	0.31
• Production	-1.86	-3.52	-3.66	-1.60	-3.52
• Tariff Revs.(\$M)	203.65	-678.39	-680.67	-821.92	-1147.89
Real Exchange Rate	-1.22	0.17	0.14	1.43	1.53
• U.S. Imports	8.29	101.22	99.88	84.84	56.00
• Exports to U.S.	82.85	101.41	106.17	7.73	72.28

Note: High Elasticity Results:  $\sigma_{DM}=6$ ,  $\eta DX=6$ ,  $\sigma_{MM}=12$

**Table D-3**  
Return to Factors in Colombia (Low Elasticity Results)

	ATPA	BILAT	USCOL	UNIUS	FTAA
SKL-LABOR	0.00	0.55	0.55	0.55	1.03
LABOR	0.59	1.15	1.17	0.53	1.57
CAPITAL	0.33	0.78	0.78	0.45	1.12
CAP-PROF	0.94	1.65	1.66	0.70	2.13
N-RES	-3.04	-0.70	-0.79	2.51	0.68

Note: Low Elasticity Results:  $\sigma_{DM}=2$ ,  $\eta DX=2$ ,  $\sigma_{MM}=4$

**Table D-4**  
Return to Factors in Colombia (High Elasticity Results)

	ATPA	BILAT	USCOL	UNIUS	FTAA
SKL-LABOR	-1.04	-0.18	-0.21	0.86	0.83
LABOR	0.77	1.47	1.51	0.59	1.82
CAPITAL	0.09	0.66	0.65	0.52	1.07
CAP-PROF	0.80	1.85	1.84	1.01	2.32
N-RES	-5.10	-1.43	-1.53	4.13	1.03

Note: High Elasticity Results:  $\sigma_{DM}=6$ ,  $\eta DX=6$ ,  $\sigma_{MM}=12$

**Table D-5**  
Colombian Production (Percentage Change, Low Elasticity Results)

	ATPA	BILAT	USCOL	UNIUS	FTAA
Coal	-3.49	-1.01	-0.96	2.61	0.92
Paddy rice	0.94	-0.21	-0.27	-1.14	-0.75
Wheat	-4.34	-9.02	-9.11	-4.84	-14.14
Other Cereal grains	-1.75	-17.12	-17.22	-15.33	-17.46
Vegetables, fruit, nuts	-0.65	-0.76	-0.79	-0.06	-1.13
Oil seeds	-0.10	-5.61	-5.70	-5.38	-6.95
Sugar cane, sugar beet	1.11	1.31	1.26	0.15	0.84
Plant-based fibers	-1.52	-4.97	-5.07	-3.43	-4.72
Other Crops	11.76	15.80	16.42	3.66	14.33
Bo horses	0.21	-0.29	-0.30	-0.50	-0.60
Other Animal products	0.04	-0.64	-0.65	-0.66	-0.94
Raw milk	0.13	-0.41	-0.43	-0.53	-0.75

Note: Low Elasticity Results:  $\sigma_{DM}=2$ ,  $\eta DX=2$ ,  $\sigma_{MM}=4$

**Table D-5 (continued)**  
*Colombian production, Low Elasticity Results*

	<b>ATPA</b>	<b>BILAT</b>	<b>USCOL</b>	<b>UNIUS</b>	<b>FTAA</b>
Wool, silk	-3.11	-1.86	-1.90	1.35	-5.45
Forestry	0.34	-0.32	-0.32	-0.65	-0.59
Fishing	0.50	-0.20	-0.20	-0.69	-0.98
Oil	-2.37	-1.09	-1.19	1.37	-0.49
Gas	-0.24	-0.52	-0.54	-0.28	-0.59
Other Minerals	-1.06	-1.28	-1.33	-0.19	-1.51
Bo meat products	0.09	-0.59	-0.60	-0.65	-0.95
Meat products	0.04	-0.64	-0.66	-0.66	-0.97
Vegetable oils and fats	-0.22	-1.07	-1.18	-0.78	-2.15
Dairy products	0.29	-0.19	-0.20	-0.60	-0.57
Processed rice	0.70	1.34	1.30	0.63	0.93
Sugar	4.79	5.54	5.44	0.54	3.20
Other Food products	0.85	1.26	1.20	0.40	0.92
Beverages and tobacco	0.50	-0.02	-0.02	-0.50	-0.62
Textiles	0.89	1.29	1.09	-0.54	4.17
Wearing apparel	4.12	4.25	4.27	-0.09	5.89
Leather products	-0.01	0.22	0.17	0.25	1.21
Wood products	-0.17	-0.98	-1.02	-0.77	-0.90
Paper products, publishing	-0.81	-1.46	-1.53	-0.64	-1.67
Petroleum, coal products	-1.22	-0.77	-0.82	0.50	-1.05
Chemical, rubber, plastic	-1.42	-1.70	-1.78	-0.25	-0.76
Other mineral products	-1.05	-1.56	-1.65	-0.47	-1.87
Ferrous metals	-3.65	-2.92	-2.95	0.83	-3.74
Other Metals	-2.73	-1.49	-1.80	1.34	-1.84
Metal products	-1.85	-3.17	-3.23	-1.27	-2.89
Motor vehicles, parts	-1.69	-1.59	-1.67	0.15	-3.81
Other Transport equip	-1.27	-0.20	-0.20	1.12	1.65
Electronic equipment	-3.41	-5.52	-5.51	-2.12	-4.21
Other machinery and equipment	-3.29	-4.93	-4.98	-1.61	-2.45
Manufactures nec	-0.74	-1.39	-1.44	-0.58	-0.66
Electricity	-0.09	-0.36	-0.38	-0.28	-0.55
Gas manufacture, distribution	-0.22	-0.51	-0.54	-0.29	-0.62
Water	0.44	-0.11	-0.11	-0.54	-0.57
Construction	-0.04	-0.03	-0.03	0.01	-0.02
Trade	-0.08	-0.36	-0.38	-0.30	-0.23
Other Transport	-0.96	-0.62	-0.63	0.39	-0.27
Water transport	-6.19	-2.37	-2.37	4.26	0.63
Air transport	-3.46	-1.34	-1.34	2.31	0.48
Communication	-0.07	-0.36	-0.36	-0.27	-0.51

