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Do Regional Trade Pacts Benefit the Poor?

An Illustration from the Dominican Republic-Central American Free Trade Agreement in Nicaragua

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Abstract

The main objective of this paper is to provide an *ex-ante* assessment of the poverty and income distribution impacts of the Central American Free Trade Area agreement on Nicaragua. A general equilibrium macro model is used to simulate trade reform scenarios and estimate their price effects, while a micro-module maps these price changes into real income changes at the individual household level. A useful insight from this analysis is that even if the final total impact on poverty is not too large, its dispersion across households – due to their heterogeneity of factor endowments, inputs use, commodity production, and consumption preferences – is significant and should be taken into account when designing compensatory policies. Additionally, growth and redistribution decomposition shows that, at least in the short to medium run, redistribution can be as important as growth. The main policy message that emerges from the paper is that Nicaragua should consider enlarging its own liberalization to countries other than the U.S. to boost trade-induced poverty reductions.

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1 Introduction

The debate on the Dominican Republic - Central American Free Trade Agreement (DR-CAFTA) between the U.S., five Central American countries (Costa Rica, Guatemala, Honduras, Nicaragua, and El Salvador), and the Dominican Republic has been heated by the usual arguments surrounding recent trade deals. A seemingly persuasive argument against these deals is that although new jobs in Central America may be generated, this may be done at the expense of American jobs and to the detriment of local workers hired in jobs that do not comply with minimum labor standards.[1] The persuasiveness of this argument comes from its partiality; the argument considers only the distributional effects of trade reforms and the fact that these reforms create winners and losers, with the poor being most likely to be the latter. Similarly, the pro-trade-deals assumptions that free trade indisputably favors growth and that growth trickles down to the poor are partial and deserve scrutiny. A careful assessment of whether trade reform can be beneficial to poor people and what can be done in the short-term to correct potential anti-poor effects is needed to settle the debate, but it is also a difficult task.

There are various channels through which trade liberalization affects the poor as discussed in conceptual terms by McCulloch, Winters and Cirera (2001), although empirical evidence is rather thin, disparate and piecemeal. In this study, a numerical simulation model – a computable general equilibrium (CGE) model – in conjunction with a non-behavioral micro-simulation module based on household survey data for Nicaragua[2] is used to estimate *ex-ante* the effects of a DR-CAFTA-like trade shock on poverty. The CGE model has the advantage of being a counterfactual analysis tool that can generate price effects which are directly and unequivocally linked to a trade reform. The changes in relative factor prices (particularly between labor and capital remunerations, and between skilled and unskilled labor wages) and relative goods prices (such as between food and non-food items) are then linked to the household survey to generate income distribution effects. This methodology does not maintain full

[1] See Elizabeth Becker's CAFTA article on the New York Times article, April 6th, 2004.
[2] For similar modeling frameworks see Ravallion and Chen (2004), Nicita and Olarreaga (2004), Bussolo, Lay, and van der Mensbrugghe (2005), Bussolo and Medvedev (2005), Hertel *et al*. (2004), Ianchovichina *et al*. (2001).

consistency between the micro data and the CGE results; however, by combining the two, it maps aggregate results from the CGE to the detailed information available in the household survey and provides a much more nuanced and useful analysis of poverty impact. This approach also allows decomposing the total effect on poverty into an aggregate income growth component and a redistribution component.

A useful insight from this analysis is that even if the total impact on poverty is not too large, its dispersion across households – due to their heterogeneity of factor endowments, inputs use, commodity production, and consumption preferences – is significant and this should help in designing compensatory policies. Additionally, our growth and redistribution decomposition shows that, at least in the short to medium run, redistribution can be as important as growth.

The paper is structured as follows: section 2 presents the CGE model, the micro module and the relevant data. The first part of section 3 describes the general equilibrium results of the trade policy shocks, and the second part the poverty implications. The final section presents some conclusions.

2 Measuring the effects of trade reforms on poverty: linking a CGE model to household surveys

This section describes the main features of the CGE model and household survey micro-simulation module.

The Nicaragua general equilibrium model and its data

A 2000 Social Accounting Matrix (SAM) represents the initial benchmark equilibrium for the CGE model. This SAM, which includes 39 sectors, 39 commodities, 3 factors (skilled and unskilled labor and one composite capital), an aggregate household account, and other accounts (government, savings and investment, and the Rest of the World), has been assembled from various sources incorporating data from the 2000 Input-Output Table and the 2001 Living Standards Measurement Survey (LSMS). As

explained in more detail in the results section, the quality of the initial dataset represented by this SAM directly influences the quality of the model results. For this reason, particular attention has been devoted in estimating the value added, trade, and tariff components of the SAM.[3]

The CGE model is based on a standard neoclassical general equilibrium model, i.e. a model that combines the standard consumer and producer theories and the Heckscher-Ohlin-Samuelson trade theory with a compatible data-set for a specific country, and the following subsections describe its main features.

Production. Output results from nested CES (Constant Elasticity of Substitution) functions that, at the top level, combine intermediate and value added aggregates. At the second level, the intermediate aggregates are obtained combining all products in fixed proportions (Leontief structure), and the value added is an aggregation of the primary factors. The full structure of production nests is shown in the annex.

Income Distribution and Absorption. Labor income and capital revenues are allocated to households according to a fixed coefficient distribution matrix derived from the original SAM. One of the main advantages of using the micro-module is to enrich this rather crude macro distribution mechanism. Private consumption demand is obtained through maximization of household specific utility function following the Linear Expenditure System (LES). Household utility is a function of consumption of different goods. Once their total value is determined, government and investment demands[4] are disaggregated into sectoral demands according to fixed coefficient functions.

International Trade. The model assumes imperfect substitution among goods originating in different geographical areas.[5] Import demand results from a CES aggregation function of domestic and imported goods. Export supply is symmetrically modeled as a Constant Elasticity of Transformation (CET) function. Producers allocate their output to domestic or foreign markets according to relative prices. Under the small country assumption, Nicaragua is unable to influence world prices and its imports and exports prices are treated as exogenous. Assumptions

[3] For more details on the SAM, see Bussolo (2004) and the Annex to this paper.
[4] Aggregate investment is set equal to aggregate savings, while aggregate government expenditures are exogenously fixed.
[5] See Armington (1969) for details.

of imperfect substitution and imperfect transformability grant a certain degree of autonomy of domestic prices with respect to foreign prices and prevent the model from generating corner solutions. Furthermore, they permit the model from cross-hauling a feature normally observed in real economies. The balance of payments equilibrium is determined by the equality of foreign savings (which are exogenous) to the value of the current account. With fixed world prices and capital inflows, all adjustments are accommodated by changes in the real exchange rates: increased import demand, due to trade liberalization, must be financed by increased exports, and these can expand due to improved resource allocation. Price decreases in importables drive resources toward export sectors and contribute to falling domestic resource costs (or real exchange rate depreciation).

Factor Markets. Labor is divided into two categories: skilled and unskilled. These categories are considered imperfectly substitutable inputs in the production process. Moreover, some degree of market segmentation is assumed: composite capital is sector specific, and labor markets are segmented between agriculture and non-agriculture, with labor fully mobile within each of the two broad sectors, but fully immobile across them. These restrictive conditions are imposed on the modeling framework so that it mimics in the best possible and least contentious way the short-term impact of trade reforms on the Nicaraguan economy. Dynamic features, market imperfections, and other complications could be introduced. However, questions about the links between trade policy and growth would emerge and, although important, is a much more difficult issue.[6] Finally, the segmented version of the model also facilitates linking the macro results of the CGE model to the household survey micro-model, where households are not allowed to respond to price changes by migrating, increasing their human capital endowments, or even changing their consumption choices.

The labor market specification is a key element of the model and an important driver of poverty and distributional results. Therefore, its specification calls for some clarification and justification. The labor market skill segmentation[7] has become a

[6] No systematic analysis of the ex-ante predictions of CGE studies exists; however, a few papers have evaluated these models' performance in predicting the NAFTA outcomes and have found that they did not score too well, especially in terms of sectoral reallocations (i.e., relative growth rates of exports and production). Generally, these studies highlight that introducing dynamic effects in these models is very difficult. For an example of these studies on NAFTA see Kehoe (2003).

[7] See Taubman and Wachter (1986) for a general discussion of labor market segmentation.

standard assumption in CGE modeling and it is easily justifiable for the case of Nicaragua, where inequalities in educational endowments and access to education support this assumption.

The assumption that the market for labor is further segmented into agricultural and non-agricultural activities is more controversial. To test its validity, we check whether incomes in agriculture are still below incomes in other sectors once the following wage determinants are controlled for: education, experience, gender, and employment-status variables such as self-employment. Additionally, to account for price differentials across space, geographical variables capturing differences among Nicaraguan regions are included in the wage estimation. Taking the largest non-agricultural sector of employment, "commerce", as a reference group, the regression analysis shows that agricultural individual labor incomes are significantly below this reference group and the gap widens between unskilled and skilled workers.

