

Domestic Linkages as a Condition for Gains from Free Trade Agreements: Welfare and Poverty implications of DR-CAFTA for Costa Rica and Nicaragua *

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Abstract

The free trade agreement between the United States and the Central American countries plus the Dominican Republic (DR-CAFTA) signed in 2004 has spurred great controversy in all signatory countries about the expected economic and social gains and losses of the further trade opening. The debate has been particularly fierce in Costa Rica and Nicaragua. This paper contributes to this debate by providing an ex-ante impact assessment of the agreement through a dynamic computable general equilibrium (CGE) analysis for Costa Rica and Nicaragua. The CGE analysis is complemented by a microsimulation methodology using household survey data to capture the full distributive (and poverty) implications of the tariff and quota changes implied by the DR-CAFTA. A key finding of the study is that the agreement would potentially yield welfare gains for both countries but the source of the gains differ as a consequence of a difference in the degree of economic diversification of the two economies. Nicaragua's main gains would come from newly acquired preferential access to textile markets in the United States, but in order to achieve such gains the production structure of the economy would have to become heavily specialized in the import-dependent *maquila* industry and producers in that sector would have to be able to withstand Asian competition. Costa Rica, in contrast, would benefit most from tariff reductions and gains would be spread throughout the economy as exports are more diversified and their production has relatively strong linkages with the domestic economy. Costa Rica thus stands to obtain more sustainable welfare gains from trade liberalisation than Nicaragua.

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1. Introduction

The process of multilateral trade negotiations has been paralleled over the past decade or so by a proliferation of bilateral and regional free trade agreements (FTAs). In Latin America, individual countries and existing regional trade blocs throughout the region have been intensely engaged in trade negotiations with the United States (US), their main trading partner. In Central America, together with the Dominican Republic, these negotiations have led to the establishment of the Dominican Republic-Central American Free Trade Agreement with the US, or DR-CAFTA as commonly known.¹ The negotiation and, subsequent ratification processes of the agreement, as elsewhere in Latin America, have been accompanied with fierce debates and social protests questioning the gains the new trade arrangement would yield. The divide about the net gains of DR-CAFTA by and large runs across the political spectra, but if one could generalize it is especially the governments which signed off on the agreement and many business leaders who expect important economic gains, while farmers, trade unions and other civil society groups in particular fear important costs will have to be incurred from larger competition of cheaper inputs from the United States, creating expected losses of employment and leading to more poverty. Economic analysts equally disagree about the precise output and distributional effects of DR-CAFTA.

In Costa Rica, the controversy has led to postponing the ratification of the country's membership of DR-CAFTA. On April 17, 2007, Costa Rica's president sent Congress a decree authorizing a referendum that will call upon popular vote to ratify or not the implementation of the agreement. DR-CAFTA is being fully implemented in all other signatory countries where, nonetheless, ratification took place only after fierce debate about the alleged cost and benefits of the upcoming bilateral trade liberalisation. In Nicaragua, Congress ratified the agreement after more than a year has passed since the agreement had been signed.

Also from a theoretical perspective, the welfare gains from FTAs are not obvious. In the standard approach, the Viner-Meade version of the Heckscher-Ohlin-Samuelson (HOS) framework

¹ On May 28, 2004, all Central American countries and the United States signed off on a final text of DR-CAFTA. On August 5 of the same year the Dominican Republic joined the agreement. These countries negotiated DR-CAFTA as a bloc but they basically agreed to a country-specific bilateral FTA with the US.

applied to customs unions, three effects are seen to determine the aggregate welfare outcomes: “trade creation” as a result of changes in commodity trade in the countries within the customs union; “trade diversion” caused by changes in trade between the customs union and the rest of the world; and “terms-of-trade” effects triggered by changes in international prices facing the countries. Trade creation and terms-of-trade gains are in general welfare-enhancing for countries within the customs union, whereas trade diversion and terms-of-trade losses are potentially damaging to countries outside the union. This turns the question whether an FTA is welfare-increasing into an empirical one. From their comprehensive review of theory and empirical literature on regional trade agreements, Burfisher *et al.*, (2004) draw two robust conclusions regarding the lessons learned from the empirical work in the Viner-Meade framework. First, such agreements are generally good for the member countries and not seriously detrimental to non-members, but global (multilateral) liberalisation would always be better. Secondly, the potential benefits of trade liberalisation in general, and regional FTAs in particular, tend to be rather small as shares of national product. The latter is due in part because the Viner-Meade version of the HOS framework does not take into account dynamic factors beyond the efficiency gains from reallocating resources according to comparative advantage.

The “new trade theory” does account for some of those forces (knowledge spill-over effects through trade, imperfect competition, rent-seeking behaviour, etc.), though related empirical work is based on more eclectic and less coherent frameworks. The empirical testing of the relationship between trade and economic growth has stirred some controversy and has given far from conclusive results (see, e.g., Rodriguez and Rodrik, 1999; Baldwin, 2003; Burfisher *et al.*, 2004; United Nations, 2006). FTAs are typically seen as a convenient mechanism to introduce reforms that make the investment environment more appealing to attract FDI from developed countries through which there may potentially be a transfer of global technology and increased productivity. Waldkirch (2006) shows that foreign investment is also subject to sovereign risk and FTAs may serve as a commitment mechanism in order to achieve higher sustainable levels of FDI. Raff (2004) even argues that FTAs affect the location of FDI since governments may adjust taxes and external tariffs to compete for FDI – whether this raises or lowers welfare is shown to depend on the relative size of the efficiency gain from integration and the revenue loss

associated with tax competition. These findings reiterate the point that the welfare gains from trade and attraction of FDI through FTAs are context-specific.

This paper attempts to contribute to the debate on the welfare gains from FTAs through a rigorous general equilibrium analysis. We find that DR-CAFTA would potentially yield welfare gains for both Costa Rica and Nicaragua but the source of the gains, as well as the likely sustainability of such gains differ as a consequence of a difference in the degree of economic diversification of the two economies. Nicaragua's main welfare improvements would come from newly acquired preferential access to textile markets in the US and to a lesser extent from enlarged quota for agro-industrial products. However, in order to achieve such gains the production structure of the economy would have to become heavily specialized in the import-dependent *maquila* industry and rely further on its agricultural sector. Both sectors show weak linkages with other economic activity and, in the case of the *maquila* industry, producers in that sector would have to be able to withstand Asian competition. Costa Rica, in contrast, would benefit most from tariff reductions and gains would be spread throughout the economy as exports are already more diversified and their production has relatively strong linkages with the domestic economy. Costa Rica thus stands to obtain more sustainable welfare gains from further liberalising trade than Nicaragua. This is in line with the conclusions of broader studies showing that gains from trade opening tend to be larger when economies have export sectors which are well integrated with domestic economic sectors and have already diversified into high-productivity and technologically more advanced industrial and services sectors (United Nations, 2006).

These general conclusions are based on an analysis using dynamic-recursive computable general equilibrium (CGE) models developed and applied for Costa Rica and Nicaragua to analyse the potential impact of trade liberalisation through tariff reductions, tariff-rate quotas (TRQs), and other preferential access quotas stipulated for a large number of goods in DR-CAFTA. The dynamic CGE model is needed, among other things, because the agreed trade liberalisation will be implemented gradually over a period of 20 years, as well as to account for relative-price effects and dynamic gains from trade. The country models follow standard formulations for the treatment of international trade, but they further specify trade flows with the US and other major

trading partners and also consider special economic sectors, such as export processing zones (EPZ), which are important to assessing the impact of DR-CAFTA. It is less obvious how to specify endogenously the dynamic gains from trade through direct investment and technology and knowledge spill-over effects as the literature is far from conclusive on this matter as discussed above. Therefore, we opt to impose such possible effects exogenously on the two country model frameworks to show, at least, the potential of such effects to magnify welfare gains or losses from the FTA. To assess the impact on poverty and income distribution with some precision, a methodology of microsimulations is applied in this dynamic setting by combining the simulations results of the CGE model with household survey data to take account of information on income distribution in its full detail.

The remainder of this paper is organized as follows. Section 2 describes the main features of the trade dependence of the economies of Costa Rica and Nicaragua, as well as their experience with trade liberalization prior to DR-CAFTA. Section 3 details the further trade opening that would take place under the DR-CAFTA agreement. Section 4 describes the main features of the CGE framework and the microsimulation methodology applied to both country cases. The main results of the empirical analysis are presented in section 5 and the conclusions are in section 6.

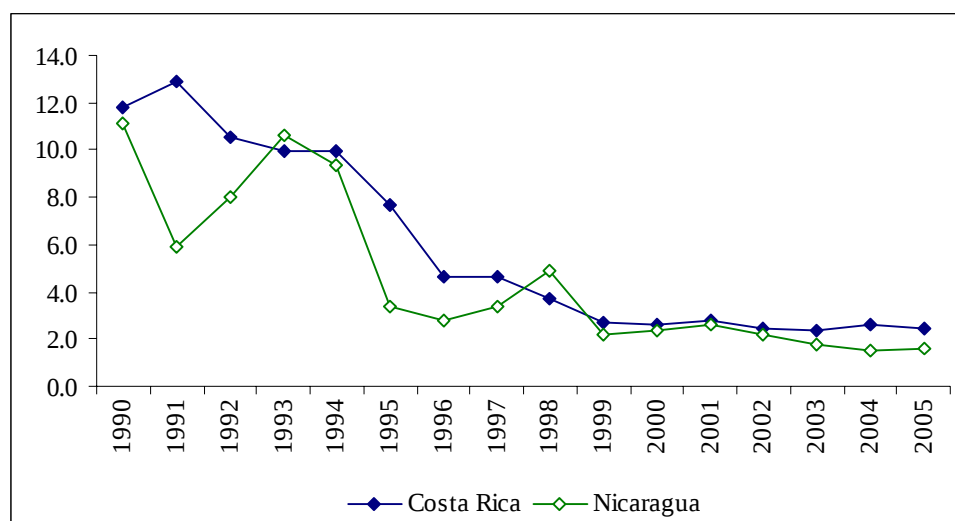
2. Trade reform and economic development in Costa Rica and Nicaragua

Trade and export diversification

Costa Rica and Nicaragua are small-open economies that rely heavily on international trade to spur economic growth. The two countries have seen in the export sector an engine to spur production and insert the economy into the rest of the world. Both countries have entered in various stages of trade opening. Both joined the Central American Common Market in 1960 pursuing regional economic integration, but trade opening with the rest of the world is more solidly pursued in the 1980s in Costa Rica and in the 1990s in Nicaragua. In the mid-1980s, in the context of structural reforms and economic stability, Costa Rica started already to open up its international trade unilaterally. A similar move was noticed in Nicaragua a decade later as the pacification process was underway and financial and commercial relations with the US and the main international financial institutions were restored. The average effective nominal tariff rate

fell notably in both countries (Figure 1). Other trade reforms have accompanied the reduction of trade taxes in the two countries: State monopolies in trading food staples, quantitative restrictions on imports and exports, and import surcharges have all been phased out. Customs procedures were also simplified.

Figure 1 Costa Rica and Nicaragua: Effective average nominal tariff rate^{1/}, 1990-2005



Source: The World Bank (World Development Indicators).

^{1/} Defined here as collected import duties as a share of the value of total imports of goods.

Deliberate measures to promote exports and diversify them have also been put in place. The two countries have instituted EPZs and have eased export procedures. Temporary tax-credit certificates have been heavily used to promote non-traditional exports, especially in the 1990s. Export taxes have been practically eliminated and export sectors obtained tax exemptions for imports of raw materials and capital goods. Exchange-rate policies have also been oriented at keeping exports competitive under a crawling-peg system of mini-devaluations.²

Export promotion measures have been relatively more effective to develop and diversify the export sector in Costa Rica as they came to be part of a well defined export-led growth strategy since the mid-1980s. Exports have risen notably as a share of GDP in Costa Rica during 1990-2005. This share now doubles that of Nicaragua (Table 1). Nonetheless, also in Nicaragua there

² In October 2006, and after more than two decades, Costa Rica introduced a managed floating system allowing the *colón* to fluctuate within a pre-established band.

was a notable recovery of exports in the early 1990s following the lifting of the trade embargo with the US and the end of a period of high macroeconomic instability. The weight of non-traditional exports in total exports increased in both countries. These became more important than traditional exports in Costa Rica in 1988 and a decade later this was also the case in Nicaragua. In 2000-2005, non-traditional exports represented on average 86.8 and 62.8 per cent of merchandise exports in Costa Rica and Nicaragua, respectively (see Table 1). These numbers hide more important differences in the degree of export diversification. In Nicaragua, growth of non-traditional exports is almost exclusively concentrated in textile and apparel produced in the EPZ, often referred to as *maquila*, a drawback-like industry that has been important for the generation of new jobs.³ However, given its high import content of production, this *maquila* industry has generated only weak linkages with the rest of the economy.⁴ In Costa Rica, in contrast, exports have been diversified into a much wider range of goods in agriculture and manufacturing, including high-tech industries producing microprocessors, computer chips and electrical microstructures, as well as into modern services. The *maquila* industry in Costa Rica is mostly associated with the electronics industry, which is atypical in the context of Central American countries.