	ATPA	BILAT	USCOL	UNIUS	FTAA
Other Financial services	-0.34	-0.37	-0.38	-0.01	-0.32
Insurance	-3.02	-1.57	-1.58	1.58	-0.59
Business services	-2.32	-1.24	-1.26	1.14	-0.47
Recreational, other services	0.12	-0.50	-0.50	-0.60	-1.07
Public admin, education, health, defense	0.04	-0.06	-0.06	-0.10	-0.16
Ownership of dwellings	0.40	-0.26	-0.25	-0.65	-0.79

Note: Low Elasticity Results:  $\sigma_{DM}=2$ ,  $\eta DX=2$ ,  $\sigma_{MM}=4$

**Table D-6**

Colombian Production (Percentage Change, High Elasticity Results)

	ATPA	BILAT	USCOL	UNIUS	FTAA
Coal	-6.06	-0.95	-0.75	5.45	4.13
Paddy rice	2.25	-2.27	-2.66	-3.70	-4.46
Wheat	-19.46	-36.21	-36.76	-19.90	-43.46
Other Cereal grains	-8.21	-45.63	-46.13	-36.46	-44.23
Vegetables, fruit, nuts	-3.58	-4.14	-4.46	-0.18	-4.93
Oil seeds	-2.97	-17.37	-17.94	-12.37	-21.99
Sugar cane, sugar beet	2.86	3.03	2.69	-0.19	0.27
Plant-based fibers	-9.30	-23.25	-23.88	-13.51	-20.65
Other Crops	38.29	51.10	53.72	10.64	38.70
Bo horses	-0.29	-1.68	-1.80	-1.25	-1.85
Other Animal products	-0.89	-2.67	-2.80	-1.51	-2.62
Raw milk	-0.44	-1.71	-1.82	-1.16	-1.82
Wool, silk	-15.07	-11.04	-11.43	5.05	-21.43
Forestry	0.27	-1.90	-1.97	-1.95	-2.10
Fishing	0.36	-1.10	-1.17	-1.32	-3.06
Oil	-3.35	-1.38	-1.50	2.24	-0.50
Gas	-1.03	-1.93	-2.03	-0.93	-1.77
Other Minerals	-3.31	-5.35	-5.58	-1.71	-6.01
Bo meat products	-0.64	-2.75	-2.82	-1.80	-2.83
Meat products	-0.79	-2.51	-2.61	-1.44	-2.53
Vegetable oils and fats	-3.00	-9.69	-10.44	-5.81	-13.53
Dairy products	-0.10	-0.66	-0.73	-1.18	-0.35
Processed rice	0.22	1.64	1.17	1.27	0.34
Sugar	18.65	21.90	22.39	1.06	5.68
Other Food products	1.24	1.91	1.20	0.75	0.39
Beverages and tobacco	0.21	-1.16	-1.20	-1.20	-3.83
Textiles	2.94	3.92	3.02	-4.75	14.55
Wearing apparel	12.78	11.95	12.02	-2.59	19.06

	ATPA	BILAT	USCOL	UNIUS	FTAA
Leather products	-1.24	-0.35	-0.67	1.04	1.58
Wood products	-1.25	-5.30	-5.52	-3.49	-4.36
Paper products, publishing	-3.25	-7.14	-7.42	-3.61	-7.75
Petroleum, coal products	-2.16	-1.13	-1.21	1.26	-1.74
Chemical, rubber, plastic	-4.62	-6.77	-7.02	-1.93	-4.22
Other mineral products	-3.22	-6.79	-7.16	-3.09	-7.90
Ferrous metals	-10.11	-10.16	-10.26	0.48	-12.26
Other Metals	-7.34	-4.75	-5.66	3.24	-4.98
Metal products	-5.77	-12.71	-12.95	-6.50	-11.07
Motor vehicles, parts	-5.84	-7.59	-8.06	-1.37	-19.57
Other Transport equip	-5.94	-0.98	-0.98	5.37	6.22
Electronic equipment	-10.49	-17.75	-17.72	-7.63	-13.35
Other machinery and equipment	-9.81	-16.09	-16.30	-6.21	-8.64
Manufactures nec	-3.37	-8.50	-8.87	-4.04	-4.90
Electricity	-0.58	-1.27	-1.34	-0.75	-1.34
Gas manufacture, distribution	-0.95	-2.09	-2.20	-1.13	-2.22
Water	0.77	0.04	0.04	-0.70	-0.48
Construction	-0.11	-0.06	-0.06	0.05	-0.02
Trade	-0.76	-1.85	-1.96	-1.17	-1.29
Other Transport	-2.71	-1.66	-1.69	1.33	-0.22
Water transport	-15.21	-5.49	-5.45	12.60	4.09
Air transport	-9.58	-3.24	-3.20	7.50	3.15
Communication	-0.60	-0.93	-0.96	-0.27	-0.73
Other Financial services	-1.07	-1.09	-1.14	0.04	-0.67
Insurance	-8.96	-4.14	-4.14	5.75	-0.06
Business services	-6.28	-3.41	-3.44	3.20	-0.72
Recreational, other services	0.29	-0.32	-0.29	-0.50	-0.94
Public admin, education, health, defense	0.00	-0.03	-0.02	-0.02	-0.09
Ownership of dwellings	0.83	0.00	0.03	-0.76	-0.62

Note: High Elasticity Results:  $\sigma_{DM}=6$ ,  $\eta DX=6$ ,  $\sigma_{MM}=12$