Table 1: Estimation results for the labor market segmentation

Wage equation for testing segmentation hypothesis - Unskilled							**Skilled**					
No. of obs.	1255652						No. of obs.	3E+05				
F(15, 1255636)	13677						F(15, 318350)	9144				
Prob > F	0.0000						Prob > F	0				
R-squared	0.1431						R-squared	0.302				
Root MSE	1.2071						Root MSE	1.105				
	Coef.	**Robust Std. Err.**	**t**	**P>|t|**	**[95% Confi. Interval]**		**Coef.**	**Robust Std. Err.**	**t**	**P>|t|**	**[95% Confi. Interval]**	
Individual characteristics												
Years of schooling	0.060	3.09E-04	194.8	0.000	0.0596	0.0608	0.227	9.82E-04	230.8	0.000	0.2246	0.2285
Experience	0.069	2.45E-04	279.9	0.000	0.0681	0.0691	0.078	6.50E-04	120.1	0.000	0.0767	0.0793
Experience squared	-0.001	3.47E-06	-227.0	0.000	-0.0008	-0.0008	-0.001	1.59E-05	-68.5	0.000	-0.0011	-0.0011
Female	-0.393	0.003	-149.1	0.000	-0.3983	-0.3880	-0.411	0.004	-101.6	0.000	-0.4188	-0.4029
Geographical dummies												
urban (Managua)	0.192	0.003	73.5	0.000	0.1868	0.1970	0.044	0.006	7.6	0.000	0.0328	0.0557
Pacific	-0.131	0.003	-45.5	0.000	-0.1365	-0.1252	-0.195	0.005	-40.0	0.000	-0.2050	-0.1858
Central	-0.173	0.003	-54.3	0.000	-0.1795	-0.1670	-0.157	0.005	-31.0	0.000	-0.1672	-0.1473
Atalantic	0.053	0.004	12.6	0.000	0.0448	0.0613	-0.041	0.008	-5.1	0.000	-0.0563	-0.0250
Self-employed	-0.146	0.003	-56.9	0.000	-0.1506	-0.1406	-0.438	0.006	-76.8	0.000	-0.4489	-0.4266
Sectoral dummies												
Agriculture	-0.504	0.003	-145.7	0.000	-0.5111	-0.4975	-0.578	0.012	-48.3	0.000	-0.6012	-0.5543
Mining and gas	-0.021	0.009	-2.3	0.022	-0.0398	-0.0031	0.483	0.008	62.8	0.000	0.4684	0.4986
Manufacturing	-0.150	0.003	-43.3	0.000	-0.1563	-0.1428	-0.283	0.008	-37.5	0.000	-0.2981	-0.2685
Construction (Commerce)	-0.258	0.005	-53.8	0.000	-0.2673	-0.2485	-0.601	0.013	-47.7	0.000	-0.6260	-0.5765
Services	-0.222	0.004	-61.8	0.000	-0.2288	-0.2147	-0.001	0.007	-0.1	0.922	-0.0140	0.0127
Government services	0.023	0.005	4.2	0.000	0.0122	0.0338	-0.390	0.005	-73.7	0.000	-0.4008	-0.3800
Constant	7.899	0.006	1411.2	0.000	7.8881	7.9100	6.801	0.014	497.7	0.000	6.7739	6.8275

There can be a number of reasons for observing this income gap between agricultural and non-agricultural employment. One explanation may be that agricultural income, in particular from self-employment, is systematically underreported. However, we control for this by including a self-employed dummy, which in fact shows a negative sign in support of this hypothesis. Another explanation for the sectoral income differential may lie in positive externalities associated with agricultural employment. Examples of such externalities include food self-sufficiency and employment opportunities for other family members. Yet, one can also easily think of negative externalities of agricultural employment, such as the exposure to weather shocks or hard physical work. These externalities are difficult if not impossible to quantify.

If we accept the existence of an income differential between agriculture and non-agricultural sectors, the question then becomes why individuals do not respond to this differential by moving to the non-agricultural sector until incomes in both sectors equalize. A likely answer is that there must be barriers to mobility between agricultural and non-agricultural employment and that these barriers are relevant to the period under our analysis. A potentially important factor that may act as a barrier to mobility, although we do not test for this hypothesis, is represented by the specificity of human capital acquired in the agricultural sector.[8]

Model Closures. The equilibrium condition on the balance of payments is combined with other closure conditions so that the model can be solved for each period. First, consider the government budget. Its surplus is fixed and the household income tax schedule shifts in order to achieve the predetermined net government position. Second, investment must equal savings, which originate from households, corporations, government and the Rest of the World. Aggregate investment is set equal to aggregate savings, while aggregate government expenditures are exogenously fixed.

[8] Results in Table 1 show that wage differentials also exist across other sectors. One could thus argue that sectoral segmentation affects labor markets beyond our assumption of the two agricultural and non-agricultural segments. However, without additional analysis, mobility barriers among say, services and manufacturing, seem less plausible and, judging from the sectoral dummies' coefficients in the estimations, seem lower than those between agriculture and the rest of the economy.

The micro module: linking household surveys to the CGE model

Poverty effects of trade reforms are estimated using a top-down approach. Initially the CGE model calculates the new equilibrium (i.e., new relative prices and quantities for factors and commodities) following a trade shock. Then prices are transferred to the micro module to estimate a new income distribution and poverty effects are calculated. No feedback from the micro module to the macro model is explicitly accounted for in this version. The following equation[9] represents the core of the micro module:

$$\frac{\partial W_h}{Y_h} = \underbrace{\sum_g -\theta_{h,g}^c \dot{p}_g}_{consumption} + \underbrace{\theta_h^\ell \dot{w}}_{labor\ \text{income}} + \underbrace{\theta_h^R \dot{w}}_{remit\ \text{tances}} + \underbrace{\theta_h^{kap} \dot{\pi}}_{profits} + \underbrace{\sum_g \theta_{h,g}^T \left(\dot{t}_g + \dot{m}_g\right)}_{tariff\ \text{revenue}} \qquad (1)$$

where the relative gains or losses (W represents welfare) for each household (h) depend on: 1) changes in prices for purchased goods (p_g, where a dot represents percentage change) and the initial share of expenditure on each good ($\theta_{h,g}^c$); 2) changes in factor returns (w stands for returns to skilled and unskilled labor, and π is returns to capital) and the shares of total initial income by source (θ_h^ℓ and θ_h^{kap}); 3) remittances and other transfers which depend on the wage rate and the government revenues. Income by source is calculated for each member of the household, and the above equation, to keep notation simple, shows results after aggregating incomes for each individual in the same household. Once the changes in welfare are calculated, a new distribution of income is generated and this counterfactual distribution is then compared to the initial distribution.

The main advantage of this approach is that it takes into account important sources of heterogeneity across households given that the structure of income by type and the composition of consumption by commodity, the various θ's in the above equation, are household specific. A large literature on trade and poverty[10] has shown that changes in the distribution of income (or consumption) might differ considerably across different

[9] The formal derivation of this equation is presented in the Annex to this paper.
[10] See Winters et al (2004) for an excellent survey.

groups of households and that predetermined groupings may not capture the whole spectrum of possible outcomes. Poor households themselves are poor for different reasons and designing compensatory policies that are targeted to the right recipients can be greatly facilitated by having a whole new counterfactual distribution. In the new distribution, households, as well as individuals, can be identified according to the full set of socio-economic characteristics recorded in the survey. It is thus easier to identify a specific characteristic – such as region of residence, employment status, gender, education, age, etc. – that may strongly correlate with larger than average losses from the trade policy reform and then use this information in targeting compensatory measures.

Clearly how this new counterfactual distribution is generated is rather important. The above equation only considers first order effects and excludes important second order mechanisms that may account for large income changes. Specifically, movements in and out of employment or across sectors of production are excluded as well as substitution in consumption, although not accounting for the latter does not normally result in large errors. This approach is better suited to estimating short run impacts and it may overestimate the effects of a trade shock, given that quantity adjustments and substitutions are ruled out. Acknowledging these limitations, the main advantages are transparency and low data requirements, and ease of implementation.

Equation (1) implies that, for each household, individual incomes can be readily imputed to the relevant factors of production, namely the two labor types and the composite capital. This is fairly straightforward for urban wage-workers. However, for a large group of the Nicaraguan population this imputation is not obvious. As explained in the next subsection, disaggregating income for the self-employed workers in the farm sector can be a laborious and error prone procedure; the labor and capital components are not often easily separable. For households whose heads belong to this group of workers, an approach that bypasses this imputation has been used. This is represented by the following equation:

$$\frac{\partial W}{Y} = \left[\sum_j \theta_j^O \dot{p}_j^O - \sum_k \theta_k^I \dot{p}_k^I \right] + \sum_f \theta_f^w \dot{w}_f - \sum_g \theta_g^C \dot{p}_g^C \qquad (2)$$

where, as before, the relative change in welfare is represented by a change in consumption (the last term in the left hand side of the equation), by a change in explicit wage earnings and by profit generated via the activity run by the household (the term in squared brackets). This is estimated as the difference between sales (holding constant the quantity shares of the different goods sold θ_j^O) and input costs (again without changing the structure of input quantities θ_j^I).

Finally, it should be noted that the consumption of home production (auto-consumption hereafter) has been explicitly excluded from the computations in both equations (1) and (2) given that price changes – in the short run, and those of the order of magnitude considered here – do not affect it. In terms of equation (2), this means that not only does final consumption need to exclude auto-consumption, but also that input costs have to be netted of the costs related to production for auto-consumption.

Household survey data preparation and brief description of the pre-liberalization income distribution

The household survey used for the computations is the LSMS 2001 for Nicaragua. At the individual level, the active employed population aged more than 12 years are classified into skilled and unskilled according to their education level. The employed population is also classified into wage-workers and self-employed. For wage-workers, the entire factor-related income is either unskilled or skilled labor income.