The trade policy reforms no doubt have helped boost trade and have pushed up trade-opening ratios, especially in Costa Rica where the international trade-to-GDP ratio reached to above 100 per cent in 2005 (Table 1). The US is the main trade partner for Costa Rica and Nicaragua. More than 30 per cent of exports are channelled to the US and over 20 per cent of imports come from the US.⁵ Most net flows of FDI also originate from the US: in 2002, net FDI flows to Costa Rica amounted to US\$ 659.4, of which about half came from the US, while Nicaragua received an inflow of US\$ 166.6 of which 56 per cent was from the US investors.⁶

³ The number of new jobs has been growing rapidly in the *maquila* EPZ since 1994. Nicaragua's Central Bank records that 63,479 jobs have been created in the sector in 2005 from 3,432 jobs in 1994. Employment in the *maquila* EPZ accounted for 21 per cent of employment in manufacturing in 2005.

⁴ According to data from the Central Bank of Nicaragua, the import/export ratio of the *maquila* EPZ is on average 68 per cent per annum in 2000-2005. This ratio is above 70 per cent since 2004.

⁵ Information based on data from the Central Banks of Costa Rica and Nicaragua.

⁶ Costa Rica is the signatory country of DR-CAFTA that most receives FDI from the US according to data from the US Department of Commerce (Kose *et al.*, 2005).

Table 1 Costa Rica and Nicaragua: macroeconomic indicators, 1990-2005 (period annual averages)

	1990-1994	1995-1999	2000-2005
Average real wage (growth rate, %) ^{1/}			
Costa Rica	3.3	1.0	-1.5
Nicaragua	-19.2	2.3	3.1
GDP (growth rate, %)			
Costa Rica	5.6	5.4	3.7
Nicaragua	0.6	5.4	3.2
Employment (growth rate, %)			
Costa Rica	2.9	2.8	5.7
Nicaragua	2.1	5.6	3.7
Exports of goods and services (% of GDP)			
Costa Rica	34.1	43.4	45.7
Nicaragua	20.0	21.4	24.8
Non-traditional exports (% of goods exports) ^{2/}			
Costa Rica	63.6	75.3	86.8
Nicaragua	26.1	47.3	62.8
Non-traditional exports, excluding <i>maquila</i> (% of goods exports) ^{2/}			
Costa Rica	56.5	72.4	85.9
Nicaragua	24.7	33.0	40.0
Inflation, consumer prices (annual percentage)			
Costa Rica	18.6	15.1	11.2
Nicaragua	2,096.3	11.2	7.7
Trade (% of GDP)			
Costa Rica	73.4	88.1	93.9
Nicaragua	66.4	66.1	76.6

Source: The World Bank (World Development indicators) for GDP, exports of goods and services, inflation and trade. All other data are from the Central Bank of each country except for the average real wage in Costa Rica the data of which are from the Multipurpose Household Survey of the National Institute of Statistics.

^{1/} Data for the first period only cover 1991-1994 in the case of Nicaragua.

^{2/} Traditional exports account for the remaining share to add to 100 per cent. These include coffee, bananas, sugar, and bovine meat in the two countries, and, in addition, cattle, seafood products (shrimp and lobster), sesame seeds, gold, and silver in Nicaragua.

Macroeconomic performance and poverty reduction

A decomposition of growth for the two countries under consideration suggests that exports have been the growth engine of the economy (see, Sánchez and Sauma, 2006; Sánchez and Vos, 2006b). Some other evidence further points that export-led growth and export diversification have been positively associated with trade policy reforms in Costa Rica (Sánchez, 2004, 2005). Costa Rica grew by 5.5 per cent per annum in 1990s when output only plunged seriously in 1996 (Table 1). Nicaragua's economic recovery from its period of hyperinflation did not start until the

mid-1990s. Macroeconomic stabilization efforts in the early 1990s, supported by massive inflows of foreign aid, helped curb inflation, but trade liberalisation initially mainly stimulated import growth at the expense of domestic production. Recovery of output growth came in the second half of the 1990s reaching an average pace of 5.4 per cent per year between 1995 and 1999. GDP growth was led by exports and, towards the end of the decade, also by reconstruction in the aftermath of Hurricane Mitch.

Both economies slowed into the first years of the new millennium, as both Costa Rica and Nicaragua were affected by deteriorating terms of trade, owing especially to declining prices for key export commodities, such as coffee, while the import bill went up because of soaring oil prices. Meagre performance of microprocessors exports in Costa Rica, and the finalization of the post-Mitch reconstruction in Nicaragua, also affected growth. Economic growth slowed to 3.7 per cent per annum in Costa Rica during 2000-2005 and to 3.2 per cent in Nicaragua. From 2004, the pace of world economic growth recovered and prices of commodity exports turned more favourable, allowing for higher growth (United Nations 2007). In 2003-2005, Costa Rica returned to its pace of 5.5 per cent GDP growth it had recorded during the 1990s. Growth recovery in Nicaragua has been more modest, reporting 3.9 per cent annual GDP growth between 2003 and 2005. Both countries are net oil importers, but Costa Rica's economy has been more resilient to the impact of high oil prices than Nicaragua's. A CGE analysis suggests that Nicaragua's aggregate output would have been higher in the absence of the oil price rise observed during 2002-2006 (see United Nations, 2007: Box 1.4).

Employment has increased in tandem with production in the two countries. Rising underemployment and informal sector employment growth characterised labour market adjustment during macroeconomic stabilisation episodes (Nicaragua in 1990-1994) or economic deceleration (Costa Rica in 2000-2006). During such episodes real wages plunged (Table 1). Real wages grew by 3.3 per cent per annum in Costa Rica in 1990-1994, with only moderate increases in the subsequent five years and declined during 2000-2005 at a pace of 1.5 per cent per year. In Nicaragua, in contrast, lower inflation and economic recovery permitted real wages to increase purchasing power at a rate of 3.1 per cent per annum in 2000-2005, continuing their recovery from the dramatic decline by 19.2 per cent per annum in the early 1990s. Costa Rica

has curbed inflation, too, but it has not been able to bring it down to one digit as in Nicaragua (Table 1).

The poverty incidence in both Costa Rica and Nicaragua reduced in the 1990s, owing to employment and real wage growth (Table 2). For Costa Rica there is evidence that trade and exchange rate policies have contributed to expand production and employment, making the way for a number of poor to get out of poverty (Sánchez, 2004, 2005). There was a process of “formalisation” in the Costa Rican labour market, too, which helped boost productivity and push real wages up in the 1990s (Sánchez and Sauma, 2006). Furthermore, increases in per-capita social spending have been positively correlated with the mitigation of poverty (Sánchez, 2006a). As a result, the incidence of poverty dropped to 20.3 per cent in 1999, down from 26.3 per cent in 1990. Thereafter, however, poverty did not fall further as employment growth was offset by real wage declines and a worsening the distribution of income (see Gini coefficient in Table 2). On the other hand, in Nicaragua the poverty incidence is three times higher than in Costa Rica and extreme poverty is even more widespread than moderate poverty in Costa Rica. Despite improvement in labour market indicators in the 1990s, the poverty incidence only decreased moderately: from 73.6 to 69.9 per cent between 1993 and 1999 (Table 2). Income distribution did not improve and impeded much of the growth recovery to trickle down to the poor.

Table 2 Costa Rica and Nicaragua: Poverty and inequality indicators, 1990-2005

	Poverty incidence ^{1/}			Extreme poverty incidence ^{2/}			Gini coefficient ^{3/}
	Total	Rural	Urban	Total	Rural	Urban	
<i>Costa Rica</i>							
1990	26.3	27.3	24.9	9.9	12.5	6.4	0.438
1999	20.3	22.3	18.1	7.8	9.8	5.4	0.473
2002	20.3	24.3	17.5	8.2	12.0	5.5	0.488
2004	20.5	23.1	18.7	8.0	11.0	5.8	0.478
2005	21.1	22.7	20.0	7.0	9.0	5.6	0.470
<i>Nicaragua</i>							
1993	73.6	82.7	66.3	48.4	62.8	36.8	0.582
1998	69.9	77.0	64.0	44.6	57.5	33.9	0.584
2001	69.3	77.0	63.8	42.4	55.1	33.4	0.579

Source: CEPAL (2006).

^{1/} Share of population whose income is below the poverty line.

^{2/} Share of population whose income is below the indigence poverty line.

^{3/} For the distribution of per capita household income.

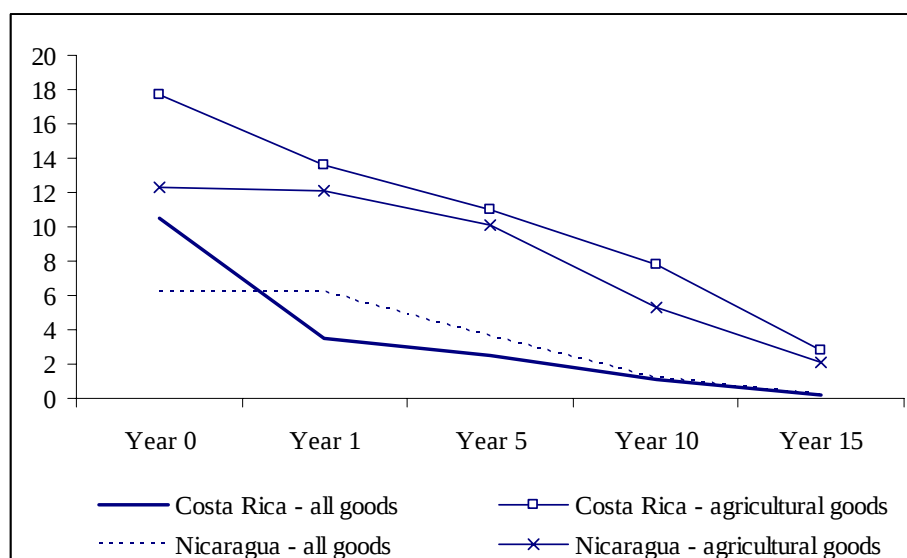
3. Trade liberalisation under DR-CAFTA

The importance of the US as main trading partner of Costa Rica and Nicaragua likely will increase further with DR-CAFTA which will liberalise, respectively, 92.5 per cent and 99.5 per cent of the bilateral trade of Nicaragua and Costa Rica with the US. The trade agreement establishes tariff reductions and TRQs and other preferential access quotas for a large number of goods, with a view to liberalize bilateral goods trade almost fully after 20 years.

Through DR-CAFTA, Costa Rica and Nicaragua also offer the US greater access to their domestic markets. The weighted average tariff rate for imports from the US before DR-CAFTA is around 10.5 and 6.2 per cent in the two countries, respectively (see Year 0 in Figure 2). Costa Rica would initially reduce tariffs more rapidly than Nicaragua, but there is convergence by the tenth year of DR-CAFTA implementation (see Figure 2). After 15 years, the weighted average tariff rate is expected to fall to 0.2 per cent. Agricultural sectors would initially retain greater protection against agricultural imports from the US. The reduction of tariffs on agricultural goods will be gradual, especially for the so-called “sensitive products” (that is, rice, beans, corn, meats, dairy products, sugar cane, and a few others).⁷ For some of these products, DR-CAFTA includes safeguard measures in the event of massive imports, and some of these products are even excluded from the tariff reduction program (i.e., potatoes and onion in Costa Rica, and white corn in Nicaragua). Even so, tariff cuts for agricultural imports from the US would be ample: by the year fifteen, the weighted average tariff rate would be approximately 2.8 and 2.1 per cent in Costa Rica and Nicaragua, respectively (Figure 2). Domestic agricultural producers in Costa Rica and Nicaragua fear this trade openness will leave many of them out of business and in greater rural poverty, especially because, even with DR-CAFTA, farmers in the US will continue to be subsidised domestically.