**Table D-7**

Colombian Import Volume (Percentage Change, Low Elasticity Results)

	ATPA	BILAT	USCOL	UNIUS	FTAA
Paddy rice	9.55	174.72	174.81	151.88	133.83
Wheat	2.23	34.32	34.25	31.31	12.38
Other Cereal grains	5.76	99.89	99.42	89.93	86.72
Vegetables, fruit, nuts	7.49	67.78	67.21	56.01	37.14

	<b>ATPA</b>	<b>BILAT</b>	<b>USCOL</b>	<b>UNIUS</b>	<b>FTAA</b>
Oil seeds	7.37	150.79	150.29	134.02	123.16
Plant-based fibers	5.49	27.02	26.87	20.38	22.22
Other Crops	-2.46	25.72	24.45	28.73	12.04
Bo horses	7.77	33.96	33.86	24.20	22.33
Other Animal products	7.57	167.11	166.96	148.29	145.59
Forestry	5.43	28.18	28.04	21.51	21.44
Fishing	4.80	76.99	76.36	68.88	38.11
Other Minerals	3.87	20.26	20.03	15.74	10.54
Bo meat products	6.49	58.43	58.40	48.72	43.33
Meat products	7.51	69.44	69.19	57.79	54.42
Vegetable oils and fats	5.91	69.61	68.40	60.48	45.29
Dairy products	6.39	32.73	32.50	73.35	23.82
Processed rice	9.41	112.26	109.14	93.89	81.73
Sugar	35.45	142.71	83.24	80.99	76.53
Other Food products	7.46	86.92	83.72	74.14	59.21
Beverages and tobacco	6.08	87.13	86.95	76.41	57.22
Textiles	6.49	65.10	63.95	55.51	41.46
Wearing apparel	4.35	56.66	56.44	50.30	40.01
Leather products	5.73	60.74	60.33	51.99	36.80
Wood products	5.47	68.40	67.69	59.73	52.69
Paper products, publishing	4.37	48.31	48.22	42.03	34.09
Petroleum, coal products	3.92	42.34	42.23	36.96	22.04
Chemical, rubber, plastic	3.73	25.97	25.87	21.38	16.61
Other mineral products	4.46	55.82	55.39	49.16	37.33
Ferrous metals	1.37	48.55	48.35	46.50	30.44
Other Metals	2.55	41.44	39.89	37.91	24.16
Metal products	3.09	48.25	48.08	43.82	31.45
Motor vehicles, parts	2.30	62.36	61.95	58.69	31.15
Other Transport equip	2.36	8.48	8.45	5.95	5.48
Electronic equipment	1.14	12.35	12.31	11.06	8.50
Other machinery and equipment	1.71	24.16	24.11	22.05	15.86
Manufactures nec	5.58	64.37	63.84	55.72	51.72
Electricity	5.21	1.69	1.64	-3.41	-0.70
Water	5.79	1.96	1.94	-3.68	-0.77
Construction	4.76	1.28	1.23	-3.38	-1.79
Trade	5.40	1.70	1.66	-3.59	-0.99
Other Transport	4.74	1.56	1.53	-3.08	-0.89
Water transport	2.13	0.50	0.45	-1.64	-0.95
Air transport	4.38	4.71	4.68	0.22	1.64
Communication	5.23	1.83	1.80	-3.28	-0.65

	ATPA	BILAT	USCOL	UNIUS	FTAA
Other Financial services	4.93	1.90	1.86	-2.94	-0.36
Insurance	4.69	1.71	1.67	-2.93	-0.83
Business services	4.04	1.50	1.44	-2.52	-0.38
Recreational, other services	-0.06	-0.27	-0.30	-0.17	-0.53
Public admin, education, health, defense	5.23	1.87	1.85	-3.25	-0.69

Note: Low Elasticity Results:  $\sigma_{DM}=2$ ,  $\eta DX=2$ ,  $\sigma_{MM}=4$

**Table D-8**

Colombian Import Volume (Percentage Change, High Elasticity Results)

	ATPA	BILAT	USCOL	UNIUS	FTAA
Paddy rice	50.90	2544.15	2552.65	1787.32	1523.67
Wheat	7.63	112.63	112.05	98.11	31.09
Other Cereal grains	28.80	1010.79	1001.29	848.05	814.74
Vegetables, fruit, nuts	37.20	406.84	397.14	270.48	179.62
Oil seeds	33.93	2280.91	2266.32	1746.23	1448.30
Plant-based fibers	22.52	95.44	94.59	62.27	70.40
Other Crops	-1.67	114.47	106.29	115.04	32.78
Bo horses	36.37	154.14	154.48	85.96	90.85
Other Animal products	35.88	2391.26	2394.84	1743.53	1776.31
Forestry	15.87	104.88	104.09	76.58	73.92
Fishing	10.79	446.87	438.30	394.48	177.94
Other Minerals	10.41	68.72	67.60	52.92	30.17
Bo meat products	25.94	296.19	296.57	214.53	204.40
Meat products	32.85	455.67	451.94	328.30	336.23
Vegetable oils and fats	20.61	355.79	343.13	294.06	202.30
Dairy products	23.40	147.80	144.58	451.40	129.22
Processed rice	34.87	874.57	822.48	624.17	514.78
Sugar	129.66	1106.92	505.67	494.70	354.46
Other Food products	30.84	582.01	528.13	436.46	345.10
Beverages and tobacco	17.91	541.66	539.08	447.77	269.12
Textiles	22.94	289.88	277.76	230.43	158.65
Wearing apparel	8.45	207.74	206.06	192.55	136.33
Leather products	18.29	299.01	294.05	238.13	133.17
Wood products	17.46	337.96	331.48	279.45	235.67
Paper products, publishing	11.95	185.38	184.65	155.57	117.95
Petroleum, coal products	6.06	169.70	168.29	155.29	80.13
Chemical, rubber, plastic	9.80	85.67	85.17	69.30	47.45
Other mineral products	13.20	235.46	232.54	198.51	136.17
Ferrous metals	3.86	199.73	198.55	188.83	101.87