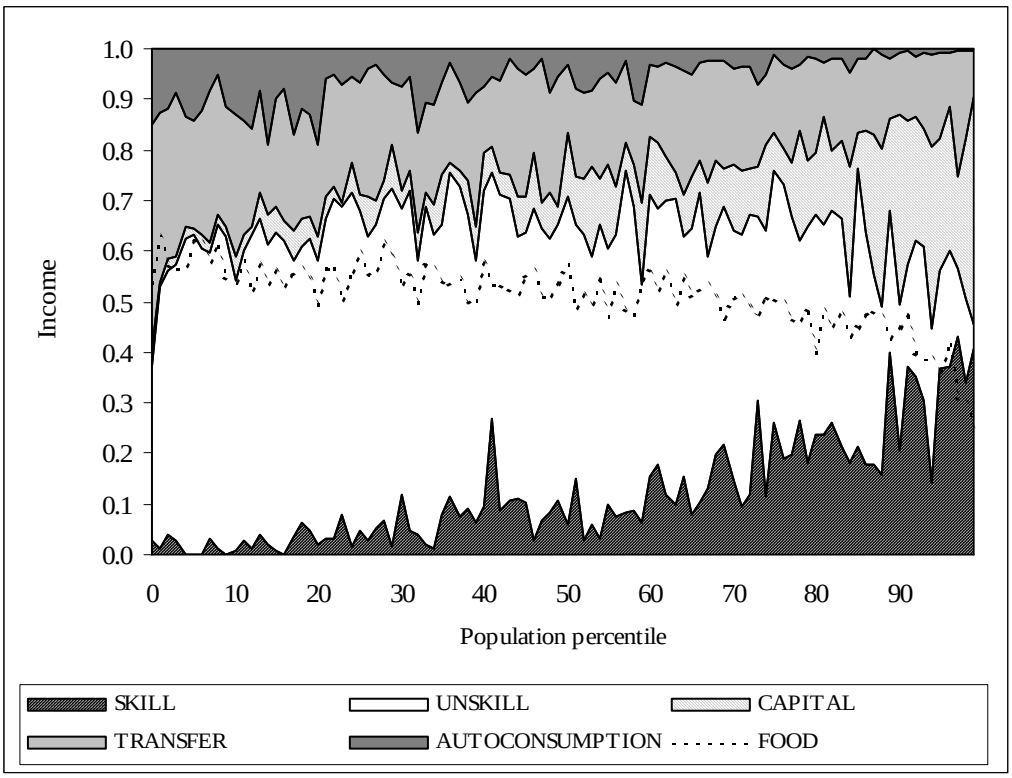
In the first stage, we assume that income reported by the self-employed is assumed to have both a labor and a capital component. To separate these two components, a wage for the self-employed is imputed based on a wage equation that is estimated for the wage-workers separately for rural and urban areas. The wage equation is a simple Mincerian wage equation with log wage earnings as the dependent variable and education, education squared, age, age squared, and additional regional and sectoral dummies as explanatory variables. The coefficients of these wage equations are then used to impute a wage for the self-employed. The difference between the reported income from self-employment and the imputed wage is assumed to represent the capital

component of self-employment income. In rural areas, the difference should be interpreted as a mixed factor income from land and capital, as the micro-data do not allow differentiating between these two factors. This procedure yields some negative differences that were set to zero, though the proportion of self-employed with an imputed wage higher than their reported self-employment earnings was quite low. In the second stage, equation (2) is used to estimate incomes for households whose heads were classified as self-employed farmers.[11]

Total household income is then calculated by aggregating the incomes of individual household members. This household income includes, in addition to the capital income from self-employment, other capital incomes such as dividends, interest and property rental income. It also includes transfers that consist of imputed rent, remittances, gifts, charities and pensions. In addition, for agricultural self-employed households, household income is augmented by auto-consumption.

[11] These two methods, namely using just equation (1) for the whole sample or a combination of the two equations applied to the relevant households, do not result in very different poverty assessments. A complete set of results across all the methods is available upon request.

Figure 1: Factor Allocation (stacked area) and food share in consumption (line) by centile



Notes: The unskilled, skilled, and capital stacked areas measure the percent contribution of each factor to that part of income which is affected by factor price changes (auto-consumption and transfers are a large fraction of the total income of the poor but they are not affected by price changes in the market). The food line represents the percentage of (marketed) food consumption on total (marketed) consumption. Both factor contributions and food percentages are measured for each centile in the population ordered by income levels.

Given that the impact of liberalization-induced price changes on households depends on the relative importance of various income sources and on consumption patterns, it is worth examining how Nicaraguan households earn and spend their income. Figure 1 shows the factor income shares for Nicaragua when its whole population is ordered in income centiles.

Some salient features of the Nicaraguan income distribution are highlighted by this graph. Auto-consumption and transfers, income components not directly linked to market prices, represent a large share of income for the poorest household, up to 60%, whereas they appear much less relevant for the upper income centiles. Similarly, toward the top part of the distribution, unskilled labor, the most important source of income for the poorer, is substituted for skilled labor and capital revenues. Finally, food related expenses drop from about 60% of total consumption to about 40% as we move from poor to rich household. This graph visually summarizes some key characteristics of income

distribution for the whole population in Nicaragua. Table 2 expands the analysis of income distribution by grouping households according to income sources, sector of employment and geographic location.

Table 2: Income distribution in Nicaragua (2001), Income % by source, sector and location

	self-employed						wages						
	farm			non-farm			farm		non-farm				
	skilled	unskill	capital	skilled	unskill	capital	skilled	unskill	skilled	unskill	transfer	autocons	food %
All	0.29	6.58	3.28	1.51	9.67	7.27	0.24	11.47	10.05	23.87	19.61	6.12	51.17
Poor-Urban	0.20	2.13	0.45	1.43	15.29	4.12	0.11	10.52	6.31	33.50	23.72	2.02	54.18
Poor-Rural	0.25	14.45	3.07	0.10	5.43	1.50	0.12	22.49	1.81	14.91	20.88	14.99	56.23
NPoor-Urban	0.24	0.89	0.97	2.98	10.47	13.27	0.41	3.52	20.90	26.70	18.79	0.85	45.94
NPoor_Rural	0.61	12.70	13.36	0.68	6.69	8.35	0.22	11.90	5.18	18.39	12.97	8.94	49.76
Income decile (all)													
1	0.39	11.01	1.28	0.12	5.99	0.73	0.00	21.67	0.96	17.41	28.76	11.20	58.44
2	0.06	12.42	2.87	0.51	10.75	1.71	0.10	19.58	1.95	15.83	21.21	13.00	55.00
3	0.40	6.51	1.33	1.00	12.73	3.29	0.14	18.18	2.26	26.26	21.13	6.76	56.08
4	0.07	7.29	1.78	0.91	10.85	3.24	0.19	13.95	5.44	28.26	19.32	8.69	53.46
5	0.22	6.35	1.99	1.18	9.70	4.66	0.15	11.17	8.99	29.84	20.63	5.11	53.51
6	0.24	6.51	5.02	0.88	11.07	6.60	0.35	11.25	5.77	28.62	17.01	6.69	51.26
7	0.12	4.13	3.58	1.83	10.43	6.37	0.19	8.57	12.17	29.61	19.77	3.23	52.16
8	0.23	4.57	3.36	1.49	10.57	8.85	0.01	5.02	17.03	27.85	17.44	3.59	49.12
9	0.34	4.00	4.50	2.39	9.35	14.47	0.52	2.75	19.35	24.46	15.74	2.12	45.35
10	0.83	3.01	7.12	4.75	5.25	22.77	0.70	2.56	26.62	10.57	15.05	0.78	37.29
Income decile (urban)													
1	0.34	3.55	0.55	0.63	13.72	1.92	0.00	16.99	2.61	27.82	27.88	3.18	55.90
2	0.10	2.01	0.64	2.12	19.77	4.53	0.00	7.21	2.52	34.76	24.73	1.62	54.05
3	0.09	1.89	0.10	1.56	14.90	4.76	0.18	11.68	8.43	35.22	18.88	2.33	54.46
4	0.29	1.15	0.53	1.63	12.43	5.20	0.27	6.17	11.87	35.86	23.57	1.04	52.54
5	0.03	1.60	0.90	1.09	13.57	7.67	0.32	8.32	8.15	37.22	19.70	1.43	51.91
6	0.03	0.60	0.36	2.53	12.98	7.60	0.33	4.69	15.59	31.75	22.57	0.96	51.06
7	0.33	1.45	0.91	1.89	11.37	8.39	0.01	3.18	20.48	31.14	19.40	1.45	48.79
8	0.14	0.41	0.51	2.93	11.18	11.02	0.25	0.76	22.73	31.99	17.30	0.78	44.90
9	0.05	0.46	0.66	4.72	9.42	21.03	1.07	2.33	26.98	17.51	15.54	0.22	45.04
10	0.84	0.69	2.48	4.55	4.51	24.34	0.50	1.67	31.73	10.61	17.94	0.17	33.47
Income decile (rural)													
1	0.59	14.30	1.83	0.00	3.99	0.32	0.00	19.20	0.00	12.59	30.04	17.14	59.55
2	0.00	17.89	1.96	0.00	5.03	0.47	0.00	25.48	0.64	8.63	23.03	16.86	56.80
3	0.01	16.77	5.18	0.00	4.08	0.41	0.00	26.08	1.40	11.55	18.06	16.46	56.18
4	0.23	10.96	2.17	0.00	7.00	0.93	0.25	25.31	2.88	16.02	20.22	14.03	55.94
5	0.61	13.04	2.82	0.09	6.43	3.78	0.54	22.96	0.90	16.86	17.41	14.56	56.53
6	0.15	13.66	4.34	0.57	5.74	2.29	0.00	17.72	4.28	21.85	17.11	12.28	52.81
7	0.41	13.09	7.96	0.52	8.52	5.63	0.38	16.19	3.55	15.03	16.53	12.18	51.41
8	0.26	12.22	10.01	0.21	5.68	3.13	0.00	16.26	4.46	23.87	13.04	10.87	53.62
9	0.16	11.56	8.87	0.66	7.50	6.92	0.00	10.99	6.53	24.14	14.52	8.14	52.20
10	1.39	14.71	22.86	1.09	4.88	15.93	0.40	6.43	5.66	11.06	10.13	5.45	43.73

For the population as a whole, non-farm unskilled wages are found to be the largest source of income, accounting for almost one-quarter of total income (see the first row of Table 2). However, there are substantial differences in these shares depending on how well-off the household is and whether the household resides in the urban or rural sector (which is a household characteristic different from that of earning a large share of income from farm activities). For the poorest decile income group, both in urban and

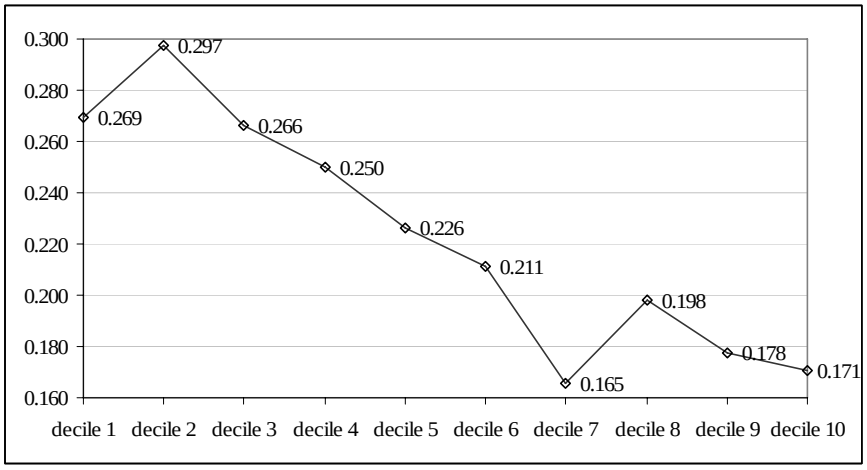
rural areas, transfers make up the highest share of total income, while capital is an important source of income only for higher income households. Skilled labor is a minor source of income for most households except for those in the upper decile income groups in the urban sector.