⁷ Agricultural tariffs under DR-CAFTA would fall more rapidly in the first years in Costa Rica, but tariffs on imports of “sensitive products” such as rice, non-processed milk, and dairy products would be reduced only as of the eleventh year. As will be mentioned shortly, TRQs for rice and dairy products conferred to the US are not expected to have an important effect in Costa Rica.

Figure 2 Costa Rica and Nicaragua: Weighted average tariff rate for imports from the US previous and during DR-CAFTA (Percentage) ^{1/}



Source: authors' construction based on data from the Ministries of Foreign Trade of Costa Rica and Nicaragua (COMEX in Costa Rica, and MIFIC in Nicaragua).

^{1/} The base tariff (in Year 0) is for 2002 and 2003 in Costa Rica and Nicaragua, respectively.

US exporters will also obtain greater access to the Costa Rican and Nicaraguan markets for a number of products through TRQs. These include rice (mostly unprocessed), corn (mostly yellow and only in Nicaragua), pork, chicken legs and dairy products (cheese, ice cream, and others). Tariff-free imports for these products would be permitted through TRQs up to certain quantitative limit above which the preferential DR-CAFTA tariff applies. The impact of these TRQs is not expected to be as important as that of the tariff reductions as thoroughly explained in Morley (2006). The effect of the TRQ for pork may be important in the first ten years since this exceeds the pre-DR-CAFTA level of imports in the two countries, though pork imports only represents a notable share of pork domestic production in Nicaragua (about 17.9 per cent). The TRQ for rice is significantly less than the average level of imports in Costa Rica and is close to the pre-DR-CAFTA level of imports in Nicaragua. Yellow corn is primarily used in animal feed in the two countries and is hardly produced in Costa Rica. Hence, the potential increase of yellow corn imports is not expected to harm domestic production in the two countries. Equally, white corn production in Nicaragua will not be affected in any major way. The TRQ is not only less than pre-DR-CAFTA import levels but it is also small relative to the total supply of the commodity. TRQs for chicken legs are very small relative to the total domestic chicken

production (0.4 per cent and 0.5 per cent in Costa Rica and Nicaragua, respectively). For cheese both the quotas and pre-DR-CAFTA imports are small relative to total supply, situation that may be similar for other dairy products. DR-CAFTA is also unlikely to have a big effect on domestic production of dairy products through TRQs because dairy imports from the US compete against the other big world dairy producers (such as the EU, New Zealand and Canada). It has been demonstrated for Costa Rica that the general equilibrium effects of TRQs conferred to the US in the framework of DR-CAFTA would be negligible (see Sánchez, 2007).

The US has also agreed upon opening up its market with DR-CAFTA. Tariff cuts are relatively unimportant, since tariffs are already fairly low and even non-existent in some cases due to unilateral preferences that the US have granted through the Generalised System of Preferences (GSP) program and the Caribbean Basin Initiative (CBI) and its extensions.⁸ It is reckoned that nearly 80 per cent of Central America's exports to the US have had duty-free access for most products owing to US unilateral preferential programs (USTR, 2005). Therefore, it may be expected that exports from Costa Rica and Nicaragua to the US will not increase notably through tariff cuts. However, DR-CAFTA makes previously unilateral preferential access permanent under its ruling. Unilateral preferences from the US can be revoked at any time previous to the implementation of DR-CAFTA. In fact, the GSP program has only been re-authorised through 2008, and CBI trade preferences may be scheduled to stop should DR-CAFTA not be implemented successfully by 2008.

Exports from Costa Rica and Nicaragua to the US are expected to increase more notably if TRQs granted by the US are fully utilised. The most important TRQs obtained by Costa Rica and the US are for sugar, beef, peanuts and dairy (Table 3). Only in the case of above-quota exports of sugar, the preferential DR-CAFTA tariff need not be paid, but rather the tariff applicable to Most Favoured Nation (MFN) status. Costa Rica and Nicaragua are the signatory countries that also obtained temporary preferential access quotas, or Tariff Preference Levels (TPLs), which allow use of third-country yarn and cloth if equal amounts of US cloth are imported. In the case of

⁸ The CBI trade preferences were granted to the countries of the region by the Caribbean Basin Economic Recovery Act (CBERA) enacted in 1983 and put into effect beginning January 1, 1984. The benefits of the CBI were expanded in 2000 with the enactment of the Caribbean Basin Trade Partnership Act (CBTPA) which allows duty-free and quota-free treatment for certain apparel assembled in qualified CBI countries, and applies reduced tariffs to certain other previously-excluded products.

Nicaragua, up to 100 million square meter equivalents (SMEs) of clothing would be allowed to enter the US annually free from rules of origin restrictions for the first ten years; a benefit owing to its status as a heavily indebted poor country (HIPC).⁹ Costa Rica obtained a two-year TPL for 500,000 SME for tailored wool clothing at a tariff level equivalent to 50 per cent of the tariff applied for most-favoured nations.

Table 3 Costa Rica and Nicaragua: TRQs under DR-CAFTA

Product	Initial quota		Annual average growth of quota (%)	
	Costa Rica	Nicaragua	Costa Rica	Nicaragua
Sugar ^{1/}	11,000	22,000	1.7	1.8
Beef ^{1/}	10,536	10,500	3.8 (unlimited in year 15)	3.8 (unlimited in year 15)
Ice cream ^{2/}	97,087	266,989	5.0 (unlimited in year 20)	5.0 (unlimited in year 20)
Milk ^{2/}	407,461	254,663	5.0 (unlimited in year 20)	5.0 (unlimited in year 20)
Other dairy ^{1/ 3/}	550	725	5.0 (unlimited in year 20)	5.0 (unlimited in year 20)
Peanuts ^{1/}		10,000		7.4 (as of year 6) (unlimited in year 15)

Source: DR-CAFTA agreement.

^{1/} TRQs are denoted in metric tons.

^{2/} TRQs are denoted in litres.

^{3/} Include cheese, butter, powder milk and other dairy products.

3. Modelling the macro-micro effects of DR-CAFTA

Theoretical foundations of the dynamic CGE framework

Dynamic recursive CGE models were developed for Nicaragua and Costa Rica to gauge potential economy-wide effects of tariff reductions and export quotas under DR-CAFTA. The CGE framework consists of a static and a dynamic block. The static part of the model provides within-period solutions, starting from the base year, and it shares most of its features with the CGE model developed at the International Food Policy Research Institute (IFPRI) and documented in Löfgren *et al.*, (2002). This model belongs to the family of structuralist-

⁹ The preferential quota will face out gradually in five years from the implementation of DR-CAFTA. Enterprises of the EPF engaged in *maquila* exports to the US would continue to benefit from the preferential access quota, however.

neoclassical general equilibrium models developed for trade policy analysis, for which the theoretical foundations can be found in Dervis *et al.* (1982) and Robinson (1989). The main changes made to the model developed by Löfgren *et al.* are: the inclusion of bilateral trade in import and export functions, an export-demand function that enables modelling changes in export quotas, a decomposition of foreign savings into capital flows and FDI, and a wage function (in the case of Nicaragua) to deal with sector-specific conditions regarding wage indexation and labour market adjustment.

The dynamic part of the model is recursive in the sense that it connects the within-period solutions overtime through updates of stock variables (particularly factors of production) and selected parameters that are either fixed or absent in the previous period and through lagged variables. All within-period solutions are consistently linked for the desired number of simulation periods (years), generating the so-called baseline scenario. In this framework, the within-period solution of the base year is considered the static or short-run solution, whereas the recursive solution from the second within-period solution is understood as the dynamic or long-run solution. More detailed descriptions of the model framework (and the simulation results) for Nicaragua and Costa Rica are found in, respectively, Sánchez and Vos (2005, 2006a and 2006b) and Sánchez (2007). The mathematical summary statement of the dynamic recursive CGE model can be found in the appendix where the model specifications are the same for both countries, except those of the factor market.¹⁰

The modelling of trade uses standard constant-elasticity-of-substitution (CES) and constant-elasticity-of-transformation (CET) functions to obtain optimal combinations of, respectively, domestically-produced and imported commodities, and production for domestic and export markets. These are, however, adapted to account for trading partners (see equations 24-5 and 28-9 in the appendix). The specification of import- and export-related equations by trading partner allows to isolate the effects of tariff and export-quota changes in trade relations with the US and further to analyze the possible trade-diversion effects arising from DR-CAFTA. Tariff reductions

¹⁰ In the appendix, Greek and lower-case letters (with or without bar) refer to parameters and elasticities, and upper-case Roman letters refer to endogenous variables (without bar) or exogenous variables (with bar). Also, subscripts either represent the domain (activities, commodities, factors, or institutions) or indicate current or past period (t or $t-1$, respectively).

under DR-CAFTA as relevant for Costa Rica and Nicaragua can be simulated by adjusting the tariff parameter in the equation that determines domestic import prices by commodity and trading partner (see equation 1 in the appendix). Furthermore, the model also includes an export-demand function in order to facilitate the simulation of the impact of export quotas (see equation 27 in the appendix). The function assumes that export sectors receiving preferential access to any foreign market through an export quota will effectively allocate the shares of output corresponding to the quota. It is also assumed that the importing foreign country providing the preferential access will demand goods to the amount of the quota. This specification also ensures equilibrium between export supply and demand by commodity and trading partner. To simulate an increase in an export quota, the base-year export volume of a particular commodity can be incremented exogenously which will induce, by assumption, a corresponding increase in the demand for that commodity in the trading partner country which has offered the preferential access to its markets. To regain equilibrium in the commodity market, producers will respond by supplying a larger share of output for the trading partner, thus affecting domestic relative prices. To simulate the impact of export quotas under DR-CAFTA, we increased export volumes to the US for commodities for which TRQs or temporary preferential access quotas have been provided, using the agreed year-to-year percentage change of the quotas.

Some equations of the static solution change in the dynamic solution as factor-market closure rules for capital and labour are changed. The marginal cost or activity-specific wage of each factor is equivalent to the product of the economy-wide wage by factor type (that is, the average wage by factor type) and an activity-specific wage-distortion factor, and is always inversely related to the quantity of factor demand.¹¹ The activity-specific wage-distortion factor is calculated from the SAM data to measure the extent to which the base-year activity-specific wage of each factor deviates from the economy-wide wage by factor type. Activity-specific wages by type of worker are not equalized, since the activity-specific wage distortion factor is different from one for all labour types.

In the static or short-run solution, capital is assumed to be underutilized and fixed and cannot be reallocated across sectors. Activity-specific rents assure that fixed activity utilization levels are

¹¹ The rent of capital is hereafter indifferently regarded as the wage of that factor.

consistent with profit maximization, through a flexible adjustment of activity-specific wage-distortion factors. Firms are allowed to increase their capacity utilization rate in response to increased demand for capital in the dynamic or long-run solution such that capital is not longer fixed. The capital market begins to clear through a flexible adjustment in the economy-wide rent with the activity-specific wage-distortion factor remaining fixed. Aggregate real investment generated at the end of each period is reallocated in order to use it as capital in the next period. This is done by allowing activities with higher past profitability to gain larger shares of investable funds as suggested in Dervis *et al.* (1982).¹² The ratio of aggregate real investment at the end of the past period to the aggregate capital stock at the beginning of the past period determines capital stock growth for sectors and the economy. The initial capital stock in each period (excluding the base year), both at the economy-wide and sector levels, is the capital stock of the past period adjusted by the growth rate of the capital stock, once depreciation has been taken out.

For the two countries labour is classified by occupational category (wage and non-wage), skill level (skilled and unskilled) and sex (male and female). The quantity demanded is assumed to be flexible - except in Nicaragua's fishing and mining activities. The labour supply (variable) is superfluous since it merely records the total quantity demanded but it is assumed to increase at given population growth rates in the dynamic or long-run solution. Other labour market and wage adjustment rules are specified in accordance with the factor market functioning of the two countries. In Costa Rica, the economy-wide (nominal) wage of wage-earners (that is, formal sector workers) is assumed to be fully indexed to changes in consumer prices, maintaining the economy-wide real consumption wage fixed for this type of workers.¹³ This segment of the labour market is cleared by adjustments in the employment level. In the segment for non-wage earners (or self-employed), in turn, the economy-wide (nominal) wage is assumed to be fixed and the market also clears via adjustments in the employment level. The economy-wide real consumption wage for these workers will fluctuate depending on the rate of inflation in

¹² A capital composition matrix usually helps translate changes in capital stocks by sector of destination into demand for capital goods by sector of origin. Due to data limitations we use the composition of aggregate investment demand and assume that it is the same for all sectors. Since capital is assumed to be homogeneous in all sectors (identical composition by sector of origin), we simply update the aggregate capital stock and let the model allocate it "efficiently" across sectors.