	ATPA	BILAT	USCOL	UNIUS	FTAA
Other Metals	8.16	169.13	160.60	149.88	83.52
Metal products	8.63	177.32	176.44	157.44	101.38
Motor vehicles, parts	6.67	273.42	268.79	251.69	70.68
Other Transport equip	4.43	23.43	23.33	17.99	13.73
Electronic equipment	2.30	33.65	33.52	30.78	20.77
Other machinery and equipment	4.51	73.87	73.69	66.74	40.83
Manufactures nec	18.44	277.54	271.43	226.69	198.46
Electricity	14.28	3.89	3.62	-9.50	-3.07
Water	16.09	5.31	5.16	-9.68	-2.62
Construction	14.09	2.35	2.17	-10.55	-7.49
Trade	15.76	4.30	4.09	-10.38	-4.56
Other Transport	13.78	4.26	4.14	-8.68	-3.48
Water transport	5.75	0.87	0.70	-5.18	-3.58
Air transport	10.86	12.99	12.80	1.08	3.34
Communication	14.25	4.50	4.31	-8.89	-2.95
Other Financial services	13.58	4.61	4.38	-8.28	-2.48
Insurance	12.77	4.52	4.34	-8.11	-3.22
Business services	10.70	3.26	3.04	-7.27	-2.41
Recreational, other services	-0.16	-0.96	-1.10	-0.54	-1.38
Public admin, education, health, defense	13.55	3.93	3.76	-8.77	-3.58

Note: High Elasticity Results:  $\sigma_{DM} = 6$ ,  $\eta_{DX} = 6$ ,  $\sigma_{MM} = 12$

**Table D-9**

Colombian Export Volume (Percentage Change, Low Elasticity Results)

	ATPA	BILAT	USCOL	UNIUS	FTAA
Coal	-3.83	-1.07	-1.00	2.88	1.72
Other Cereal grains	-2.24	-11.37	-11.26	-9.04	-12.98
Vegetables, fruit, nuts	10.83	12.84	13.49	1.92	12.58
Sugar cane, sugar beet	-1.61	0.84	1.15	2.56	-10.26
Other Crops	70.82	77.42	80.52	4.07	61.49
Bo horses	-1.07	0.86	0.95	2.05	-10.67
Other Animal products	-1.37	0.18	0.27	1.66	-1.43
Wool, silk	-2.58	0.36	0.37	3.12	-1.85
Forestry	-2.75	-1.51	-1.38	1.31	-0.07
Fishing	-1.93	-1.02	-0.92	0.94	0.07
Oil	-4.15	-1.84	-1.68	2.46	-0.04
Other Minerals	12.74	14.49	14.58	1.60	14.57
Bo meat products	14.52	16.33	16.38	1.66	14.50

	<b>ATPA</b>	<b>BILAT</b>	<b>USCOL</b>	<b>UNIUS</b>	<b>FTAA</b>
Vegetable oils and fats	12.02	15.38	15.79	3.08	8.04
Dairy products	244.80	251.99	255.13	2.10	207.47
Processed rice	15.61	20.34	20.52	4.12	16.19
Sugar	260.02	272.61	283.72	3.73	119.73
Other Food products	32.52	37.03	38.48	3.46	34.59
Beverages and tobacco	6.86	9.32	10.34	2.36	1.16
Textiles	44.46	108.99	110.35	2.59	83.75
Wearing apparel	35.49	39.34	39.70	2.67	33.51
Leather products	15.65	18.67	19.02	2.66	10.93
Wood products	2.94	4.76	5.20	1.84	-4.98
Paper products, publishing	-0.83	1.34	2.03	2.24	3.52
Petroleum, coal products	1.20	3.51	3.69	2.34	5.77
Chemical, rubber, plastic	14.29	17.13	17.63	2.55	15.32
Other mineral products	2.43	4.37	4.87	1.96	2.59
Ferrous metals	1.90	4.81	4.87	2.94	5.81
Other Metals	-0.48	2.94	3.00	3.52	3.52
Metal products	6.33	8.02	8.54	1.69	3.68
Motor vehicles, parts	0.15	3.14	3.39	3.06	-7.13
Other Transport equip	4.29	8.08	8.40	3.69	8.78
Electronic equipment	1.57	2.56	2.65	1.05	1.82
Other machinery and equipment	5.90	7.31	7.65	1.44	-0.39
Manufactures nec	-1.10	0.73	0.91	1.95	0.29
Water	-2.88	-1.37	-1.33	1.61	0.06
Trade	-3.24	-1.48	-1.46	1.86	0.57
Other Transport	-3.87	-1.70	-1.68	2.35	0.40
Water transport	-7.22	-2.72	-2.70	5.03	1.24
Air transport	-5.25	-1.86	-1.83	3.70	1.35
Communication	-3.26	-1.63	-1.60	1.74	-0.04
Other Financial services	-3.42	-1.69	-1.66	1.85	-0.04
Insurance	-5.13	-2.49	-2.44	2.89	-0.23
Business services	-4.77	-2.29	-2.26	2.68	-0.08
Recreational, other services	-3.22	-1.99	-1.95	1.34	-0.90
Public admin, education, health, defense	-3.11	-1.27	-1.23	1.94	0.21

Note: Low Elasticity Results:  $\sigma_{DM} = 2$ ,  $\eta_{DX} = 2$ ,  $\sigma_{MM} = 4$