Regarding the consumption side, average food share is about 51%. It remains above 50% for all rural households except for those in the highest income decile group, whereas it is less than 50% for the upper four income groups and drops to one-third of total expenditure for the highest income decile in the urban sector. It should also be pointed out that auto-consumption has a relatively high share for less well-off households in the rural sector. The implication is that these households are less engaged in market transaction and would benefit or suffer less from the price shocks depending on whether the shocks are positive or negative.

Summing up, even at the high level of aggregation of Table 2, different groups of households display a high degree of heterogeneity more so across their income sources than in their consumption patterns. Incomes appear to originate from few sources for the poor. The rural poor earn on average 40% of their income from the farm sector, which is a very high share considering that 36% of income is attributed to transfers and auto-consumption while the remaining share that is not directly related to agriculture account for only 24%. Furthermore, this is an average across all poor rural households; the poorest have even higher degree of concentration in their income sources.

Figure 2 reports the Herfindahl-Hirschman index of concentration calculated as the sum of the squared shares of different income sources for the ten deciles of rural households and it shows an unambiguous downward trend as income rises, meaning that poorer households have income originating from a more concentrated set of sources.

Figure 2: Herfindahl-Hirschman index of concentration of income sources (rural households by income deciles)



This strong dependence on a few income sources, especially for the poor households, may be a result of a rational choice aiming at avoiding risks, or it may reflect more limited employment opportunities due to limited skills and remote location. A consequence of this limited number of income sources is that it may trap these households in their poverty condition. Recent studies estimating households' response to price incentives such as those induced by trade reforms show that poor households respond less to these incentives. Deininger and Olinto (2000) showed that, for households in Zambia, the absence of key productive assets (draft animals, implements) was a major limitation in exploiting opportunities created by trade liberalization. López, Nash and Stanton (1995) found that the level of capital inputs was, on average, directly related to the responsiveness to price incentives across a sample of farm households in Mexico.

These suggest that the micro analysis approach in this paper, where no quantity response nor occupational/sectoral change is allowed, is appropriate and that its intrinsic bias in considering just first order effects may be less significant for the poor households that are our primary interest. Finally, this literature, together with the segmentation regression shown above, supports the assumption of segmented markets in the CGE model, making the whole macro-micro analysis more consistent.

3 Poverty effects of trade policy reforms

This section first presents the results of the general equilibrium model and then the poverty estimations obtained by linking changes in the macro variables to the household survey data.

3.1 Policy scenarios

The Dominican Republic-Central America Free Trade Agreement (DR-CAFTA) is a recently negotiated free trade agreement (FTA) between Central American countries (Costa Rica, El Salvador, Guatemala, Honduras and Nicaragua), the Dominican Republic and the U.S.[12] Central American countries have already been enjoying the preferential market access to US markets through the Caribbean Basin Initiative (CBI) program. DR-CAFTA will not only consolidate and formalize these existing benefits, but also provide greater market access by eliminating remaining tariffs on goods that have been exempted from the CBI preferences. The agreement also incorporates a gradual opening of Central American markets for US agricultural commodities.[13] Other main achievements of DR-CAFTA include the greater flexibility of rules of origin for textiles and apparel, commitments to help producers meet sanitary and phytosanitary standards required for the entry into the U.S., reciprocal commitments on access to service markets, and the institutional and legal framework to ease foreign direct investment (FDI) flows to the region.[14] Besides providing almost full free access to one of their major markets, the DR-CAFTA agreement should assist the implementation of additional domestic market reforms, and produce significant efficiency gains due to resource reallocations toward more competitive sectors by requiring reciprocal opening. However, as brilliantly

[12] DR-CAFTA was approved by the US Senate and House of Representatives in June-July 2005 and it has also been approved by the legislatures in El Salvador, Guatemala and Honduras, while its approval is pending in Costa Rica, the Dominican Republic and Nicaragua as of writing this paper.
[13] DR-CAFTA, however, exempts from further liberalization some sensitive agricultural products including sugar imports to the U.S., white maize imports to four Central American countries (El Salvador, Guatemala, Honduras and Nicaragua), and potatoes and onions to Costa Rica.
[14] For more details see: (Francois *et al.*, 2005; World Bank, 2005).

illustrated by the Chilean multi-pronged strategy of trade liberalization,[15] CAFTA is just one of the many trade options that the Central American countries can pursue, and probably the best way to evaluate the opportunities offered by such a regional agreement is to compare it with a benchmark case of full liberalization. Two main scenarios are thereby considered: 1) a CAFTA type reciprocal liberalization, and 2) a full unilateral non-discriminatory trade liberalization. The potential advantages and disadvantages of the *reciprocal* liberalization entailed by the regional scenario are illustrated by further decomposing the CAFTA scenario into two separate unilateral liberalizations: first, Nicaragua liberalizes vis-à-vis the U.S., which does not reciprocate, and then the U.S. unilaterally liberalizes vis-à-vis Nicaragua. Although not being a realistic policy choice, the full unilateral liberalization provides a useful measure against which CAFTA can be evaluated.

In all the simulations, only tariffs are modified and they are completely eliminated in one step with no attempt to capture any sequencing across sectors or phase-out periods. As mentioned earlier, each of the simulations is based on a comparative static framework with no capital accumulation, no changes in labor supply or skill levels, and factor market segmentation. The short-term time horizon implicit in this CGE set up was assumed to focus on the immediate impact of trade shocks on poverty and to facilitate *communication* between the macro and micro modules, where no substitution (i.e., no long term behavior) is allowed.

Additional simulations where factor mobility restrictions are eliminated are carried out to complete the analysis and assess the implication of the assumption of factor markets segmentation. However, in these cases, given the behavioral limitations imposed on the micro module, poverty and income distribution results will only be inferred from the macro results.

[15] Chile started liberalizing trade unilaterally toward the end of the 1970s and then moved toward signing trade agreements in the early 1990s, the idea being that it could get useful concessions from trade partners that were not available with unilateral tariff reductions. Chile has signed Agreements with most economies in South America: Bolivia, Colombia, Cuba, Ecuador, Peru, Venezuela and Mercosur. Chile has also signed standard FTAs with the: European Union, Canada, Mexico, the United States, EFTA, Central America, and a recently ratified agreement with South Korea. Besides, Chile enjoys full membership of the WTO and benefits from the multilateral rounds of trade liberalization under the WTO's auspices. Through this strategy, Chile has achieved almost fully free access to most OECD markets and the other developing countries relevant to its trade.

3.2 Trade reforms: macro results first…

In a general equilibrium model all relative prices and quantities are determined simultaneously. However, to disentangle the trade policy reform effects on the economy, it is helpful to describe the adjustment process as if it were sequential. First, tariffs are reduced and impact import flows, which in turn displaces domestic production and generates resource reallocations. These shifts, by interacting with factor supply and demand, determine factor prices, and combined with new goods prices, ultimately affect the household's real income level. Then, changed household incomes feed back into the system through changes in consumption choices and the process continues until a new equilibrium is reached. Three main elements determine the *position* – i.e., the values of the endogenous variables – of the new equilibrium: 1) the starting level of some key variables in the initial equilibrium, i.e., the prices and quantities implicit in the initial SAM; 2) the functional forms of the model's behavioral equations; and 3) some key parameters, namely substitution elasticities among factors in the production process and, for a trade reform analysis, the elasticities of substitution in demand between domestic and imported commodities and the elasticity of transformation in supply between domestic and foreign markets. A broad consensus has emerged about the appropriate functional forms, and the model used here is in line with this consensus. The values for the elasticities have been borrowed from the available econometric literature, however, depending on the estimation methods as well as on the period or country considered, these values show considerable variation, and has created heated controversies among supporters and skeptics of these types of models. Systematic sensitivity analysis, where all elasticities are randomly changed and results are presented with accompanying confidence intervals, has been proposed as a solution to these controversies. Nevertheless, even this rather computationally intensive proposal has its problems and we do not attempt it here.

The bottom line is that results presented here are indicative of a likely response to the analyzed shocks. In most cases, the sign and relative, if not absolute, magnitude of

the model's results – for example, a finding that gains for unskilled labor are larger than those for skilled labor – should be reliable.