¹³ Please note that in both models the producer price index is used as the numéraire. The consumer price index is a composite of endogenous prices of final consumption goods.

consumer prices, but the real wage does not clear the market. In the Nicaragua model, the labour market is cleared by adjustments in the employment level as activity-specific wages (that is, economy-wide wages and activity-specific wage-distortion factors) are fixed with two exceptions. Firstly, activity-specific wages are indexed to consumer prices for all unskilled wage workers (except those in fishing and mining) and for skilled workers in government and public utility sectors. Secondly, workers in fishing and mining activities usually find it very hard to move to other sectors in the Nicaraguan context. Therefore the labour demand (and supply) in these sectors is assumed to be sector-specific and the activity-specific wage equilibrates the labour market (through changes in the activity-specific wage-distortion factor), while the demand for workers in these sectors is assumed to be fixed.

Dynamic gains from trade are not endogenised in the models and total factor productivity (TFP) growth is exogenous. There is little empirical evidence about the driving forces of trade-induced efficiency gains in Costa Rica or Nicaragua. However, a number of simulations in the scenario analysis of the impact of DR-CAFTA assume exogenous increases in TFP growth and FDI in export sectors to assess the economy-wide implications of possible dynamic gains from trade.

Macroeconomic closure rules

The same macro-closure rules are assumed for the static and dynamic solutions for both country models. In the fiscal adjustment process, government savings are summed to be endogenous and tax rates are fixed. Foreign exchange market equilibrium is achieved through a flexible adjustment of the “nominal” exchange rate, under the assumption that both countries have constrained access to foreign finance and hence foreign savings are kept fixed. This closure rule for the external balance is a reasonable proxy of the managed floating exchange rate regime of Costa Rica. Nicaragua uses a “crawling peg” with a scheme of pre-announced mini-devaluations. This would resemble more closely a fixed exchange rate regime. When using a fixed exchange rate closure, foreign savings would become implausibly high under trade liberalization scenario of DR-CAFTA.¹⁴ Furthermore, much of Nicaragua’s foreign savings consist of official

¹⁴ In the simulation of trade liberalization under DR-CAFTA in Nicaragua we found that imports increase much more than exports. This effect tends to be exaggerated when foreign savings are the clearing variable of the external sector since this essentially entails that there is no constraint for financing any emerging trade deficit. As a result, foreign savings moved to implausibly high levels as a share of nominal GDP.

development assistance which does not tend to move to accommodate trade deficits. For these reasons, a flexible exchange-rate adjustment was also assumed for Nicaragua. Even though not fully in line with the prevailing exchange rate regime, the simulation results for Nicaragua should be informative as to the required adjustment to keep the exchange rate competitive under DR-CAFTA. A “balanced” savings-investment closure rule was applied to ensure overall balance between savings and investment. This closure may be viewed as a variant of investment-driven macroeconomic closures (Löfgren *et al.*, 2002). Under this closure rule, the share of nominal absorption for household consumption is implicitly defined by fixing the shares of nominal absorption for investment and government consumption at base-year levels. Savings rates for private institutions (households and firms) are adjusted endogenously to meet these targets. This kind of “neutral” macro closure helps to avoid large and unlikely swings in macro aggregates arising from experiments that cause adjustments in the trade or fiscal balances.

Model calibration

The base-year calibration of each country model is implemented using a Social Accounting Matrix (SAM) compiled by the authors (for 2000 for Nicaragua and for 2002 for Costa Rica) in collaboration with government experts from the two countries. Each SAM captures the key economic activities and commodities relevant for the analysis of trade liberalisation, including special entries for the commodities produced in the EPZ.¹⁵ The SAMs also have disaggregated external accounts, detailing trade and financial bilateral transactions with different trading partners. Model parameters and elasticities were estimated based on country-specific data. According to a sensitivity analysis, the conclusions are not affected within a reasonable range of the elasticity values. For further details about the construction of the SAMs and derivation of model parameter values, see Sánchez (2006b, 2007) for Costa Rica and Sánchez and Vos (2006b) for Nicaragua.

Scenarios for ex-ante impact assessment of DR-CAFTA

The baseline scenario is a “business-as-usual” scenario since observed values for exogenous and policy variables from the base year until the latest available data observation are used.

¹⁵ Costa Rica’s model includes 18 production sectors and 68 commodities, whereas Nicaragua’s model has 40 production sectors and the same number of commodities.

Subsequently, exogenous and policy variables are kept constant or adjusted using past trends for the remainder of the simulation period.¹⁶ DR-CAFTA scenarios were generated from the baseline scenario by simulating either a reduction of tariffs (through the domestic import price equation) or the application of export quotas (through the export demand function), or both, according to the schedule agreed upon in DR-CAFTA at the commodity level.¹⁷ Furthermore, the trade liberalization scenarios for DR-CAFTA were also applied under alternative assumptions to capture possible dynamic gains from trade. We assume generally modest TFP gains in export sectors of 1 per cent per annum relative to the baseline scenario which are allegedly triggered by a 2 per cent annual increase in autonomous FDI relative to the baseline scenario.¹⁸ Additional TFP growth is assumed to kick in with a lag of three years after initiation of DR-CAFTA, because it is unlikely that the FTA will bring instantaneous efficiency gains.

Modelling the impact on poverty

Since CGE models typically only specify a limited number of representative households, they provide us with insufficient detail regarding changes in the distribution to be able to make robust statements regarding poverty outcomes. In consequence, the CGE analysis needs to be supplemented by certain assumptions (such as fixed within-group distributions) or, as has been done for the empirical analysis reported here, by a method of microsimulations, which takes the labour market outcomes (relative remunerations, employment, changes in skill level) from the CGE for different types of workers and applies them to a micro data set (such as a household survey) to obtain the required details about income distribution for the poverty analysis.

Bourguignon *et al.* (2002), Ganuza *et al.* (2002) and Vos *et al.* (2006) offer a discussion and application of such methods in conjunction with CGE model analysis. The approach followed here is that of Ganuza *et al.* (2002) and Vos *et al.* (2006) which was designed for application in the context of a static CGE model. This method adjusts the original labour market structure (λ) as observed in a household survey to simulate the effects of a new labour market structure (λ^*)

¹⁶ In this scenario the economy records observed growth in 2000-2005 (see Table 1) and it subsequently grows by 2 per cent and 5.5 per cent per annum in Nicaragua and Costa Rica, respectively.

¹⁷ In the simulated tariff reduction scenario we do not impose any constraint on import volumes to allow for negotiated safeguard measures

¹⁸ For this purpose we used the productivity parameter in the value-added production function (see equation (16) in the appendix) and the autonomous FDI variable that is part of foreign savings (see equation (44) in the appendix).

with consequent changes in employment, household income levels and their distribution. The original labour market structure:

$$\lambda = f(P_j, U_j, S_{jk}, O_{jk}, W1_{jk}, W2, M_{jk})$$

is adjusted using simulated CGE labour market outcomes to obtain the new labour market structure:

$$\lambda^* = f(P_j^*, U_j^*, S_{jk}^*, O_{jk}^*, W1_{jk}^*, W2^*, M_{jk}^*)$$

where P and U respectively are the participation and unemployment rates for labour type j ; S and O represent the structure of employment by, respectively, sector and occupational category, for labour type j in segment k ; $W1$ is the relative remuneration (i.e. relative to the mean) for labour type j in segment k ; $W2$ is the average per worker labour remuneration; and M is the structure of employment by skill (education) level of workers of type j in segment k .¹⁹ The microsimulation procedure assumes that workers move between occupational situations and economic sectors according to a random process in a normal distribution. Confidence intervals are generated for the generation of poverty and inequality indicators using a Monte Carlo procedure. A more elaborate exposition of this procedure and the related assumptions is found in Ganuza *et al.* (2002) and Vos *et al.* (2006). On the other hand, for the application of this microsimulation methodology in a dynamic setting, a number of additional assumptions are required, as observed survey data are only available for the base year (and a few subsequent years eventually). In essence, we assume no demographic shifts (such as migration or population ageing) take place during the simulation period. We essentially take labour market outcomes from the CGE model scenarios to generate labour market structures for t periods (λ_t and λ_t^*) and apply them to the micro dataset. Sánchez (2004) and Sánchez and Vos (2005 and 2006b) present a discussion of these assumptions and their limitations for the analysis.

4. Analysis of simulation results

The CGE simulations suggest generally positive economic gains from DR-CAFTA for both Nicaragua and Costa Rica. It should be stressed though that these gains are generally modest.

¹⁹ The participation rate is a constant in our CGE model and thus does not play a role in the microsimulation analysis. The base-year unemployment rate by labour type is a constant in the model, too, but we changed it inversely (and proportionately) in response to changes in the employment rate by labour type in order to implement the microsimulations.

This is not surprising given the fact that, firstly, both countries had already rather liberalised trade regimes prior to DR-CAFTA and, secondly, DR-CAFTA liberalises trade further with the US only. While the US is both countries' major trading partner, important shares of their trade would only be affected indirectly through the agreement and the related effects would mostly dampen the overall outcomes through trade diversion.

The results further show, interestingly, that Nicaragua mainly stands to gain from its increased preferential access to US textile and apparel markets and to a lesser extent from enhanced agricultural export quota, while Costa Rica would benefit most from tariff reductions. Combined, tariff reductions and export quotas increase the average level of output in Costa Rica and Nicaragua by, respectively, 1.3 and 2.0 per cent during the first five years. The gains would be higher in the years thereafter, particularly in Nicaragua where output is estimated to be 5 per cent higher compared to the baseline scenario. As these welfare gains are spread over a longer period of time, they imply only a very modest gain in terms of average annual growth of output. Employment and labour incomes increase as a result as well and this translates into a modest reduction of poverty incidence in the two countries.

The main results from the CGE model simulations and the microsimulations are summarized in Table 4. The table reports the percentage deviation of the simulated values (levels) for the DR-CAFTA scenarios from those of the baseline scenario for each year, but averaged for the indicated periods.

Impact of tariff reductions

Tariff reductions under DR-CAFTA would have a negative impact on producers of basic grains (especially, rice, beans and corn) in both Nicaragua and Costa Rica. To a lesser extent this also holds for farmers in other agricultural activities and livestock, silviculture and fishing. A large number of producers would no longer be able to compete with US imports.

While agricultural production is harmed in both countries to similar degrees, the economy-wide effects differ. In Costa Rica, the tariff cuts would lead to a total output gain of 1.2 per cent on average during the first five years of DR-CAFTA implementation and of 2.0 per cent thereafter

(Table 4), while there is no noticeable change in total output in Nicaragua. Why would the tariff cuts under DR-CAFTA work out more positively for the economy as a whole in Costa Rica? The answer is that the simulated impact on the cheapening of imports of intermediate inputs and capital goods is stronger in Costa Rica than in Nicaragua. This stimulates further export diversification into agro-industrial products and non-agricultural commodities, and by this means yields overall net gains in output and employment growth given the stronger linkages of export sectors with the domestic economy in Costa Rica. These effects are much less significant in Nicaragua where export sectors are somewhat weakly integrated with the rest of the economy - either because these produce primary products or they are *maquila*-type industries with high import content. This is further evidenced by the fact that, as explained in section 2, Costa Rica has a more developed and diversified export sector than Nicaragua.

This result confirms findings identified in broader studies showing that gains from trade (liberalization) tend to be higher when export sectors have a relatively high degree of integration with the rest of the economy and have already diversified into higher productivity commodities (United Nations, 2006). In Nicaragua (as in much of the rest of Central America) exports mainly consist of primary products and/or *maquila*-type industries (such as textiles and apparel), which form a weak starting point to bring gains from trade. Costa Rica's export diversification, including the development of high-technology export activities prior to DR-CAFTA, puts it in a stronger position.