**Table D-10**  
*Colombian Export Volume (Percentage Change, High Elasticity Results)*

	<b>ATPA</b>	<b>BILAT</b>	<b>USCOL</b>	<b>UNIUS</b>	<b>FTAA</b>
Coal	-6.99	-0.87	-0.59	6.44	6.49
Other Cereal grains	-15.70	-37.83	-37.43	-22.12	-35.72
Vegetables, fruit, nuts	22.72	29.16	30.72	6.23	32.35
Sugar cane, sugar beet	-8.73	-2.32	-2.76	7.42	-28.84
Other Crops	314.87	355.19	372.04	12.69	237.72
Bo horses	-13.07	-7.60	-7.62	7.32	-28.88
Other Animal products	-11.53	-7.49	-7.35	5.39	-8.05
Wool, silk	-15.44	-7.39	-7.74	10.25	-13.06
Forestry	-8.47	-5.29	-4.88	3.86	-0.63
Fishing	-4.38	-2.50	-2.21	2.01	1.09
Oil	-7.11	-2.88	-2.33	4.67	1.34
Other Minerals	43.98	48.91	49.31	3.90	49.91
Bo meat products	42.39	48.79	48.89	5.19	44.61
Vegetable oils and fats	33.56	42.88	45.73	7.65	25.96
Dairy products	3175.95	3400.31	3455.69	7.89	1285.79
Processed rice	48.67	67.21	68.40	12.19	51.11
Sugar	3635.29	4018.03	4260.94	13.28	942.79
Other Food products	122.94	146.52	155.06	11.15	146.28
Beverages and tobacco	18.97	29.17	34.68	9.07	17.49
Textiles	196.61	695.40	708.37	7.21	544.67
Wearing apparel	145.07	167.75	170.26	7.88	145.80
Leather products	52.15	65.74	68.03	9.45	41.60
Wood products	8.04	13.08	15.42	5.46	-9.55
Paper products, publishing	-3.55	2.51	4.92	6.93	18.81
Petroleum, coal products	8.66	13.49	14.13	4.61	19.47
Chemical, rubber, plastic	49.10	60.08	62.44	7.97	62.68
Other mineral products	7.61	12.78	14.95	5.58	15.23
Ferrous metals	6.49	14.73	15.06	8.33	20.93
Other Metals	-0.22	10.05	10.45	10.91	13.39
Metal products	19.91	23.85	26.09	4.26	21.80
Motor vehicles, parts	-1.15	8.12	9.48	9.95	6.12
Other Transport equip	10.90	27.22	29.29	14.96	42.27
Electronic equipment	5.15	7.18	7.58	2.54	7.64
Other machinery and equipment	18.50	22.21	23.75	4.02	11.87
Manufactures nec	-4.18	-0.62	0.20	4.96	1.69
Water	-8.31	-3.21	-3.06	5.90	2.14
Trade	-9.85	-4.78	-4.71	5.90	2.26
Other Transport	-10.75	-4.55	-4.49	7.45	2.55

	ATPA	BILAT	USCOL	UNIUS	FTAA
Water transport	-18.13	-6.42	-6.29	15.44	6.41
Air transport	-14.10	-4.25	-4.09	12.12	6.83
Communication	-9.13	-4.07	-3.93	5.93	1.43
Other Financial services	-9.35	-4.32	-4.19	5.93	1.17
Insurance	-14.22	-6.35	-6.10	9.83	1.77
Business services	-12.64	-5.85	-5.72	8.17	1.30
Recreational, other services	-8.62	-4.50	-4.34	4.91	-0.53
Public admin, education, health, defense	-8.00	-2.55	-2.37	6.16	2.16

Note: High Elasticity Results:  $\sigma_{DM} = 6$ ,  $\eta_{DX} = 6$ ,  $\sigma_{MM} = 12$

**Table D-11**

*Change in Terms of Trade (Percentage Change, Low Elasticity Results)*

	ATPA	BILAT	USCOL	UNIUS	FTAA
Other Cereal grains	1.36	29.26	29.32	27.31	31.72
Vegetables, fruit, nuts	2.42	3.71	3.98	1.21	11.65
Oil seeds	1.42	19.48	19.41	17.67	25.14
Plant-based fibers	1.54	8.21	8.23	6.54	9.00
Other Crops	4.07	4.35	4.86	0.28	6.07
Bo horses	1.29	3.38	3.41	2.02	9.98
Other Animal products	1.39	12.65	12.66	11.03	15.95
Wool, silk	1.58	0.89	0.91	-0.71	8.58
Forestry	0.81	2.46	2.46	1.62	3.56
Fishing	0.45	0.39	0.52	-0.08	11.83
Other Minerals	0.99	1.50	1.55	0.48	4.59
Bo meat products	1.52	14.93	14.93	13.18	18.92
Vegetable oils and fats	0.55	6.00	6.23	5.31	13.03
Dairy products	4.12	5.66	5.52	4.62	11.13
Processed rice	-0.48	-0.49	0.15	-0.02	2.42
Sugar	-5.44	-4.88	9.71	0.11	-1.64
Other Food products	2.27	4.27	5.15	1.87	10.07
Beverages and tobacco	1.24	4.96	4.73	3.63	14.83
Textiles	1.82	7.47	7.64	4.00	13.49
Wearing apparel	6.70	20.86	20.89	13.30	18.94
Leather products	2.19	2.95	2.98	0.72	8.78
Wood products	1.14	6.68	6.77	5.42	12.35
Paper products, publishing	1.28	5.19	5.03	3.85	7.68
Petroleum, coal products	1.86	2.86	2.86	0.96	8.27
Chemical, rubber, plastic	1.56	4.21	4.13	2.60	6.36