Major advantages of this type of model are that it represents the whole economy in a consistent and theoretically sound framework and that the structural features of the country investigated strongly influence the final results. Table 3 shows these features for Nicaragua in terms of sectoral shares of gross production, imports, exports and private demand; the middle panel details, for each sector, the U.S. weight in total trade; the right panel shows Nicaraguan tariffs against the U.S. and other partners and the U.S. tariffs against Nicaraguan products. For convenience, the bottom panel of the table reports measurements for aggregate macro sectors, although the model's actual 28 sectors are shown in the top panel. In commenting on the results of the policy simulations, we will refer to data in this table.

The initial import protection, both in its level and sectoral variability, is among the key elements determining the outcome of the simulated trade reforms. Three key features are highlighted by the tariff data: 1) the overall trade-weighted protection rate is rather low, 2) its dispersion is high with a clear bias against agricultural imports, and 3) tariffs against the U.S. are generally above the trade-weighted average of tariffs against the Rest of the World.

Table 3 also shows that domestic Nicaraguan agricultural producers may be facing strong competition from U.S. imports, which are 41% of total imports of agricultural commodities. It is likely that a liberalization of U.S. imports, which reduces an anti-agricultural import bias, would lead to an increase of competition in the agricultural sectors with a potential initial negative shock for households strongly dependent on farming incomes. Clearly, the level of sector aggregation used in the model may exacerbate this potentially negative outcome. It may be that at finer sectoral levels, one finds that imports and domestic products are complements rather than substitutes. For example, lower feed costs could stimulate livestock and poultry productions. However, agricultural products are normally fairly homogeneous, and thus substitutable, and the risk of negative impacts should not be completely ruled out.

Table 3: Nicaragua's economic structure (2000)

		Sectoral shares				US weight		Tariffs		
		Xp	M	Ex	Xc	M Us	Ex US	Nic - US	Nic - ROW	US - Nic
Agriculture	Coffee	2	0	20	0	14	26	8	6	0
	Sugar Cane	1	0	0	0	0	0	0	0	0
	Basic Grain	3	1	1	4	72	0	29	17	0
	Other Agri. Products	3	2	7	5	18	3	8	4	11
	Livestock	5	1	3	3	35	0	4	2	0
	Forestry	1	0	0	1	93	0	1	1	0
	Fishery	1	0	1	0	34	5	10	5	0
Minin gEne	Mining	1	10	4	0	1	4	2	0	0
	Electricity Gas Water	2	0	0	1	0	0	10	6	0
	Water Distribution	1	0	0	1	0	0	0	0	0
Food Processing	Meat and Fish Products	5	0	23	5	19	27	18	8	3
	Sugar Producs	2	0	5	2	6	11	8	7	0
	Dairy	2	1	3	3	32	0	12	8	0
	Other Food	4	8	2	11	19	0	7	4	1
	Beverages	2	1	1	6	9	0	12	6	0
	Tobacco	0	1	1	1	2	9	4	0	7
Other Manufacturing	Textiles Clothing & Leather	3	4	12	5	39	5	4	4	4
	Wood Products	2	2	2	1	28	0	8	3	0
	Paper Print Products	1	3	0	1	21	0	3	2	0
	Refined Oil	3	5	2	2	9	0	7	7	0
	Chemicals	1	17	2	6	21	0	3	2	0
	Glass No-Metal Products	1	3	1	0	9	2	4	2	0
	Metal Products	0	7	1	0	15	0	3	2	0
	Machinery and Equipment	0	26	1	2	40	0	2	3	0
Services	Construction	9	0	0	0	0	0	0	0	0
	Commerce	10	0	0	1	0	0	0	0	0
	Other Services	29	5	4	28	24	1	0	0	0
	Transport Services	5	1	4	8	24	3	0	0	0
	Total	100	100	100	100	24	36	4	3	
	--- Aggregate sectors averages ---									
	Agriculture	17	4	32	13	41	28	20	6	
	Food Processing	15	12	36	29	18	54	8	4	
	Mining and Energy	4	10	4	3	1	64	2	0	
	Other Manufacturing	12	68	20	19	28	14	3	3	
	Services	53	6	8	37	24	40	0	0	

Source: Nicaragua SAM estimated by the author.
Notes: In the left panel, **Xp** represents the sectoral output as a percentage of total output, **M** the sectoral total imports, **Ex** the exports shares, **Xc** the private consumption shares. In the middle panel, **M US** the initial share of imports coming from the U.S. over total imports, **Ex US** the initial share of exports going to the U.S. In the right panel, there are tariffs: **Nic - US** and **Nic - ROW** are Nicaraguan tariffs against the U.S. and other partners imports, respectively, and **US - Nic** are the U.S. tariffs against Nicaraguan exports.

The main macro results for the trade policy reforms are described in the following subsections. First, we examine the effects of the unilateral non-discriminatory full liberalization in the benchmark scenario. Then, the CAFTA case is analyzed and compared with the benchmark and the effects of this regional agreement are decomposed into those originating from liberalization of Nicaragua with no response from the U.S. and those derived from the U.S. reciprocating. Finally, to assess the sensitivity of the results to the assumption of factor markets segmentation, both the non-discriminatory and the regional trade reforms are simulated allowing perfect factor mobility in the model. This set up should more closely represent the likely impact of the reforms in the longer run, although no factor accumulation or explicit dynamic effects are accounted for.

Unilateral liberalization against all trading partners

As outlined above, the adjustment process caused by this reform is initially described in terms of sectoral demand and supply changes as shown in Table 4. Consider first the demand/imports side. Initial tariff rates tm[16] are highest in *Agriculture* and *Food Processing* sectors – in particular in *Basic Grains*, *Meat and Fish Products*, *Sugar Products* and *Dairy* – accordingly these sectors experience the largest imports once protection is removed. Observing the aggregate results (in the bottom panel of the table), import volumes increase (ΔM) by 23% for *Agriculture* and 6% for *Food Processing* from their pre-liberalization levels; these increases compare with the average 2% increase for total imports. However, imports do not represent a large share of local demand (M/D) in *Agriculture* and account for just a moderate one in *Food Processing*. Thus, even with a high elasticity of substitution between local production and imports (3), the impact of increased imports on sales of domestic goods (ΔS) for *Agriculture* and *Food Processing* is very low. Compared to these sectors, the other manufacturing sectors suffer slightly larger domestic sales contractions due to their larger initial share of import dependency despite their lower initial level of protection. Reflecting Nicaragua's dependency on foreign production of capital goods, intermediates, and energy, imports are well above 50% of total local demand for *Other Manufacturing* and just below that threshold for energy and mining. For the other manufacturing sectors, cheaper imports displace almost 3% of domestic production.

[16] Note that column tm in Table 4 is the trade weighted average of the Nicaraguan tariffs against US and the Rest of the World (which are separately shown in Table 3).

Table 4: Sectoral effects of full unilateral trade liberalization

		Imports and Local Sales					Exports and production			
		tm	ΔM	M/D	ΔS	ΔPd	ΔEx	Ex/Xp	ΔXp	ΔPx
Agriculture	Coffee	6	13	8	-1	-1.4	5	101	4	-0.2
	Sugar Cane	0	0	0	1	-2.2	0	0	1	-2.2
	Basic Grain	26	55	11	-4	-6.8	27	3	-3	-6.6
	Other Agri. Products	5	6	14	0	-2.7	12	26	3	-2.1
	Livestock	2	2	4	1	-2.1	10	8	2	-2.0
	Forestry	1	-8	1	1	-4.1	19	2	1	-4.0
	Fishery	6	24	4	1	0.7	-2	6	1	0.7
Mining Ene	Mining	0	-5	85	-2	-1.1	3	55	1	-0.5
	Electricity Gas Water	6	12	2	-1	-2.1	8	0	-1	-2.1
	Water Distribution	0	0	0	-1	-0.8	0	0	-1	-0.8
Food Processing	Meat and Fish Products	10	25	4	-1	-1.8	6	53	2	-0.9
	Sugar Producs	7	18	1	-1	-1.2	4	33	1	-0.9
	Dairy	9	18	18	-3	-2.3	6	22	-1	-1.8
	Other Food	5	3	35	1	-3.9	18	7	2	-3.6
	Beverages	6	12	8	-1	-1.8	6	3	-1	-1.7
	Tobacco	0	-2	85	-1	-0.5	1	96	0	-0.1
Other Manufacturing	Textiles Clothing & Leather	4	4	38	-2	-1.8	5	55	1	-0.9
	Wood Products	5	7	23	-1	-2.0	7	12	-1	-1.7
	Paper Print Products	3	1	55	-3	-1.3	2	3	-3	-1.2
	Refined Oil	7	13	26	-6	-0.7	-3	8	-6	-0.7
	Chemicals	2	0	71	-1	-1.7	6	18	0	-1.4
	Glass No-Metal Products	2	2	35	-1	-0.7	2	7	-1	-0.7
	Metal Products	2	1	72	0	-1.6	7	16	1	-1.4
	Machinery and Equipment	3	1	83	2	-2.9	15	73	10	-1.0
Services	Construction	0	0	0	1	-0.5	0	0	1	-0.5
	Commerce	0	0	0	-1	-0.4	0	0	-1	-0.4
	Other Services	0	-3	5	0	-0.9	3	2	0	-0.9
	Transport Services	0	-5	6	0	-1.6	6	9	0	-1.5
	Total	3	2	23	-1	-1.5	6	12	0	-1.3
	--- Aggregate sectors averages ---									
	Agriculture	12	23	7	-0.4	-2.9	7	23	1.1	-2.5
	Food Processing	5	6	21	-0.7	-2.3	6	28	1.1	-1.8
	Mining and Energy	0	-4	48	-0.8	-1.6	3	12	-0.4	-1.5
	Other Manufacturing	3	2	57	-2.9	-1.3	5	21	-1.6	-1.0
	Services	0	-4	3	-0.2	-0.8	5	2	-0.1	-0.8

Notes: **tm** represents initial tariff rates, **ΔM** the percent variation in total import volumes with respect to the initial levels, **M/D** the ratio of imports to domestic demand (the sectoral import dependency, calculated using pre-liberalization levels), **ΔS** the percent variation in the volumes of domestic sales of domestic output, **ΔPd** the percent variation in domestic prices for local sales, **ΔEx** the percent variation in the volumes of exports, **Ex/Xp** the ratio of exports to domestic output (the sectoral export orientation), **ΔXp** the percent change of domestic output, and **ΔPx** the percent change of output prices.