Table 4 Costa Rica and Nicaragua: Simulated macroeconomic and distributional effects of trade liberalisation under DR-CAFTA (percentage deviations from baseline scenario)

	Tariff reductions		TRQs		TPL quota		All trade liberalisation	
	First 5 years Thereafter ^{1/}		First 5 years Thereafter ^{1/}		First 5 years Thereafter ^{1/}		First 5 years	Thereafter ^{1/}
Costa Rica								
GDP	1.2	2.0	0.0	0.0	- ^{2/}	- ^{2/}	1.3	2.2
Exports	2.4	3.1	0.0	0.1	- ^{2/}	- ^{2/}	2.6	3.3
Imports	0.8	1.1	0.0	0.0	- ^{2/}	- ^{2/}	1.1	1.5
Employment	1.6	2.1	0.0	0.0	- ^{2/}	- ^{2/}	1.7	2.2
Mean labour income	0.3	0.7	0.0	0.0	- ^{2/}	- ^{2/}	0.3	0.8
Total poverty ^{4/}	-0.9	-2.6	-0.1	-0.1	- ^{2/}	- ^{2/}	-1.5	-2.2
Extreme poverty ^{4/}	1.9	-1.3	0.0	1.1	- ^{2/}	- ^{2/}	1.6	-0.6
Gini – labour income ^{4/}	-0.2	-0.1	-0.1	0.1	- ^{2/}	- ^{2/}	0.0	0.1
Gini – per capita household income ^{4/}	0.0	0.0	0.0	0.1	- ^{2/}	- ^{2/}	-0.3	0.0
Nicaragua								
GDP	0.0	0.0	0.5	1.2	1.6	4.0	2.0	5.1
Exports	0.2	0.0	0.6	0.8	7.2	8.0	8.1	8.8
Imports	0.0	0.0	0.8	0.9	5.7	6.4	6.5	7.3
Employment	0.0	0.0	0.5	1.2	1.9	4.4	2.3	5.5
Mean labour income	0.0	0.0	0.1	0.2	0.3	0.9	0.4	1.0
Total poverty ^{4/}	0.1	0.1	-0.1	-0.4	-1.1	- ^{3/}	-1.0	- ^{3/}
Extreme poverty ^{4/}	0.6	0.5	-0.6	-1.1	-1.6	- ^{3/}	-1.0	- ^{3/}
Gini – labour income ^{4/}	0.0	0.0	-0.1	0.0	-0.2	- ^{3/}	-0.3	- ^{3/}
Gini – per capita household income ^{4/}	0.1	0.1	-0.2	-0.2	-0.2	- ^{3/}	-0.2	- ^{3/}

Source: simulations with CGE models and microsimulations.

^{1/} Includes five and three more years of simulated DR-CAFTA implementation in Costa Rica and Nicaragua, respectively.

^{2/} Costa Rica only obtained a two-year TPL quota for tailored wool clothing at a tariff level of 50 per cent of the tariff applied for most-favoured nations. For this reason, and considering the fairly low share of exports to the US of tailored wool clothing in total exports, the impact of the TLP quota was not simulated.

^{3/} As a consequence of the simulated labour demand projections, the microsimulations could no longer be applied beyond 2010, because no more workers could be found under given participation rates and population size.

^{4/} Results for this variable are statistically significant at the 5 per cent level.

These findings also have a bearing on employment and poverty outcomes. In Costa Rica, most employment gains from the tariff cuts and related stimulus to export sectors concentrate among workers in formal, non-agricultural sectors.²⁰ Table 5 shows the significant (positive) employment and labour income effects. These effects are fairly generalized leading to minor shifts in the income distribution. Poverty reduction effects kick in mainly after year 5 from the simulated implementation of DR-CAFTA. Extreme poverty increases in the first years of the implementation of the FTA owing to the negative welfare effects for the producers of basic grains. In Nicaragua, in contrast, the modest employment gains that would be created due to the tariff cuts under DR-CAFTA concentrate among groups of self-employed agricultural workers (farmers) in agriculture (except basic grains), but jobs would be lost in non-agricultural sectors as a consequence of greater import competition. The net outcome would be a small increase in the poverty incidence.

Impact of export quotas

In Costa Rica, the macroeconomic effects of TRQs negotiated under DR-CAFTA are almost negligible (Table 4). The main reason is that the export commodities for which a new quota would be obtained have a low importance in the overall export structure which further points to the relatively high diversification of exports in Costa Rica.²¹ In addition, initial export production capacity in the corresponding production sectors is limited and the quota would not lift profitability sufficiently to induce large investments that would generate a fast expansion of output capacity in those sectors. Hence, the TRQs mainly divert trade to the US from other export markets and from production for the domestic market to export production.

In the case of Nicaragua, the quotas would produce more significant economy-wide effects, especially through a strong expansion of textile and apparel exports through the temporary preferential access (TPL) quota (Table 4). The country has obtained increased

²⁰ Sanchez (2004) arrived at a similar conclusion when simulating the impact of the unilateral trade liberalization and export promotion policies in Costa Rica of the 1990s.

²¹ In the base year of the Costa Rican model, exports to the US of products with TRQs negotiated under DR-CAFTA only account for 0.3 per cent of total exports.

access to US markets for products that have important weight in the export structure (i.e., sugar, beef, and textiles and apparel). In the simulations, though, quite possibly, we overestimate the positive effects of export quotas by assuming that producers will actually be in a position to increase exports to the level of the quota. This may be optimistic because for several of these products the country currently has preferential access already, but without having been able to export quantities up to the level of the permitted quota. In the case of the TLP quota for the textile and clothing sector, substantial new investments in capacity would be required to produce up to the given quota increases. Under these assumptions modest economy-wide output gains could be obtained from the enhanced quota for agro-industrial exports, but the more substantial gains would come from the potentially strong expansion of textile and apparel exports. The latter, however, would trigger a major restructuring of the Nicaraguan economy, making it strongly reliant on the *maquila* sector. Traditional agricultural and agro-industrial export sectors that do not benefit from TRQs would decline under the strong relative price shifts (including real exchange rate appreciation) induced by the shift in the weight of the economy towards textile and apparel production. The EPZ would become the main source of foreign exchange generation, but this would not imply export diversification, but continued high concentration of exports – with textile and apparel exports replacing agricultural exports. Net export gains are limited, though, because of the high import intensity of the *maquila* sector.

In Costa Rica, the employment and poverty effects of the simulated application of export quotas are equally negligible as the output effects. Extreme poverty might even rise slightly – without accounting for the effect of tariffs - after five years from the initiation of DR-CAFTA, because the shift in resource allocation towards production to meet the export quota would go at cost of other activities that do not benefit from the quota regime and affect employment and labour incomes in that part of the economy. In contrast, in Nicaragua the expansion of the *maquila* industry through the TLP quota helps generate lots of new jobs, especially for unskilled female workers. This, together with income gains for farmers and other self-employed in agriculture and agro-industries benefiting from TRQs, helps reduce poverty.

It should be noted, however, that the simulated growth of the expansion of Nicaragua's *maquila* sector may well prove unfeasible given the sheer size of Nicaragua's labour market. Under the given assumptions of the simulated TLP quota increases, the corresponding expansion of production increases labour demand in the *maquila* sector from 61,776 workers in 2004 to a simulated number of 470,000 by 2010 and almost 2 million by 2012! The latter is almost equivalent to the entire size of Nicaragua's labour market. It is unlikely such abrupt labour market shifts could take place in short periods of time even if workers who have migrated to the US and Costa Rica returned to Nicaragua. Therefore, absolute labour shortages would likely start emerging after 2010 should such an abrupt shift in the production structure take place. In fact, as a consequence of the simulated labour demand projections, the microsimulations could no longer be applied beyond 2010, because no more workers could be found in the micro dataset under given participation rates and population size. In consequence, effectuating a redirection of Nicaragua's production structure to export up to the level of the permitted quota for textiles and apparel would seem implausible because of the economy's own constraints. Competition from Asian textile exports is not considered here, but this could also of course limit US demand for Nicaraguan textile exports in reality.

DR-CAFTA and dynamic gains from trade

As expected, the simulated productivity gains generally strengthen the positive outcomes of trade liberalization under DR-CAFTA discussed above, or weaken the negative outcomes (see Table 5). This is partly because, interestingly, the productivity gains appear to be sufficient to avoid the negative effects of the agreement on agricultural production (i.e., basic grains sectors in particular) and this helps to improve the distribution of income somewhat. The simulated TFP increase leaves only few sectors incapable of competing with imports (i.e., livestock in Costa Rica).²² Newly attracted FDI (which, as explained earlier, accompanies TFP growth in our simulation) induces a

²² Coffee and mining in Nicaragua are sectors where output still falls after the productivity gains have been factored in. Unlike livestock in Costa Rica, sector that competes with increased imports of meat and dairy products from the US, coffee and mining in Nicaragua lose in the process because they become relatively less profitable compared to other export sectors that attract more resources.

real exchange rate appreciation and this may harm exports to some extent. This is an effect to take into consideration especially in Costa Rica where the export sector accounts for a much larger share of GDP. Even so, employment and poverty outcomes remain unambiguously improved except for total poverty in Nicaragua.

Table 5 Costa Rica and Nicaragua: Macroeconomic and distributional effects of trade liberalisation under DR-CAFTA with and without productivity gains (percentage deviations from baseline scenario) ^{1/}

	Without productivity gains		With productivity gains	
	First 5 years	Thereafter ^{2/}	First 5 years	Thereafter ^{2/}
<i>Costa Rica</i>				
GDP	1.3	2.2	1.7	3.6
Exports	2.6	3.3	2.3	3.2
Imports	1.1	1.5	1.9	2.9
Employment	1.7	2.2	2.0	3.0
Mean labour income	0.3	0.8	0.5	1.1
Total poverty ^{4/}	-1.5	-2.2	-1.9	-3.1
Extreme poverty ^{4/}	1.6	-0.6	1.1	-1.9
Gini – labour income ^{4/}	0.0	0.1	0.0	-0.2
Gini – per capita household income ^{4/}	-0.3	0.0	-0.4	-0.3
<i>Nicaragua</i>				
GDP	2.0	5.1	2.8	6.2
Exports	8.1	8.8	8.9	9.2
Imports	6.5	7.3	6.7	7.7
Employment	2.3	5.5	2.7	6.0
Mean labour income	0.4	1.0	0.4	1.2
Total poverty ^{4/}	-1.0	- ^{3/}	-0.7	- ^{3/}
Extreme poverty ^{4/}	-1.0	- ^{3/}	-1.3	- ^{3/}
Gini – labour income ^{4/}	-0.3	- ^{3/}	-0.4	- ^{3/}
Gini – per capita household income ^{4/}	-0.2	- ^{3/}	-0.2	- ^{3/}

Source: simulations with CGE models and microsimulations.

^{1/} Trade liberalisation includes both schedule tariff reductions and quotas under DR-CAFTA.

^{2/} Includes five and three more years of simulated DR-CAFTA implementation in Costa Rica and Nicaragua, respectively.

^{3/} As a consequence of the simulated labour demand projections, the microsimulations could no longer be applied beyond 2010, because no more workers could be found under given participation rates and population size.

^{4/} Results for this variable are statistically significant at the 5 per cent level.

5. Conclusions

Tariff reductions and quotas have been negotiated under DR-CAFTA to liberalise bilateral trade between the US and its other signatories. Costa Rica and Nicaragua are two signatory countries that expect important outcomes from the FTA essentially because the US is their main trade partner and most of their bilateral trade with the US would be liberalised. Not surprisingly, then, signing and ratifying DR-CAFTA have spurred a fierce debate in these countries about its potential impact. We have found that most of the impact of the FTA for these countries would arise from reducing tariffs and increasing exports to the level of the quotas that have been conferred by the US.

Larger access to their domestic markets conferred by Costa Rica and Nicaragua to the US through TRQs is not expected to be as important as that of the tariff reductions. In some cases the quota is either significantly less than the average level of imports or close to the pre-DR-CAFTA level of imports. In some other cases the quota is fairly small compared to domestic production or the product to be more freely imported from the US does not compete directly with domestic production. Import tariff reductions in the US are expected to have minimal impact owing to existing preferential access which, nonetheless, would essentially become permanent under DR-CAFTA.