	ATPA	BILAT	USCOL	UNIUS	FTAA
Other mineral products	1.58	5.02	4.99	3.36	9.43
Ferrous metals	1.63	2.49	2.50	0.82	5.80
Other Metals	1.73	2.12	2.49	0.35	5.77
Metal products	1.48	6.41	6.32	4.83	10.98
Motor vehicles, parts	0.88	2.62	2.64	1.70	11.61
Other Transport equip	0.96	1.34	1.27	0.36	1.43
Electronic equipment	1.59	4.89	4.87	3.23	5.52
Other machinery and equipment	1.57	5.37	5.29	3.71	8.65
Manufactures nec	1.14	7.44	7.55	6.18	8.79
Water	0.79	0.36	0.36	-0.44	0.09
Trade	0.89	0.39	0.39	-0.50	0.01
Other Transport	1.03	0.44	0.44	-0.60	-0.01
Water transport	1.93	0.70	0.71	-1.24	-0.22
Air transport	1.41	0.68	0.68	-0.74	0.03
Communication	0.88	0.43	0.42	-0.47	0.08
Other Financial services	0.93	0.44	0.44	-0.50	0.10
Insurance	1.38	0.64	0.64	-0.76	0.18
Business services	1.29	0.60	0.60	-0.70	0.15
Recreational, other services	0.88	0.52	0.51	-0.38	0.33
Public admin, education, health, defense	0.84	0.33	0.32	-0.51	-0.02

Note: Low Elasticity Results:  $\sigma_{DM}=2$ ,  $\eta_{DX}=2$ ,  $\sigma_{MM}=4$

**Table D-12**

*Change in Terms of Trade (Percentage Change, High Elasticity Results)*

	ATPA	BILAT	USCOL	UNIUS	FTAA
Other Cereal grains	1.76	24.83	24.88	21.52	25.84
Vegetables, fruit, nuts	3.01	5.13	5.68	1.83	11.36
Oil seeds	1.98	14.12	14.01	11.34	19.05
Plant-based fibers	2.30	10.23	10.32	7.50	10.18
Other Crops	5.27	5.60	6.31	0.30	7.57
Bo horses	2.10	5.00	5.06	2.67	10.13
Other Animal products	1.94	10.26	10.30	7.90	12.68
Wool, silk	2.33	1.61	1.67	-0.76	9.31
Forestry	0.80	2.87	2.88	2.01	3.91
Fishing	0.26	0.37	0.56	0.09	11.02
Other Minerals	0.93	1.69	1.74	0.71	4.74
Bo meat products	1.93	16.46	16.46	14.17	19.11
Vegetable oils and fats	0.59	6.70	6.90	5.59	11.85

	ATPA	BILAT	USCOL	UNIUS	FTAA
Dairy products	5.80	6.50	6.60	3.77	15.68
Processed rice	-0.36	-0.26	0.45	0.11	2.28
Sugar	-3.37	-1.74	10.71	-0.08	-1.33
Other Food products	1.72	3.78	5.13	1.59	7.57
Beverages and tobacco	1.32	5.10	4.76	3.57	14.35
Textiles	1.53	9.90	10.24	5.38	12.88
Wearing apparel	6.59	22.71	22.73	15.04	20.39
Leather products	2.13	3.45	3.51	1.21	8.82
Wood products	0.94	7.73	7.77	6.39	11.97
Paper products, publishing	1.31	6.74	6.55	5.28	7.85
Petroleum, coal products	1.30	3.01	3.03	1.66	7.82
Chemical, rubber, plastic	1.53	4.78	4.68	3.13	6.24
Other mineral products	1.44	6.45	6.37	4.78	9.43
Ferrous metals	1.54	3.25	3.24	1.62	6.24
Other Metals	1.52	2.35	2.70	0.71	5.66
Metal products	1.46	8.26	8.11	6.57	10.91
Motor vehicles, parts	0.87	3.88	3.90	2.90	11.48
Other Transport equip	1.13	1.33	1.20	0.18	0.64
Electronic equipment	1.58	5.31	5.27	3.62	5.66
Other machinery and equipment	1.57	6.23	6.12	4.51	8.20
Manufactures nec	0.84	9.23	9.41	7.91	9.75
Water	0.73	0.28	0.27	-0.48	-0.07
Trade	0.87	0.41	0.41	-0.48	-0.04
Other Transport	0.96	0.39	0.39	-0.60	-0.12
Water transport	1.68	0.56	0.55	-1.19	-0.43
Air transport	1.28	0.57	0.56	-0.75	-0.18
Communication	0.81	0.35	0.34	-0.48	-0.05
Other Financial services	0.83	0.38	0.37	-0.48	-0.01
Insurance	1.29	0.55	0.54	-0.78	-0.02
Business services	1.14	0.51	0.50	-0.66	0.02
Recreational, other services	0.76	0.38	0.38	-0.41	0.13
Public admin, education, health, defense	0.70	0.22	0.21	-0.50	-0.15

Note: High Elasticity Results:  $\sigma_{DM} = 6$ ,  $\eta_{DX} = 6$ ,  $\sigma_{MM} = 12$ .

## CROSS COUNTRY COMPARISON

**Table D-13**

*Percentage Equivalent Variation Impact (Low Elasticity Results)*

	ATPA	BILAT	USCOL	UNIUS	FTAA
Colombia	0.81	0.53	0.54	-0.28	0.25
United States	0.07	0.02	0.02	-0.06	0.03
Venezuela	-0.34	-0.14	-0.15	0.20	0.59
Brazil	0.12	0.01	0.01	-0.10	-0.22
Other Andean Pact	0.59	0.48	-0.07	-0.11	-0.14
Mexico	-0.20	-0.07	-0.06	0.13	0.11
Central America	0.64	0.03	0.05	-0.60	1.39
Other South America	0.13	0.00	0.01	-0.12	0.18
Canada	-0.20	-0.06	-0.06	0.13	-0.08
European Union	-0.04	-0.01	-0.01	0.03	-0.04
Rest of World	-0.05	-0.01	-0.01	0.04	-0.03
Other MERCOSUR	0.05	0.00	0.00	-0.04	0.66

Note: Low Elasticity Results:  $\sigma_{DM}=2$ ,  $\eta_{DX}=2$ ,  $\sigma_{MM}=4$