For the economy as a whole, these low or moderate domestic market share losses are reflected in small declines of producer prices for local sales (ΔPd). Some of these effects are larger when disaggregated sectors are examined, and complementary analyses considering very disaggregated sectors of production may be needed to identify specific sensitive commodities.[17]

[17] These usually analyses consider data at the tariff line level, i.e., at a very fine degree of disaggregation. Trade data at this level may be available, but production, consumption and other important data needed to calibrate CGE models are normally available at a much more aggregate level. Therefore tariff lines analyses are normally partial equilibrium analyses and they should be considered in conjunction with the general equilibrium analysis presented here.

These demand/imports effects are linked to the supply response to which we now turn. For producers of exportable goods, the reduction of prices in local markets (ΔPd) combined with unchanged export prices creates incentives to increase the share of sales destined to foreign markets. This export response (ΔEx) varies across sectors and is linked to the pattern of Nicaragua's comparative advantage, which, according to the export sectoral distribution (column "Ex" in Table 3) and the export orientation (Ex/Xp in Table 4), is within three main sectors: *Coffee*, *Meat and Fish Products,* and *Textiles and Clothing*. For these sectors, rising export sales more than offset the reduction of domestic sales and lead to an overall increase in sectoral production (ΔXp). In other sectors,[18] with lower export orientation, the change in sectoral production is roughly equal to the change in local sales (ΔS). Sectors enjoying export led growth record output price reductions (ΔPx) that are smaller than those of domestic sales prices (ΔPd) because output prices are a combination (CES prices) of fixed export prices and domestic prices.

In summary, trade liberalization, even if it consists of eliminating relatively low economy-wide protection (3%), entails considerable sectoral structural adjustment.[19] Within agriculture, *Basic Grains* is the only sector registering a contraction due to its high tariffs and low export orientation. Among other sectors, *Coffee* and *Other Agricultural Products* enjoy significant export-led growth. Similarly, in the non-farm portion of the economy, import competing sectors contract and release resources that move toward sectors that were less protected or produced for foreign markets. Considering the aggregate averages, the macro-sector *Food processing* records positive output changes, whereas the other non-farm macro sectors experience moderate contractions.

Changes in factor remunerations, shown in Table 5, are another important aspect of the structural adjustment caused by trade reform. Changes in wages and capital returns

[18] Due to the sectoral classification used in this model, some sectors in Table 4, notably *Tobacco* and *Machinery and Equipment*, appear to be both import and export intensive. However, the apparent export intensity in these sectors results from dividing low levels of exports (probably re-exports) by even lower levels of domestic production. As clearly shown in Table 3, exports of *Tobacco* and *Machinery and Equipment* jointly account for just 2% of total exports.

[19] Due to the closure rule of the external account, namely the fixing of foreign savings and the full employment assumption, the larger expansion of the volumes of exports with respect to import volumes is compensated with a real exchange rate depreciation which originates from falling domestic resource costs. In other words, exporting sectors expand by employing resources whose relative prices have declined because of their falling demand from the contracting import competing sectors.

are linked to changes of goods prices through the production technology and the functioning of the factor markets. Different production technologies are approximated by different factor and intermediate inputs intensities across sectors, as shown in Table 6, and factor markets function so as to mimic short-term adjustment possibilities. Capital is sector specific, and the farm and non-farm sectors constitute two segmented markets for skilled and unskilled labor.

Table 5: Factor price changes due to full trade liberalization

	ΔP	**Δ(P/CPI)**
Non-Farm Segment:		
Skilled Labor	-0.3	2.1
Unskilled Labor	0.6	2.9
Capital	-0.6	1.8
Sk/Unsk wage gap		-0.9
Farm Segment:		
Skilled Labor	-4.0	-1.6
Unskilled Labor	-6.3	-3.9
Capital	2.7	5.1
Sk/Unsk wage gap		2.5
Price indexes:		
Food price index	-3.6	
Non food price index	-1.5	
CPI	-2.4	

Sources: Author calculations from model results.
Notes: The first column, **ΔP**, represents the percent variation of the price of each factor with respect to the initial levels, and **Δ(S/CPI)** is the percent variation of the price deflated by the Consumer Price Index.

In the farm segment (which corresponds to the macro-sector *Agriculture* in the previous tables), capital (including land) has a positive real price change and skilled and unskilled labor experience wage reductions. The expanding agricultural sectors – shaded in Table 6 – are those which use capital relatively more intensively than *Basic Grains*, the contracting sector. The combined *Coffee*, *Other Agricultural Products* and *Livestock* sectors, the largest output gainers, use almost 70% of the total farm capital value added. Unskilled labor in *Basic Grains* contracts relative to skilled labor.

Table 6: Value added and employment by sector and factor, and sectoral intermediate uses (%)

	Value Added							Employment (# of workers)				
	Sectoral Intensity				Sectoral Shares			Sect. Intens.		Sect. Shares		
	Sk	Usk	K&L	Xint	Sk	Usk	K&L	Sk	Usk	Sk	Usk	ΔXp
Coffee	3	66	31	29	7	21	10	1	99	4	10	4.4
Sugar Cane	2	27	71	40	2	3	7	2	98	4	5	0.8
Basic Grain	6	77	17	29	17	31	7	2	98	41	55	-3.4
Other Agri. Products	17	40	43	35	53	16	18	7	93	9	4	2.5
Livestock	4	32	63	36	20	19	40	4	96	39	23	1.6
Forestry	0	75	25	47	0	8	3	0	100	0	1	1.1
Fishery	1	10	89	37	1	2	15	4	96	3	2	0.5
Mining	9	73	18	48	0	2	1	5	95	0	1	0.5
Electricity Gas Water	34	6	59	42	3	0	6	63	37	1	0	-0.6
Water Distribution	20	55	25	37	1	2	1	28	72	1	1	-1.1
Meat and Fish Products	25	46	29	82	2	3	2	21	79	1	1	2.3
Sugar Producs	12	33	55	70	0	1	3	11	89	0	1	0.7
Dairy	35	30	35	71	1	1	2	21	79	0	0	-1.0
Other Food	31	42	27	70	3	3	3	13	87	2	5	2.1
Beverages	48	15	37	60	3	1	3	51	49	1	0	-1.2
Tobacco	4	43	53	47	0	0	0	13	87	0	0	0.5
Textiles Clothing & Leather	20	72	7	50	2	6	1	22	78	5	6	1.0
Wood Products	16	75	9	58	1	4	1	9	91	0	1	-0.5
Paper Print Products	28	66	6	61	0	1	0	25	75	0	0	-2.9
Refined Oil	69	0	31	97	0	0	0	100	0	0	0	-5.8
Chemicals	36	35	29	65	1	1	1	27	73	0	0	0.0
Glass No-Metal Products	29	62	9	72	1	1	0	12	88	1	1	-0.6
Metal Products	24	71	5	76	0	1	0	17	83	1	1	1.1
Machinery and Equipment	31	63	6	76	0	0	0	20	80	1	2	10.2
Construction	16	64	20	54	5	17	8	11	89	4	10	1.4
Commerce	33	56	11	29	18	26	7	19	81	23	31	-0.6
Other Services	40	21	39	36	55	24	61	35	65	55	32	-0.4
Transport Services	27	70	3	71	3	6	0	14	86	3	5	0.2
Total	27	41	32	48	200	200	200	16	84	200	200	0.1
					--- Aggregate sectors averages ---							
Agriculture	6	48	46	35	100	100	100	3	97	100	100	1.1
Food Processing	31	34	35	72	10	9	13	15	85	4	8	1.1
Mining and Energy	26	31	43	42	4	4	8	24	76	2	2	-0.4
Other Manufacturing	24	66	11	71	6	14	3	20	80	9	11	-1.6
Services	35	37	28	41	80	73	76	25	75	85	79	-0.1

Notes: All the values in the table except in the last column are calculated from values in the initial equilibrium. The highlighted (shaded) rows are those corresponding to expanding sectors. Sectoral intensity sums to 100% in each sector. **Sk** represents skilled labor, **Usk** and **K&L** unskilled labor and capital and land respectively, **Xint** is the share of intermediate inputs in total output, and **ΔXp** is the percent change of domestic output due to full trade liberalization.

Turning to the non-farm segment and in the bottom panel of Table 6, it is easy to see that *Food Processing*, the sector with the largest output expansion, is relatively intensive in the use of capital, and, in terms of number of workers (rather than value added which includes wage differential biases), is the sector that uses most intensively unskilled workers. *Other Manufacturing*, the sector experiencing the largest contraction, uses unskilled labor to a large extent but not as intensively as *Food Processing*. This relative intensity in the use of labor combined with the initial levels of protection and output changes explains the observed wage movements.

The combination of the trade shock with this production structure explains why unskilled labor is the largest gainer in the non-farm segment, followed by skilled labor and capital as shown in Table 5. These results are consistent with the comparative advantage of Nicaragua, a country with abundant unskilled labor that specializes in the production of agriculture derived products. It is also import dependent for capital goods and intermediates, which are normally produced by sectors using skilled workers intensively.

Even with segmented labor markets, the farm and non-farm parts of the economy have strong interconnections that determine the final results. These inter-segment links are illustrated in Table 7 for the *Agricultural* and the *Food Processing* aggregate sectors.[20] Both sectors face the largest average drops in tariff protection and large inflows of imports; however, they also have the largest aggregate output gains. This is achieved by significant structural shifts that are qualitatively different for these two sectors.