The general equilibrium analysis suggests that DR-CAFTA would potentially have positive effects, economically and socially, for both Costa Rica and Nicaragua. Tariff cuts would produce most gains in Costa Rica, mainly because of that economy's already dynamic and diversified export sectors with relatively strong integration with the domestic economy. Import liberalization would do relatively little for Nicaragua's economy, precisely because of a lack of backward linkages of its export sectors with the rest of the economy. In addition, in the two countries the envisaged tariff cuts under DR-CAFTA would hurt basic grain producers, in particular, and also other agricultural producers, to a lower extent, and under that scenario the FTA would produce more and not less (rural) poverty in Nicaragua. To avoid such a dismal outcome, Nicaragua has to put hopes on the stimulus which the temporary preferential access quotas for textile and

apparel exports, mainly, but also the TRQs for agro-industrial products, to a lower extent, would bring to the economy.

However, to live up to that potential, substantial production capacity and likely also productivity increases would be needed in both agriculture and the textile and apparel industry in Nicaragua. The latter might be achievable through the attraction of foreign investors to the *maquila* sector, but – according to the CGE simulations – this might hit on labour supply constraints and would require an implausible structural adjustment of the economy with most of the work force in the *maquila* industry. This, even if feasible resource-wise, would likely be an undesirable sector shift, as it would make the economy vulnerable to the volatility that typically characterizes the *maquila* sector, as the experience in other Central American countries (i.e., Honduras and El Salvador) points out. In addition, the sector shift would not imply export diversification, but continued high concentration of exports at the expense perhaps of agricultural exports. Hence, the simulation results of the impact of increased export quota for textiles and apparel most likely overestimate the true economic gains which the country could obtain. In the case of agricultural and agro-industry export quota, policy makers would probably need to consider complementary policies strengthening production capacity and productivity in the corresponding sectors, since at present these appear incapable of exporting amounts permitted under already existing export quota for these products.

In the case of Costa Rica, the model simulations seem more realistic given the country's proven record of export dynamics and available production capacity. While less than in the case of Nicaragua, also in Costa Rica insufficient productivity growth remains a limiting factor in the country's capacity to reap more gains from trade opening.

Substantial productivity improvements would be needed to avoid welfare losses that would result from the demise of traditional domestic-consumption agriculture, especially basic grain farming, as a consequence of the trade opening under DR-CAFTA. Most employment gains under DR-CAFTA and related stimulus to export sectors are expected to concentrate among workers in formal, non-agricultural sectors. The simulation results also indicate that should the labour market be flexible enough to absorb displaced labour

from non-competitive sectors, the FTA would be expected to lead to some moderate poverty reduction, even in the absence of productivity improvements in traditional agriculture. Hence, much depends on the degree of labour market flexibility in Costa Rica's economic adjustment to DR-CAFTA. There may be important social costs involved here in the short and medium run as not all workers will be able in practice to flexibly move from one sector to another and acquire the skills required to maintain opportunities to obtain remunerative employment elsewhere. To avoid such costs, the government would have to undertake more active labour market and social policies (including education and vocational training programmes tailored to individual worker needs).

References

- Baldwin, Robert E. (2003) "Openness and Growth: What's the Empirical Relationship?", National Bureau of Economic Research Working Paper No. 9578.
- Bourguignon, François, Anne-Sophie Robilliard and Sherman Robinson (2002) "Representative versus real households in the macro-economic modeling of inequality". Washington, D.C.: World Bank and International Food Policy Research Institute (mimeo).
- Burfisher, Mary E., Sherman Robinson and Karen Thierfelder (2004) "Regionalism: Old and New, Theory and Practice", in G. Anania (ed), *Agricultural Policy Reform and the WTO: Where Are We Heading?*, Cheltenham, U.K. and Northampton, Mass.: Elgar, pp. 593-622.
- CEPAL (*Comisión Económica para América Latina y el Caribe*) (2006) *Panorama Social de América Latina 2006*. CEPAL: Santiago de Chile.
- Dervis, Kemal, Jaime de Melo and Sherman Robinson (1982) *General Equilibrium Models for Development Policy*. Cambridge: Cambridge University Press.
- Ganuza, Enrique, Ricardo Paes de Barros and Rob Vos (2002) "Labour market adjustment, poverty and inequality during liberalisation", in Rob Vos, Lance Taylor and Ricardo Paes de Barros (eds.), *Economic Liberalisation, Distribution and Poverty: Latin America in the 1990s*, pp. 54-88. Cheltenham: Edward Elgar.
- Kose, M. Aihan, Alessandro Rebucci and Alfred Schipke (2005) "Macroeconomic implications of CAFTA-DR", in Markus Rodlauer and Alfred Schipke (eds.), *Central America: Global Integration and Regional Cooperation*, pp. 8-40. Washington, D. C.: International Monetary Fund.
- Löfgren, Hans, Rebecca Lee and Sherman Robinson (2002) "A standard computable general equilibrium (CGE) model in GAMS", *Microcomputers in Policy Research* 5. Washington, D. C.: International Food Policy Research Institute.
- Morley, Samuel (2006) "Trade Liberalization under CAFTA: An Analysis of the Agreement with special reference to agriculture and smallholders in Central America", DSGD Discussion Paper No. 33. Washington, D.C.: International Food Policy Research Institute.
- Raff, Horst (2004) "Preferential Trade Agreements and Tax Competition for Foreign Direct Investment", *Journal of Public-Economics*, 88(12): 2745-63.
- Robinson, Sherman (1989), "Multisector models", in Hollis Chenery and T. N. Srinivasan (eds.), *Handbook of Development Economics*, vol. 2, Amsterdam, New York and Oxford, Elsevier Science, North Holland, pp. 885-947.

- Rodriguez, Francisco and Dani Rodrik (1999) "Trade Policy and Economic Growth: A Skeptic's Guide to Cross-National Evidence", NBER Working Paper No. 7081, Cambridge (MA): National Bureau of Economic Research
- Sánchez, Marco V. (2004) *Rising Inequality and Falling Poverty in Costa Rica's Agriculture during Trade Reform: A Macro-micro General Equilibrium Analysis*. Maastricht: Shaker.
- Sánchez, Marco V. (2005), "Reformas Económicas, régimen cambiario y choques externos: Efectos en el desarrollo económico, la desigualdad y la pobreza en Costa Rica, El Salvador y Honduras", *Serie Estudios y Perspectivas*, N° 36. Mexico City: ECLAC.
- Sánchez, Marco V. (2006a) "Crecimiento exportador en Centroamérica: Alcances y limitaciones para el bienestar social", in Sojo, A. and A. Uthoff (eds.), *Desempeño económico y política social en América Latina y el Caribe: Los retos de la equidad, el desarrollo y la ciudadanía*, pp. 257-309. Mexico City: CEPAL, FLACSO, GTZ and INDESOL.
- Sánchez, Marco V. (2006b), "Matriz de contabilidad social (MCS) 2002 de Costa Rica, y los fundamentos metodológicos de su construcción", *Serie Estudios y Perspectivas*, N° 47. Mexico City: ECLAC.
- Sánchez, Marco V. (2007) "Liberalización comercial en el marco del DR-CAFTA: efectos en el crecimiento, la pobreza y la desigualdad en Costa Rica", *Serie Estudios y Perspectivas*, N° 80. Mexico City: ECLAC.
- Sánchez, Marco V. and Pablo Sauma (2006) "Costa Rica: export-orientation and its effect on growth, inequality and poverty", in Rob Vos, Enrique Ganuza, Samuel Morley and Sherman Robinson (eds.), *Who Gains from Free Trade? Export-led Growth, Inequality and Poverty in Latin America*, pp. 204-30. London and New York: Routledge.
- Sánchez, Marco V. and Rob Vos (2005) "Impacto del Tratado de Libre Comercio con Estados Unidos en el crecimiento, la pobreza y la desigualdad en Panamá: Una evaluación ex ante usando un modelo de equilibrio general computable dinámico", Project Report prepared for Panama's government. The Hague, Mexico and Panama City: Institute of Social Studies, Sub-regional Office of ECLAC in Mexico and UNDP (August, mimeo).
- Sánchez, Marco V. and Rob Vos (2006a) "DR-CAFTA: Panacea o fatalidad para el desarrollo económico y social en Nicaragua", *Serie Estudios y Perspectivas*, N° 57. Mexico City: ECLAC.
- Sánchez, Marco V. and Rob Vos (2006b) "Impacto del CAFTA en el crecimiento, la pobreza y la desigualdad en Nicaragua". Managua: Ministerio de Fomento a la Industria y el Comercio and UNDP.

- United Nations (2007) *World Economic Situation and Prospects 2007*. New York: United Nations.
- United Nations (2006) *World Economic and Social Survey 2006: Diverging Growth and Development*, New York: United Nations.
- USTR (Office of the United States Trade Representative) (2005) “The case for CAFTA”, *CAFTA Facts* (CAFTA Policy Brief), February.
- Vos, Rob, Enrique Ganuza, Samuel Morley and Sherman Robinson (eds.) (2006) *Who Gains from Free Trade? Export-led Growth, Inequality and Poverty in Latin America*, London and New York: Routledge.
- Waldkirch, Andreas. (2006) “The ‘New Regionalism’: Integration as a Commitment Device for Developing Countries”, *Journal of Economic Integration*, 21(2): 397-425.

Appendix: Mathematical summary statement for the CGE model

Sets

$a \in A$	activities
$a \in ALMO(\subset A)$	activities hiring mobile labour (all except fishing and mining; set only used in Nicaragua's model).
$a \in ALNMO(\subset A)$	activities hiring non-mobile labour (only fishing and mining; set only used in Nicaragua's model).
$a \in APU(\subset A)$	public and utility sector activities (set only used in Nicaragua's model).
$a \in APULMO(\subset A)$	public and utility sector activities hiring mobile labour (set only used in Nicaragua's model).
$a \in APULNMO(\subset A)$	public and utility sector activities hiring non-mobile labour (set only used in Nicaragua's model).
$c \in C$	commodities
$c \in CD(\subset C)$	commodities with domestic sales of domestic output.
$c \in CDN(\subset C)$	commodities without domestic sales of domestic output.
$c \in CE(\subset C)$	exported commodities (with domestic production).
$c \in CEN(\subset C)$	non-exported commodities (complement of CE).
$c \in CM(\subset C)$	imported commodities (with domestic production).
$c \in CMN(\subset C)$	non-imported commodities (complement of CM).
$c \in CT(\subset C)$	transaction service commodities
$c \in CX(\subset C)$	commodities with domestic production
$f \in F$	factors
$f \in K(\subset F)$	capital
$f \in L(\subset F)$	labour
$f \in LWA(\subset L)$	wage labour (set only used in Costa Rica's model).
$f \in LNWA(\subset L)$	non-wage labour (set only used in Costa Rica's model).
$f \in LSK(\subset L)$	skilled labour (set only used in Nicaragua's model).
$f \in LUSK(\subset L)$	unskilled labour (set only used in Nicaragua's model).
$f \in LWASK(\subset L)$	skilled wage labour (set only used in Nicaragua's model).
$f \in LWAUSK(\subset L)$	unskilled wage labour (set only used in Nicaragua's model).
$f \in LMO(\subset L)$	labour demanded by activities hiring mobile labour (all except fishing and mining; set only used in Nicaragua's model).
$f \in LNMO(\subset L)$	labour demanded by activities hiring non-mobile labour (only fishing and mining; set only used in Nicaragua's model).
$i \in INS$	institutions
$i \in INSD(\subset INS)$	domestic institutions
$i \in INSDNG(\subset INSD)$	domestic non-government institutions

$i \in \text{INSND}(\subset \text{INS})$	rest of the world
$r \in R(\subset \text{INSND})$	partners of the rest of the world
$h \in H(\subset \text{INSDNG})$	households

Model parameters and variables

Parameters

$\overline{capsh}_{ka}$	activity share of aggregate capital income.
$cwts_c$	weight of commodity c in the <i>CPI</i> .
$\overline{d}$	capital depreciation rate (economy-wide).
$dwts_c$	weight of commodity c in the producer price index.
ica_{ca}	quantity of commodity c per unit of aggregate intermediate input used in activity a .
$icd_{cc'}$	quantity of commodity c as trade input per unit of c' produced and sold domestically.
$ice_{cc'}$	quantity of commodity c as trade input per exported unit of c' .
$icm_{cc'}$	quantity of commodity c as trade input per imported unit of c' .
$inadj_{la}$	wage adjustment factor with respect to consumer price changes for labour type l in activity a .
$inta_a$	quantity of aggregate intermediate input per activity unit.
$lfgr_l$	labour force growth rate for labour type l .
$pdwt_c$	weight of commodity c in the <i>PD</i> index.
pwe_{rc}	world export price of commodity c for trading partner r (foreign currency).
$pwei$	world export price index.
$pwewt$	weight of aggregate exports in the world (tradables) price index.
pwm_{rc}	world import price of commodity c for trading partner r (foreign currency).
pwm_i	world import price index.
$pwmwt$	weight of aggregate imports in the world (tradables) price index.
$qdst_c$	quantity of inventory (stock) change.
$\overline{qinv}_c$	base-year quantity of investment demand by commodity c .
$\overline{qinvsh}_c$	shares of investment goods in the aggregate capital.
$shif_{if}$	share for domestic institution i in income of factor f .
$shii_{ii'}$	share of net income of i' to i ($i' \in \text{INSDNG}'$; $i \in \text{INSDNG}$).
ta_a	indirect tax rate for activity a .
te_{rc}	export tax rate for exported commodity c for trading partner r .
$tins_i$	exogenous direct tax rate for domestic institution i .
tm_{rc}	import tariff rate for imported commodity c for trading partner r .
tq_c	rate of sales tax for commodity c .
$trnsfr_{if}$	transfers from institution i to factor f .