**Table D-14**

*Welfare gain in US\$ (billion)*

	ATPA	BILAT	USCOL	UNIUS	FTAA
Colombia	0.53	0.34	0.35	-0.18	0.16
United States	4.00	0.96	1.07	-3.02	1.80
Venezuela	-0.20	-0.08	-0.09	0.12	0.34
Brazil	0.60	0.07	0.07	-0.53	-1.12
Other Andean Pact	0.37	0.30	-0.04	-0.07	-0.09
Mexico	-0.53	-0.19	-0.17	0.33	0.29
Central America	0.50	0.02	0.04	-0.47	1.09
Other South America	0.08	0.00	0.00	-0.07	0.11
Canada	-0.73	-0.24	-0.21	0.49	-0.28
European Union	-1.77	-0.46	-0.39	1.30	-1.79
Rest of World	-3.29	-0.84	-0.74	2.44	-1.97
Other MERCOSUR	0.13	0.01	0.01	-0.11	1.78

**Table D-15**  
*Percentage Equivalent Variation Impact (High Elasticity Results)*

	ATPA	BILAT	USCOL	UNIUS	FTAA
Colombia	1.19	0.84	0.88	-0.34	0.47
United States	0.06	0.01	0.02	-0.05	0.04
Venezuela	-0.31	-0.15	-0.15	0.17	0.92
Brazil	0.11	0.01	0.01	-0.10	-0.17
Other Andean Pact	0.78	0.58	-0.10	-0.19	-0.08
Mexico	-0.20	-0.09	-0.08	0.11	0.18
Central America	0.58	0.01	0.03	-0.55	2.10
Other South America	0.12	0.00	0.00	-0.11	0.24
Canada	-0.19	-0.08	-0.07	0.11	-0.03
European Union	-0.03	-0.01	-0.01	0.03	-0.04
Rest of World	-0.05	-0.01	-0.01	0.04	-0.04
Other MERCOSUR	0.04	0.00	0.00	-0.04	0.87

Note: High Elasticity Results:  $\frac{3}{4}DM = 6$ ,  $\frac{1}{4}DX = 6$ ,  $\frac{3}{4}MM = 12$ .

**Table D-16**  
*Welfare gain in US\$ (billion)*

	ATPA	BILAT	USCOL	UNIUS	FTAA
Colombia	0.77	0.55	0.57	-0.22	0.31
United States	3.47	0.81	0.87	-2.64	2.13
Venezuela	-0.18	-0.09	-0.09	0.10	0.53
Brazil	0.55	0.05	0.05	-0.49	-0.86
Other Andean Pact	0.48	0.36	-0.06	-0.12	-0.05
Mexico	-0.53	-0.25	-0.22	0.29	0.48
Central America	0.46	0.01	0.02	-0.44	1.66
Other South America	0.07	0.00	0.00	-0.07	0.14
Canada	-0.70	-0.29	-0.24	0.42	-0.10
European Union	-1.62	-0.40	-0.31	1.23	-2.18
Rest of World	-2.99	-0.75	-0.61	2.25	-2.26
Other MERCOSUR	0.11	0.00	0.00	-0.10	2.34



# Appendix E. Welfare Mechanisms and the IRTS Model

## Introduction

The IRTS technology and productivity effects are incorporated into the model using a Dixit-Stiglitz (1979) product-variety approach. In this approach, firms are more productive when they have more choices for intermediate inputs. The fundamental assumption is that a better "fit" for inputs translates directly into increased productivity. For example, a mechanic's ability to fix cars improves as new tools become available. The key notion, written algebraically, is equation (3), from Appendix A of this report. This equation is re-produced here:

$$X_i^K = \left( \sum_{i=1}^{n_i^k} (\chi_i^k)^\rho \right)^{1/\rho} = (n_i^k (\chi_i^k)^\rho)^{1/\rho} = (n_i^k)^{\frac{1-\rho}{\rho}} \bar{X}_i^k \quad k \in \{D, F\}$$

In this equation,  $\frac{\partial X}{\partial n}$  is positive, which implies the *effective* supply of  $X$  increases as the number of firms (varieties) grows.  $X_i^K$  is called the Dixit-Stiglitz *effective supply index*. The responsiveness of the effective supply function depends upon  $\rho$ , the elasticity of substitution between varieties. The higher the elasticity of substitution, the lower the benefits from product variety. In the limit, where varieties are perfect substitutes, there are no productivity gains from increased product variety.

In order to operationalize an IRTS framework in the CGE model, we must also mobilize a theory about the type of competition. The standard choices are: monopoly, duopoly, oligopoly, and monopolistic competition. We chose monopolistic competition and Chamberlanian free entry. In this framework, each firm is differentiated, but there do not exist any barriers to entry. This lack of barriers implies that firms enter the market and drive profits to zero. But the fact that each firm must incur a fixed cost as a "startup cost" implies

that the price will be higher than marginal cost. In some treatments, this is called a "blueprint cost". Firms must then recover this fixed cost by charging a markup above marginal cost. This markup, and the number of firms a particular market can bear, is again defined by the elasticity of substitution between varieties ( $\rho$ ). In the model code, number of firms in the benchmark is scaled to unity, then the level of productivity increases when the number of firms increases. Typically, the number of firms increases by 20% to 100% in a given market when government restrictions to entry are eliminated.

## NTB to Foreign Entry

Colombia along with almost all countries in the world have some barriers to foreign competition. These are either ownership requirements, licenses, or outright ownership rejection. We use estimates of the level of restrictiveness to identify the premium paid by foreign firms to enter the local market. In the counterfactual scenarios, NTB elimination allows more firms to enter the market. As the number of varieties increases, productivity rises via the effective-supply index. Because supply increases, price falls. It is this fall in prices that generates welfare gains to the population.