For *Agriculture*, the main adjustment consists of a reduction of one single sub-sector and a specialization toward export oriented sectors. Prices for imported intermediate goods are reduced by the removal of tariffs. However, due to the moderate use of intermediates (35% of total input value), cost savings needed to compete with cheaper imports in domestic markets and to increase competitive advantage in export markets have to be realized by factor price reductions, and this also explains why labor wages are reduced in *Agriculture*.

For *Food Processing*, the inflow of imports does not entail large sectoral contractions because producers can still compete in domestic markets by enjoying reduced production costs due to their use of cheaper intermediates, which represent on average almost three-quarters of total input values. In fact, most of these intermediate inputs come from agriculture whose prices are reduced following the trade shock.

[20] These two sectors account for a third of total production and for almost 40% of total employment.

Table 7: Inter-sectoral links between Agriculture and Food processing

	Agriculture	Food Processing
Initial tariffs, %	12	5
Intermediates as % of output	35	72
Share (%) of tot inputs from sector:		
Agriculture	22	63
Food Processing	13	14
Mining and Energy	1	3
Other Manufacturing	52	14
Services	12	6

Factor price changes as well as the inter-sectoral intermediates cost savings explain why certain sectors reduce or marginally increase imports following tariff abatement. For instance, the absence of import surges for *Livestock*, after the market opening, is due to increased domestic sales of local producers who can produce at lower costs and are able to gain market share. A partial equilibrium framework where tariff reduction can only lead to increased imports and lower prices would not account for these types of inter-sectoral linkages.

CAFTA bilateral trade liberalization

The full unilateral trade liberalization serves as a benchmark against which the CAFTA regional agreement can be compared. Table 8 reports sectoral results for the simulation of this regional free trade agreement. This policy discriminates between import origins and has trade diverting effects that may not be compensated by trade creation. However, as shown below, this geographic discrimination is not the most relevant aspect to be considered in an evaluation of this policy option.

Table 8: Effects of the CAFTA agreement on Nicaragua's economic sectors

		Imports and Local Sales					Exports and production			
		tmUS	ΔM	M/D	ΔS	ΔPd	ΔEx	Ex/Xp	ΔXp	ΔPx
Agriculture	Coffee	8	3	8	1	-0.6	3	101	3	-0.1
	Sugar Cane	55	0	0	0	-1.3	0	0	0	-1.3
	Basic Grain	29	54	11	-4	-4.8	17	3	-3	-4.6
	Other Agri. Products	8	2	14	1	-0.5	10	26	3	0.1
	Livestock	4	5	4	1	-0.2	2	8	2	-0.2
	Forestry	1	-3	1	1	-2.2	10	2	1	-2.2
	Fishery	10	29	4	2	4.4	-15	6	1	4.2
Mining Ene	Mining	2	0	85	-1	0.2	-2	55	-1	0.1
	Electricity Gas Water	10	1	2	0	0.3	-1	0	0	0.3
	Water Distribution	0	0	0	0	0.5	0	0	0	0.5
Food Processing	Meat and Fish Products	18	13	4	0	0.4	8	53	4	1.4
	Sugar Producs	8	2	1	0	-0.1	1	33	0	0.0
	Dairy	12	11	18	-1	-0.3	0	22	-1	-0.3
	Other Food	7	1	35	2	-1.9	11	7	3	-1.8
	Beverages	12	4	8	0	0.0	0	3	0	0.0
	Tobacco	4	0	85	-4	1.5	3	96	2	3.2
Other Manufacturing	Textiles Clothing & Leather	4	4	38	-1	-0.1	2	55	0	0.2
	Wood Products	8	4	23	-1	-0.6	1	12	-1	-0.5
	Paper Print Products	3	1	55	-1	0.1	-2	3	-1	0.1
	Refined Oil	7	2	26	-1	0.0	0	8	-1	0.0
	Chemicals	3	1	71	-1	-0.2	0	18	0	-0.2
	Glass No-Metal Products	4	1	35	-1	0.2	-1	7	-1	0.2
	Metal Products	3	0	72	-1	-0.1	0	16	-1	-0.1
	Machinery and Equipment	2	0	83	-2	-0.2	-1	73	-1	-0.1
Services	Construction	0	0	0	0	0.3	0	0	0	0.3
	Commerce	0	0	0	0	0.7	0	0	0	0.7
	Other Services	0	1	5	0	0.4	-2	2	0	0.4
	Transport Services	0	0	6	0	0.2	-1	9	0	0.1
	Total	4	2	23	0	0.0	4	12	0	0.1
	--- Aggregate sectors averages ---									
	Agriculture	21	22	7	0.1	-0.9	5	23	1.0	-0.7
	Food Processing	8	3	21	0.5	-0.4	6	28	1.9	0.0
	Mining and Energy	2	0	48	-0.2	0.3	-2	12	-0.4	0.3
	Other Manufacturing	3	1	57	-0.8	-0.1	1	21	-0.5	0.0
	Services	0	1	3	-0.1	0.4	-1	2	-0.1	0.4

Notes: **tm** represents initial tariff rates, **ΔM** the percent variation in total import volumes with respect to the initial levels, **M/D** the ratio of imports to domestic demand (the sectoral import dependency, calculated using pre-liberalization levels), **ΔS** the percent variation in the volumes of domestic sales of domestic output, **ΔPd** the percent variation in domestic prices for local sales, **ΔEx** the percent variation in the volumes of exports, **Ex/Xp** the ratio of exports to domestic output (the sectoral export orientation), **ΔXp** the percent change of domestic output, and **ΔPx** the percent change of output prices.

Nicaragua's liberalization of U.S. imports affects just one-quarter of total imports (as shown Table 3) and, thus, has a smaller aggregate impact than full unilateral trade liberalization. However, the overall structural adjustment and inter-sectoral resource reallocations are quite significant due to the large U.S. weight in some critical sectors – such as the 72% of *Basic Grains* imports and the 26% of exports for the two largest exporting sectors in Nicaragua, *Coffee* and *Meat and Fish Products*. The CAFTA agreement obviously includes increased market access for Nicaraguan products in the U.S. market. As shown more clearly in the next section, however, this reciprocal liberalization amounts to a positive but rather small shock. In the model, the implied

increased market access is accounted for by increasing border prices for goods exported to the U.S., implicitly assuming that Nicaraguan exporters do not influence domestic prices in the U.S. and that they can enjoy the full rents provided by the initial U.S. tariffs.[21] Given the initial low level of the U.S. tariffs, these rents are not significant.

A preferential bilateral agreement with the U.S. shows some relevant divergences from a full liberalization, especially with respect to factor price changes. Firstly, the overall price deflation resulting from partial trade reform is roughly equal to one-quarter of the deflation induced by complete tariff abatement (see the bottom right panel of Table 9). Secondly, a CAFTA agreement entails a liberalization that is not only geographically biased but also *sectorally* distortionary. Consider again the shares of imports originating from the U.S. in Table 3. The economy-wide average share is 24%, but the imports of the U.S. agricultural goods represent more than 40% of total imports in that macro-sector, with peaks of 72% for *Basic Grains*, which is also the most protected sector. Additionally, tariffs against U.S. imports are slightly higher than those against other partners. Thus, the CAFTA agreement-induced imports surge of agricultural goods is equal to 94% of that induced by a full unilateral liberalization, whereas the economy-wide average stands at 76%. These sectoral distortions explain why factor returns in the farm segment undergo changes that are very close to those experienced in a full liberalization scenario. The unskilled labor real wage contraction is in fact the same in the two cases, whereas factor returns in the non-farm sector record a smaller percentage of the full liberalization shock.

[21] A regional multi country model that includes the whole US economy, rather than the current single country model, would be better suited to account for all the direct and indirect effects of a liberalization of the U.S. tariffs. However, the approach used here, namely to model the U.S. simply as one of Nicaragua's trading partners, can be considered as a reduced form of a more complete multi country model which, although theoretically more appealing, has much higher data intensity and empirical implementation costs.

Table 9: Factor price changes due to CAFTA

	ΔP	Δ(P/CPI)	% of Full Lib
Non-Farm Segment:			
Skilled Labor	0.7	1.2	60
Unskilled Labor	1.0	1.6	55
Capital	0.9	1.5	85
Sk/Unsk wage gap		-0.4	
Farm Segment:			
Skilled Labor	-2.0	-1.4	87
Unskilled Labor	-4.5	-3.9	100
Capital	4.1	4.7	92
Sk/Unsk wage gap		2.6	
Price indexes:			
Food price index	-1.4		39
Non food price index	0.0		-1
CPI	-0.6		24

Sources: Author calculations from model results.

Notes: The first column, **ΔP**, represents the percent variation of the price of each factor with respect to the initial levels, and **Δ(S/CPI)** is the percent variation of the price deflated by the Consumer Price Index. The column, **% of Full Lib**, shows the percent ratio of the real price changes in the CAFTA scenario with respect to the unilateral non discriminatory full liberalization case.

In summary, the impact on factor remunerations of the examined trade reforms, full liberalization and CAFTA agreements, should be positive for urban workers, both wage-employed or self-employed with physical capital, but it may, at least temporary, be negative for wage workers of the rural sector. Furthermore, the regional agreement replicates this negative effect with potential worrying implications for inequality and poverty. For agricultural households receiving part of their income from capital and land, or even from non-farm activities, the unfavorable farm wage changes should have a less harmful effect. Notice also that the wage gap between skilled and unskilled workers does not significantly change with this kind of trade reform.[22]

Decomposing the CAFTA scenario

In order to distinguish the effects of market access from those of own tariff unilateral abatement, the simulated reciprocal CAFTA trade agreement has been decomposed into two separate reforms: in the first, Nicaragua unilaterally eliminates all

[22] This outcome may not hold under a different production specification where skilled workers, for example, are modeled as a complement to capital, rather than as substitutes.

tariffs against U.S. imports, and, in the second, the U.S. unilaterally responds, i.e., it preferentially liberalizes imports from Nicaragua.[23]

As anticipated, the opening up of the Nicaraguan market accounts for almost three-quarters of the CAFTA variation in imports, exports, and domestic output recorded by the reciprocal case. As shown in Table 10, in the case of unilateral U.S. liberalization, effects on imports and local sales are more or less muted, and the most visible effects consist of some additional specialization in exports of food processing products.