$transfr_{fi}$	transfers from factor f to institution i .
tva_a	rate of value-added tax for activity a .
α_a^a	CES activity-function efficiency parameter.
α_c^e	CET function shift parameter.
α_{cr}^e	export-demand function shift parameter.
α_c^m	<i>Armington</i> function shift parameter.
α_a^{va}	efficiency parameter in the CES value-added function.
β_{ch}	marginal-budget share of consumption spending on commodity c for household h .
δ_a^a	CES activity-function share parameter.
δ_c^e	CET function share parameter.
δ_c^m	<i>Armington</i> function share parameter.
δ_{fa}^{va}	CES value-added function share parameter for factor f in activity a .
γ_{ch}	subsistence consumption of marketed commodity c for household h .
κ	mobility of investable funds parameter.
θ_{ac}	yield of output c per unit of activity a .
ρ_a^a	CES activity function exponent.
ρ_c^e	CET function exponent.
ρ_{cr}^e	export-demand function exponent.
ρ_c^m	<i>Armington</i> function exponent.
ρ_a^{va}	CES value-added function exponent.

Exogenous variables

$\overline{DPI}$	producer price index for domestically marketed output.
$\overline{FDI}$	autonomous foreign direct investment.
$\overline{GOVSHR}$	government consumption share in nominal absorption.
$\overline{INVSHR}$	investment share in nominal absorption.
$\overline{KFLOW}$	net capital inflows from the rest of the world.
$\overline{QF}_{fa}$	quantity demanded of factor f (for capital in static solution) in activity a .
$\overline{WF}_f$	economy-wide wage for factor f (for non-wage labour in the whole solution and capital in the static solution).
$\overline{WFDIST}_{fa}$	wage-distortion factor for factor f (for labour in the whole solution and capital in the dynamic solution) in activity a .
$\overline{WFREAL}_f$	economy-wide real consumption wage of factor f (for wage labour in the whole solution and capital in the dynamic solution).

Endogenous variables

CPI	consumer price index .
$DMPS$	change in domestic institution savings rates (= 0 for base year).
EG	government expenditure.

EH_h	consumption expenditure in household h .
EXR	exchange rate (local currency per unit of foreign currency).
$FSAV$	foreign savings (implicitly fixed because of its composition).
$GSAV$	government savings.
$IADJ$	investment adjustment factor.
EH_h	activity-shares of investable funds (in dynamic solution).
$IREAL_k$	aggregate real investment.
$IREALAC_{ka}$	real investment by sector (activity) of destination (in dynamic solution).
KGR_k	period growth rate of aggregate capital stock (in dynamic solution).
$KGRAC_{ka}$	period growth rate of sectoral capital stock (in dynamic solution).
MPS_i	marginal propensity to save for domestic non-government institution i .
PA_a	activity price (gross revenue per unit of activity).
PDD_c	demand price for commodity c produced and sold domestically.
PDI	domestic (non-tradables) price index.
PDS_c	supply price for commodity c produced and sold domestically.
PE_{rc}	domestic export price for commodity c for trading partner r (domestic currency).
$PINTA_a$	aggregate intermediate input price for activity a .
PK	aggregate capital good price.
PM_{cr}	domestic import price for commodity c for trading partner r (domestic currency).
PQ_c	composite price for commodity c (including sales tax).
PVA_a	aggregate value-added price for activity a .
PWI	world (tradables) price index (foreign currency).
PW_{cr}	average world price of commodity c for trading partner r .
PX_c	producer price for commodity c .
$PXAC_{ac}$	activity specific commodity price.
QA_a	quantity of activity a .
QD_c	quantity of domestic output c sold domestically.
QE_{rc}	quantity of exports of commodity c for trading partner r .
QF_{fa}	quantity demanded of factor f (for labour in the whole solution and capital in the dynamic solution) in activity a .
QFS_f	quantity supplied of factor f .
QG_c	government consumption demand for commodity c .
QH_{ch}	quantity of consumption of marketed commodity c for household h .
$QINTA_a$	quantity of aggregate intermediate input in activity a .
$QINT_{ca}$	quantity of commodity c as intermediate input to activity a .
$QINV_c$	quantity of investment demand for commodity c .
QM_{cr}	quantity of imports of commodity c for trading partner r .
QQ_c	quantity of composite good c supplied to the domestic market.
QT_c	quantity of commodity c demanded as trade input

QVA_a	quantity of aggregate value-added in activity a .
QX_c	aggregate quantity of domestic output of commodity c .
$QXAC_{ac}$	marketed output quantity of commodity c from activity a .
$REXR$	real exchange rate.
$TABS$	total nominal absorption.
$TRII_{ii'}$	transfers from institution i' to institution i .
WF_f	economy-wide wage for factor f (for wage labour in the whole solution and capital in the dynamic solution).
$WFDIST_{fa}$	wage-distortion factor for factor f (for capital in the static solution) in activity a .
$WFDISTK_{ka}$	activity-shares of average economy-wide rental on all capital.
$WFKAV_k$	average economy-wide rental on all capital.
$WFREAL_f$	economy-wide real consumption wage of factor f (for non-wage labour in the whole solution and capital in the static solution).
YF_f	income of factor f .
YG	government revenue.
YI_i	income of non-government institution i .
YIF_{if}	income transferred to domestic institution i from factor f .

Model equation blocks

Price system block

$$PM_{rc} = pwm_{rc} \cdot EXR \cdot (1 + tm_{rc}) + \sum_{c' \in CT} PQ_{c'} \cdot icm_{c'c} \quad c \in CM, r \in R \quad (1)$$

$$PE_{cr} = pwe_{cr} \cdot EXR \cdot (1 - te_{cr}) + \sum_{c' \in CT} PQ_{c'} \cdot ice_{c'c} \quad c \in CE, r \in R \quad (2)$$

$$PDD_c = PDS_c + \sum_{c' \in CT} PQ_{c'} \cdot icd_{c'c} \quad c \in CD \quad (3)$$

$$PQ_c \cdot (1 - tq_c) \cdot QQ_c = PDD_c \cdot QD_c + \sum_{r \in R} (PM_{rc} \cdot QM_{rc}) \quad c \in (CD \cup CM) \quad (4)$$

$$PX_c \cdot QX_c = PDS_c \cdot QD_c + \sum_{r \in R} (PE_{cr} \cdot QE_{cr}) \quad c \in CX \quad (5)$$

$$PA_a = \sum_{c \in C} PXAC_{ac} \cdot \theta_{ac} \quad a \in A \quad (6)$$

$$PINTA_a = \sum_{c \in C} PQ_c \cdot ica_{ca} \quad a \in A \quad (7)$$

$$PA_a \cdot (1 - ta_a) \cdot QA_a = PVA_a \cdot QVA_a + PINTA_a \cdot QINTA_a \quad a \in A \quad (8)$$

$$CPI = \sum_{c \in C} PQ_c \cdot cwts_c \quad (9)$$

$$\overline{DPI} = \sum_{c \in C} PDS_c \cdot dwts_c \quad (10)$$

$$PDI = \left(\sum_{c \in C} PDD_c \cdot pdwt_c \right) \quad (11)$$

$$PWI = (pwewt \cdot pwei) + (pwmwt \cdot pwmi) \quad (12)$$

$$REXR = EXR \cdot \frac{PWI}{PDI} \quad (13)$$

Production technology block

$$QA_a = \alpha_a^a \cdot \left(\delta_a^a \cdot QVA_a^{-\rho_a} + (1 - \delta_a^a) \cdot QINTA_a^{-\rho_a} \right)^{\frac{1}{\rho_a}} \quad a \in A \quad (14)$$

$$\frac{QVA_a}{QINTA_a} = \left(\frac{PINTA_a}{PVA_a} \cdot \frac{\delta_a^a}{1 - \delta_a^a} \right)^{\frac{1}{1 + \rho_a}} \quad a \in A \quad (15)$$

$$QVA_a = \alpha_a^{va} \cdot \left(\sum_{fa \in F} \delta_{fa}^{va} \cdot \overline{QF}_{fa}^{-\rho_a^{va}} \right)^{-\frac{1}{\rho_a^{va}}} \quad \begin{matrix} a \in A \\ a \in ALNMO \end{matrix} \quad (16a)$$

$$QVA_a = \alpha_a^{va} \cdot \left(\sum_{fa \in F} \delta_{fa}^{va} \cdot QF_{fa}^{-\rho_a^{va}} \right)^{-\frac{1}{\rho_a^{va}}} \quad \begin{matrix} a \in A \\ a \in ALMO \end{matrix} \quad (16b)$$

$$QINT_{ca} = ica_{ca} \cdot QINTA_a \quad a \in A, c \in C \quad (17)$$

$$\overline{WF}_k \cdot WFDIST_{ka} = PVA_a \cdot (1 - tva_a) \cdot QVA_a \cdot \left(\sum_{k \in K} \delta_{ka}^{va} \cdot \overline{QF}_{ka}^{-\rho_a^{va}} \right)^{-1} \cdot \delta_{ka}^{va} \cdot \overline{QF}_{ka}^{-\rho_a^{va}-1} \quad a \in A, k \in K \quad (18a)$$

$$\overline{WF}_l \cdot WFDIST_{la} = PVA_a \cdot (1 - tva_a) \cdot QVA_a \cdot \left(\sum_{l \in L} \delta_{la}^{va} \cdot \overline{QF}_{la}^{-\rho_a^{va}} \right)^{-1} \cdot \delta_{la}^{va} \cdot \overline{QF}_{la}^{-\rho_a^{va}-1} \quad a \in ALNMO, l \in LNMO \quad (18b)$$

$$\overline{WF}_l \cdot \overline{WFDIST}_{la} = PVA_a \cdot (1 - tva_a) \cdot QVA_a \cdot \left(\sum_{l \in L} \delta_{la}^{va} \cdot QF_{la}^{-\rho_a^{va}} \right)^{-1} \cdot \delta_{la}^{va} \cdot QF_{la}^{-\rho_a^{va}-1} \quad \begin{matrix} a \in A, l \in LNWA \\ a \in ALMO, l \in LMO \end{matrix} \quad (18b)$$

$$WF_l \cdot \overline{WFDIST}_{la} = PVA_a \cdot (1 - tva_a) \cdot QVA_a \cdot \left(\sum_{l \in L} \delta_{la}^{va} \cdot QF_{la}^{-\rho_a^{va}} \right)^{-1} \cdot \delta_{la}^{va} \cdot QF_{la}^{-\rho_a^{va}-1} \quad a \in A, l \in LWA \quad (18c)$$

$$WFKAV_k = \sum_{a \in A} (\overline{WF}_k \cdot WFDIST_{ka}) \cdot \overline{capsh}_{ka} \quad k \in K \quad (19)$$

$$WFDISTK_{ka} = \frac{\overline{WF}_k \cdot WFDIST_{ka}}{WFKAV_k} \quad a \in A, k \in K \quad (20)$$

$$WFREAL_k = \overline{WF}_k / CPI \quad k \in K \quad (21a)$$

$$WFREAL_l = WF_l / CPI \quad l \in LMO \quad (21b)$$

$$WFREAL_l = \overline{WF}_l / CPI \quad \begin{matrix} l \in LNWA \\ l \in LNMO \end{matrix} \quad (21c)$$