Higher productivity and lower prices imply two types of gains. The first is a direct consumption gain -- consumers can now purchase more goods for the same amount of money. The second gain from higher productivity is in trade. Exports are now more competitive on the global market, and imports are now less competitive against domestic suppliers. In general, these effects are called "behind the border" effects. Although these effects are rooted in a trade agreement, most of the gains from productivity changes occur completely within Colombia.

In the Colombia trade model, Nino estimate that non-tariff barriers (NTB's) are equivalent to ad-valorem tariffs between 10% and 32%. We assume that three of the 17 sectors in the Colombian economy are subject to IRTS technology (Communications (32%), transportation (25%), and skilled services (24.7%)). The "full" scenario in the Quantitative Assessment eliminates these NTBs in conjunction with standard import tariffs. There are two effects. The first effect is the elimination of price distortions caused by the import tariffs. The net welfare effect from tariff elimination is generally small because the tariff revenues must be recovered elsewhere in the economy. The net gain comes from the difference in efficiency between tariffs and the alternate source (e.g., the VAT). The second effect is the productivity effect. This is generally much larger, stemming from the theory presented above.<sup>13</sup>

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<sup>13</sup> The productivity gains have been estimated for the US/Europe as well as other countries (e.g., Mexico) over the past 20 years and are found to be substantial.

This is why we find a net welfare gain of 0.5% for tariff elimination, and a much larger gain, near 5% from full liberalization.

## Steady State Effects

A major drawback of comparative-static models is that households cannot respond to a higher or lower real return to capital. This is because, by definition, savings in a single period should be fixed<sup>14</sup>. We have derived the comparative steady-state model in order to consider the possibility of an investment response to changes in the real return to capital. The motivation and mathematics behind this formulation is discussed in section 2 of the Quantitative Assessment.

In the CGE model, the steady-state response is included by using a capital stock rationing mechanism. This mechanism increases or decreases the capital supply until the long run return to capital is equal to the price of investment, i.e., until Tobin's Q is equal to unity. This rationing variable  $(\kappa)$  scales the capital endowment for all agents in the model: households, the government and firms.

If a particular scenario increases the real return to capital, then in the steady-state formulation,  $(\kappa)$  rises. This forces each agent to increase savings and investment, which in turn increases the capital stock. This drives down the real return to capital and drives up the price of investment. The "full" scenario, under the steady-state, will increase the capital supply by 100%. Typically, the changes in the steady-state are considered an upper-bound in the very long run. In fact, they may overestimate the gains because the opportunity cost of capital (i.e., the forgone cost of present consumption) is not considered.

## Welfare Changes in the Steady State with Service Liberalization

This discussion helps to identify the trade mechanisms and productivity assumptions that drive the changes in welfare. We next turn to identifying the large negative welfare effects in a particular type of scenario: large NTB reduction in the steady-state formulation.

In this scenario, there are assumed to be particularly large governmental barriers to entry for *both* the foreign and domestic firms. The exact magnitude of these barriers is shown below:

	com	tin	ser
D	32.26	25	24.78
F	32.26	25	24.78

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<sup>14</sup> Savings is fixed in a static model because there is only a single time period.

This means that there exists a 24.78% ad-valorem cost that the insurgent firm must pay to enter the domestic market. These are significant barriers -- especially for domestic firms. Most trade models apply a 20% ad-valorem NTB to *foreign firms only*, and the foreign market share is assumed to be small. These NTBs are particularly egregious because they are applied on a *gross basis* rather than a *net basis*. This means that the NTBs are paid on output. The portion of the GAMS model code shows this here:

```
$prod:z(f,g)$mc0(f,g) s:1 dm:esubz
o:pnc(f,g) q:(mc0(f,g)+fc0(f,g)) a:ra t:tau(f,g)
i:pd(g) q:dd0(f,g) dm:
i:pn(g) q:dm0(f,g) dm:
i:pn(f,g) q:dn0(f,g)
```

In this formulation, a 50% tax on output is equivalent to a 100% tax on inputs. It's important to note that the figures for  $\tau^{fg}$  are estimated on a gross basis, or should be converted to the rates from net-basis to a gross basis.

## MARKET SHARE

The market share for foreign firms in Colombia is below:

```
table fdi_data(+,+,+) Base year value shares for FDI firms
      low  central  high
theta_fdi.com  0.05  0.10  0.15
theta_fdi.ser  0.01  0.03  0.05
theta_fdi.trn  0.01  0.03  0.05

theta_m.com    0.05  0.1  0.15
theta_m.ser    0.05  0.1  0.15 ;
```

Foreign companies comprise between 1% to 15% of the Colombian market in communications, services, and transportation. Now, to assume that *domestic firms*, who comprise the remainder of the market, also share the same ad-valorem barriers as foreign firms implies that there is little or no free competition in these markets.

Full tariff and NTB elimination in the steady-state scenario leads to massive changes in the capital stock. In the scenario where  $\tau$  equals the levels shown above, the long-run capital stock ( $K$ ) increases by 100%. This means that investment and the capital endowment are doubled.

Overall steady-state welfare changes, given these assumptions about domestic and foreign barriers to entry are shown in the table below.

Equivalent variation calculation in the Steady State Model (%-change)

Foreign NTB	100%	100%	100%	100%
Domestic NTB	100%	80%	60%	50%
(%consumption)	46.96	42.41	38.24	34.41
(%GDP)	30.93	27.94	25.19	22.68
<b>kappa</b>	<b>104.02</b>	<b>93.21</b>	<b>83.28</b>	<b>74.16</b>

(scenario: Full Elimination and Steady State Capital stock)

Static Model Welfare changes if both Domestic and Foreign firms face the same Barriers to Entry:

Foreign NTB	100%	100%	100%	100%
Domestic NTB	100%	80%	60%	50%
(%consumption)	8.85	8.16	7.54	7.01
(%GDP)	5.83	5.37	4.97	4.62