$$\overline{WFREAL}_l = WF_l / CPI \quad l \in LWA \quad (21d)$$

Commodity market block

$$QXAC_{ac} = \theta_{ac} \cdot QA_a \quad a \in A, c \in CX \quad (22)$$

$$QX_c = \sum_{a \in A} QXAC_{ac} \quad c \in CX \quad (23)$$

$$QX_c = \alpha_c^e \cdot \left(\sum_{r \in R} \delta_{cr}^e \cdot QE_{cr}^{\rho_c^e} + (1 - \sum_{r \in R} \delta_{cr}^e) \cdot QD_c^{\rho_c^e} \right)^{\frac{1}{\rho_c^e}} \quad c \in (CE \cap CD) \quad (24)$$

$$\frac{QE_{cr}}{QD_c} = \left(\frac{PE_{cr}}{PDS_c} \cdot \frac{1 - \sum_{r \in R} \delta_{cr}^e}{\delta_{cr}^e} \right)^{\frac{1}{\rho_c^e - 1}} \quad c \in (CE \cap CD), r \in R \quad (25)$$

$$QX_c = QD_c \quad c \in (CD \cap CEN) \quad (26)$$

$$QE_{cr} = \alpha_{cr}^e \cdot \left(\frac{PW_{cr}}{pwe_{cr}} \right)^{\rho_{cr}^e} \quad c \in (CE \cap CD), r \in R \quad (27)$$

$$QQ_c = \alpha_c^m \cdot \left(\sum_{r \in R} \delta_{rc}^m \cdot QM_{rc}^{-\rho_c^m} + (1 - \sum_{r \in R} \delta_{rc}^m) \cdot QD_c^{-\rho_c^m} \right)^{-\frac{1}{\rho_c^m}} \quad c \in (CM \cap CD), r \in R \quad (28)$$

$$\frac{QM_{rc}}{QD_c} = \left(\frac{PDD_c}{PM_{rc}} \cdot \frac{\delta_{rc}^m}{1 - \sum_{r \in R} \delta_{rc}^m} \right)^{\frac{1}{1 + \rho_c^m}} \quad c \in (CM \cap CD), r \in R \quad (29)$$

$$QQ_c = QD_c \quad c \in (CD \cap CMN) \quad (30)$$

$$QT_c = \sum_{r \in R} \sum_{c' \in C'} (icm_{cc'} \cdot QM_{rc'} + ice_{cc'} \cdot QE_{c'r} + icd_{cc'} \cdot QD_{c'}) \quad c \in CT \quad (31)$$

Income and expenditure block

$$YF_k = \sum_{a \in A} \overline{WF}_k \cdot WFDIST_{ka} \cdot \overline{QF}_{ka} \quad k \in K \quad (32a)$$

$$YF_l = \sum_{a \in A} \overline{WF}_l \cdot WFDIST_{la} \cdot \overline{QF}_{la} \quad l \in LNMO \quad (32b)$$

$$YF_l = \sum_{a \in A} \overline{WF}_l \cdot \overline{WFDIST}_{la} \cdot \overline{QF}_{la} \quad l \in LNWA \quad (32c)$$

$$YF_l = \sum_{a \in A} \overline{WF}_l \cdot \overline{WFDIST}_{la} \cdot \overline{QF}_{la} \quad l \in LWA \quad (32d)$$

$$YIF_{if} = shif_{if} \cdot [YF_f - (\sum_{r \in R} trnsfr_{rf} \cdot EXR)] \quad i \in INSD, f \in F \quad (33)$$

$$YI_i = \sum_{f \in F} YIF_{i,f} + \sum_{i' \in INSDNG} TRII_{i,i'} + (trnsfr_{i,gov} \cdot CPI) + (\sum_{r \in R} trnsfr_{ir} \cdot EXR) \quad i \in INSDNG \quad (34)$$

$$TRII_{i,i'} = shii_{i,i'} \cdot (1 - MPS_{i'}) \cdot (1 - \overline{tins}_{i'}) \cdot YI_{i'} \quad i \in INSDNG, i' \in INSDNG' \quad (35)$$

$$EH_h = \left(1 - \sum_{i \in INSDNG} shii_{ih} \right) \cdot (1 - MPS_h) \cdot (1 - \overline{tins}_h) \cdot YI_h \quad h \in H \quad (36)$$

$$QH_{ch} = \gamma_{ch} + \frac{\beta_{ch} \cdot \left(EH_h - \sum_{c \in C} PQ_c \cdot \gamma_{ch} \right)}{PQ_c} \quad c \in C, h \in H \quad (37)$$

$$QINV_c = \overline{qinv}_c \cdot IADJ \quad c \in C \quad (38)$$

$$\begin{aligned} YG = & \left(\sum_{i \in INSDNG} \overline{tins}_i \cdot YI_i \right) + \left(\sum_{a \in A} tva_a \cdot PVA_a \cdot QVA_a \right) + \left(\sum_{a \in A} ta_a \cdot PA_a \cdot QA_a \right) \\ & + \left(\sum_{r \in R} \sum_{c \in CM} tm_{rc} \cdot EXR \cdot pwm_{rc} \cdot QM_{rc} \right) + \left(\sum_{c \in CE} \sum_{r \in R} te_{cr} \cdot EXR \cdot pwe_{cr} \cdot QE_{cr} \right) \\ & + \left(\sum_{c \in C} tq_c \cdot PQ_c \cdot QQ_c \right) + \left(\sum_{r \in R} trnsfr_{gov,r} \cdot EXR \right) \end{aligned} \quad (39)$$

$$EG = \sum_{c \in C} PQ_c \cdot QG_c + \sum_{i \in INSDNG} trnsfr_{i, gov} \cdot CPI \quad (40)$$

System constraint block for static solution and real investment

$$QFS_k = \sum_{a \in A} \overline{QF}_{ka} \quad k \in K \quad (41a)$$

$$QFS_l = \sum_{a \in A} \overline{QF}_{la} \quad l \in LNMO \quad (41b)$$

$$QFS_l = \sum_{a \in A} \overline{QF}_{la} \quad l \in LWA \quad (41c)$$

$$QQ_c = \sum_{a \in A} QINT_{ca} + \sum_{h \in H} QH_{ch} + QG_c + QINV_c + qdst_c + QT_c \quad c \in C \quad (42)$$

$$\begin{aligned} & \sum_{r \in R} \sum_{c \in CM} pwm_{rc} \cdot QM_{rc} + \sum_{r \in R} \sum_{f \in F} trnsfr_{rf} = \sum_{r \in R} \sum_{c \in CE} pwe_{cr} \cdot QE_{cr} \\ & + \sum_{i \in INSDNG} \sum_{r \in R} trnsfr_{ir} + FSAV \end{aligned} \quad (43)$$

$$FSAV = \overline{KFLOW} + \overline{FDI} \quad (44)$$

$$YG = EG + GSAV \quad (45)$$

$$\begin{aligned} & \left[\sum_{i \in INSDNG} MPS_i \cdot (1 - \overline{tins}_i) \cdot YI_i \right] + GSAV + (EXR \cdot FSAV) = \\ & \sum_{c \in C} PQ_c \cdot QINV_c + \sum_{c \in C} PQ_c \cdot qdst_c \end{aligned} \quad (46)$$

$$MPS_i = \overline{mps}_i + DMPS \quad i \in INSDNG \quad (47)$$

$$PK = \sum_{c \in C} PQ_c \cdot \overline{qinvsh}_c \quad (48)$$

$$IREAL_k = \left(\sum_{c \in C} PQ_c \cdot QINV_c \right) / PK \quad (49)$$

$$\begin{aligned} TABS = & \sum_{h \in H} \sum_{c \in C} PQ_c \cdot QH_{ch} + \sum_{c \in C} PQ_c \cdot QG_c + \sum_{c \in C} PQ_c \cdot QINV_c \\ & + \sum_{c \in C} PQ_c \cdot qdst_c \end{aligned} \quad (50)$$

$$\overline{INVSHR} \cdot TABS = \sum_{c \in C} PQ_c \cdot QINV_c + \sum_{c \in C} PQ_c \cdot qdst_c \quad (51)$$

$$\overline{GOVSHR} \cdot TABS = \sum_{c \in C} PQ_c \cdot QG_c \quad (52)$$

Investment allocation, capital accumulation and equations changed for dynamic solution (t stands for period and excludes first within-period equilibrium solution)

$$INVSH_{ka,t} = \overline{capsh}_{ka} \cdot [1 + \kappa \cdot (WFDISTK_{ka,t-1} - 1)] \quad a \in A, k \in K \quad (53)$$

$$QVA_a = \alpha_a^{va} \cdot \left(\sum_{f \in F} \delta_{fa}^{va} \cdot QF_{fa}^{-\rho_a^{va}} \right)^{-\frac{1}{\rho_a^{va}}} \quad a \in A \quad (54)$$

$$\begin{aligned} & WF_k \cdot \overline{WFDIST}_{ka} = \\ & PVA_a \cdot (1 - tva_a) \cdot QVA_a \cdot \left(\sum_{k \in K} \delta_{ka}^{va} \cdot QF_{ka}^{-\rho_a^{va}} \right)^{-1} \cdot \delta_{ka}^{va} \cdot QF_{ka}^{-\rho_a^{va}-1} \end{aligned} \quad a \in A, k \in K \quad (55)$$

$$YF_k = \sum_{a \in A} WF_k \cdot \overline{WFDIST}_{ka} \cdot QF_{ka} \quad k \in K \quad (56)$$

$$WFKAV_k = \sum_{a \in A} (WF_k \cdot \overline{WFDIST}_{ka}) \cdot \overline{capsh}_{ka} \quad k \in K \quad (57)$$

$$WFDISTK_{ka} = \frac{WF_k \cdot \overline{WFDIST}_{ka}}{WFKAV_k} \quad a \in A, k \in K \quad (58)$$

$$WFREAL_k = WF_k / CPI \quad k \in K \quad (59)$$

$$IREALAC_{ka,t} = INVSH_{ka,t} \cdot IREAL_{k,t-1} \quad a \in A, k \in K \quad (60)$$

$$KGR_{k,t} = \frac{IREAL_{k,t-1}}{QFS_{k,t-1}} - \bar{d} \quad k \in K \quad (61)$$

$$KGRAC_{ka,t} = \frac{IREALAC_{ka,t}}{QF_{ka,t-1}} - \bar{d} \quad a \in A, k \in K \quad (62)$$

$$QFS_{k,t} = QFS_{k,t-1} \cdot (1 + KGR_{k,t}) \quad k \in K \quad (63)$$

$$QF_{ka,t} = QF_{ka,t-1} \cdot (1 + KGRA_{ka,t}) \quad a \in A, k \in K \quad (64)$$

$$QFS_k = \sum_{a \in A} QF_{ka} \quad a \in A, k \in K \quad (65)$$

$$\begin{aligned} & (\overline{WF}_l \cdot \overline{WFDIST}_{la,t}) \cdot [1 + (CPI_t - CPI_{t-1}) \cdot inadj_{la}] = \\ & \left[PVA_a \cdot (1 - tva_a) \cdot QVA_a \cdot \left(\sum_{l \in L} \delta_{la}^{va} \cdot QF_{la}^{-\rho_a^{va}} \right)^{-1} \cdot \delta_{la}^{va} \cdot QF_{la}^{-\rho_a^{va}} - 1 \right]_t \end{aligned} \quad \begin{array}{l} a \in ALMO, \\ l \in LWAUSK \end{array} \quad (66a)$$

$$\begin{aligned} & (\overline{WF}_l \cdot \overline{WFDIST}_{la,t}) \cdot [1 + (CPI_t - CPI_{t-1}) \cdot inadj_{la}] = \\ & \left[PVA_a \cdot (1 - tva_a) \cdot QVA_a \cdot \left(\sum_{l \in L} \delta_{la}^{va} \cdot QF_{la}^{-\rho_a^{va}} \right)^{-1} \cdot \delta_{la}^{va} \cdot QF_{la}^{-\rho_a^{va}} - 1 \right]_t \end{aligned} \quad a \in APU, l \in LSK \quad (66b)$$

$$QFS_{l,t} = QFS_{l,t-1} \cdot (1 + lfgr_{l,t}) \quad l \in L \quad (67)$$