Table 10: Decomposing sectoral effects of CAFTA

	Nicaragua Unilat. Lib						US Unilat. Lib					
	Imports and Local Sales			Exports and production			Imports and Local Sales			Exports and production		
	ΔM	**ΔS**	**ΔPd**	**ΔEx**	**ΔXp**	**ΔPx**	**ΔM**	**ΔS**	**ΔPd**	**ΔEx**	**ΔXp**	**ΔPx**
Agriculture	19	-0.1	-1.9	5	1.0	-1.7	3	0.2	1.0	0	0.1	1.0
Food Processing	1	0.5	-1.1	3	1.3	-0.9	1	-0.1	0.7	3	0.6	0.9
Mining and Energy	0	-0.2	-0.2	0	-0.2	-0.2	0	0.0	0.5	-2	-0.2	0.5
Other Manufacturing	1	-0.7	-0.4	1	-0.3	-0.3	0	-0.2	0.3	0	-0.2	0.3
Services	-1	-0.1	-0.1	0	-0.1	-0.1	2	0.1	0.5	-2	0.0	0.5
Total	1	-0.1	-0.6	3	0.3	-0.5	1	0.0	0.6	1	0.1	0.6

Notes: **ΔM** represents the percent variation in total import volumes with respect to the initial levels, **ΔS** the percent variation in the volumes of domestic sales of domestic output, **ΔPd** the percent variation in domestic prices for local sales, **ΔEx** the percent variation in the volumes of exports, **ΔXp** the percent change of domestic output, and **ΔPx** the percent change of output prices.

As highlighted in Table 10, the two unilateral liberalizations are consistent in their sectoral output effects. Both induce additional growth of agricultural and food processing sectors and, in this sense, help Nicaragua exploit its comparative advantage. Although the U.S. has already granted preferential access to Nicaraguan exports in the past, the remaining current U.S. tariffs seem to inhibit potential growth in some key sectors in Nicaragua, and obtaining full access to the U.S. markets may then bring some advantages.

[23] This decomposition is not exact given that the sequence in which these reforms are carried out matters for the final results. However, in this particular case, given that the magnitude of the shocks, especially the reduction of the U.S. tariffs against Nicaraguan products, is not too large, the order in which the two simulations are carried out is almost indifferent.

Table 11: Decomposing factor price changes due to CAFTA

	Nicaragua Unilat. Lib			US Unilat. Lib		
	ΔP	**Δ(P/CPI)**	**% of CAFTA**	**ΔP**	**Δ(P/CPI)**	**% of CAFTA**
Non-Farm Segment:						
Skilled Labor	0.0	1.1	86	0.6	0.2	14
Unskilled Labor	0.5	1.5	94	0.6	0.1	6
Capital	0.2	1.2	81	0.8	0.3	19
Sk/Unsk wage gap		-0.4			0.1	
Farm Segment:						
Skilled Labor	-3.2	-2.2	160	1.3	0.8	-60
Unskilled Labor	-5.2	-4.1	106	0.7	0.3	-6
Capital	2.1	3.1	67	2.0	1.5	33
Sk/Unsk wage gap		2.1			0.6	
Price indexes:						
Food price index	-2.0			0.6		
Non food price index	-0.4			0.4		
CPI	-1.0			0.5		

Sources: Author calculations from model results.

Notes: The first column, **ΔP**, represents the percent variation of the price of each factor with respect to the initial levels, and **Δ(S/CPI)** is the percent variation of the price deflated by the Consumer Price Index. The column, **% of CAFTA**, shows the percent ratio of the real price changes in the unilateral liberalizations with respect to the bilateral CAFTA case.

As far as factor market effects are concerned, Table 11 shows that the non-reciprocal removal of Nicaragua's tariffs causes factor prices of the non-farm segment to vary almost as much as with the CAFTA scenario, leaving a small contribution to the full price change to the U.S. unilateral response. Interestingly, the two unilateral liberalizations have contrasting price effects for factors in the farm segment. In the case of the U.S. liberalizing its tariffs, factor prices go up due to the increased export demand and this inflationary effect is not counterbalanced by inflows of cheaper imports. However, these inflows explain why factor prices tend to contract with the unilateral liberalization of Nicaragua. This shows that increasing market access mitigates the potentially negative shocks to farm incomes associated with the liberalization of Nicaraguan agricultural markets.

Beyond a short term impact analysis: Full liberalization and CAFTA with fully flexible factor markets

The model used here to evaluate trade policy reform is a static model, which only accounts for the allocative efficiency gains originating from trade liberalization. It does not measure the potentially vastly larger dynamic gains. For instance, in the current

set up, market access does not appear to provide large benefits, but these would be much more significant in an analysis that included increased capital flows, productivity gains, locking up of important domestic reforms, and other dynamic links between trade regimes and growth. In addition to its static nature, the current model imposes extra restrictions to the mobility of factors across sectors. This intensifies sectoral price responses to tariff abatement: factors "trapped" in sectors hit by import surges experience decreasing demand and lower returns. This specification can be very useful to highlight potential losers and inform compensatory policies. However, since factors move from one sector to another in the longer run, it seems desirable to test the sensitivity of results to this mobility assumption. Therefore, to conclude the macro analysis, the full liberalization and CAFTA scenarios are replicated in a version of the model where factors are fully mobile across all sectors of the economy.

In this version sectoral specialization is stronger, and in the full unilateral liberalization case, Nicaragua exploits its static comparative advantage in producing agricultural goods. As shown in Table 12, *Agriculture*, which accounts for almost 20% of total output, records the largest expansion. In stark contrast, *Agriculture* contracts in the CAFTA scenario. This is because CAFTA is very close to a partial liberalization where agriculture imports are granted free access and the rest of the economy remains protected. In such a situation, cheaper imports displace domestic agriculture and released factors of production find jobs in other sectors.

Table 12: Sectoral effects of Nicaragua trade liberalization scenarios with perfect factor mobility

	Sectoral Output	tm	Imports and Local Sales				Exports and production			
			ΔM	M/D	ΔS	ΔPd	ΔEx	Ex/X	ΔXp	ΔPx
Full Unilateral Liberalization										
Agriculture	17	12	32	7	-2.6	-1.4	19	23	1.8	-0.6
Food Processing	15	5	9	21	-1.1	-1.2	4	28	0.1	-1.0
Mining and Energy	4	0	-4	48	-0.4	-0.6	10	12	0.9	-0.4
Other Manufacturing	12	3	3	57	-2.2	-1.3	8	21	-0.4	-0.9
Services	53	0	0	3	0.3	-0.2	3	2	0.4	-0.2
Total	100	3	4	23	-0.6	-0.7	10	12	0	0
CAFTA										
Agriculture	17	21	30	7	-0.9	1.4	-8	23	-2.3	1.0
Food Processing	15	8	5	21	0.3	0.6	27	28	7.1	1.0
Mining and Energy	4	2	1	48	0.4	1.6	0	12	0.4	1.6
Other Manufacturing	12	3	2	57	0.7	-0.2	5	21	1.4	0.0
Services	53	0	6	3	0.5	1.4	-4	2	0.4	1.4
Total	100	4	4	23	-0.6	-0.7	10	12	0.5	-0.5

Sources: Author calculations from model results.
Notes: The first two columns show pre-liberalization levels of sectoral outputs and tariff levels (in the top panel these are trade weighted averages of tariffs against all countries, in the bottom panel just against the U.S.). For a legend for **ΔM**, **ΔS**, **ΔPd**, **ΔEx**, **ΔXp**, **ΔPx** see Table 10.

In the full liberalization case, unskilled workers experience an economy-wide increase in their real wages. In fact the positive 0.4% increment is an average of the real wage changes recorded in the segmented markets case. In that set-up non-farm unskilled workers were experiencing a 2.9% raise, but farm workers were facing a –3.9% cut in their wages. The contraction of agriculture does not help unskilled workers in the CAFTA case. Demand for their services increases in the non-farm sectors but not to a level sufficient to compensate for the job losses of the farm sector.

Table 13: Factor price changes with perfect factor mobility

	ΔP	Δ(P/CPI)	ΔP	Δ(P/CPI)
	Full Liberalization		CAFTA	
Skilled Labor	1.1	2.5	3.0	2.5
Unskilled Labor	-1.0	0.4	-1.6	-2.1
Capital	1.8	3.2	5.2	4.7
Sk/Unsk wage gap		2.2		4.7
Price indexes:				
Food price index	-2.2		-0.1	
Non food price index	-0.9		0.9	
CPI	-1.4		0.5	

Overall, assuming flexible factor markets results in stronger specialization and in a slightly higher positive change in real GDP. In the full liberalization case, real GDP increases by about 1.1% with perfect mobility and by about 0.6% with segmented factor markets while in the CAFTA case the respective values are 1.1% and 0.5%. Assuming perfect mobility reduces an additional distortion and, as expected, aggregate results account for this improvement toward a first best case. Both perfect mobility as well as perfect segmentation are extreme characterizations of the functioning of factor markets, and the real situation would probably be in between these two extremes.

3.3 … and micro results: the poverty effects of trade reforms

The aggregate macro results, specifically the factor and goods price changes, are used to shock the micro data to produce a new income distribution. This counterfactual distribution accounts for the whole heterogeneity arising from household specific income and consumption shares, the θ's parameters in equations (1) and (2), and it thereby includes the full growth and inequality impact originating from the trade shocks. This way of obtaining the counterfactual distribution is labeled the "full distribution" approach.

In fact, a reform of trade policy not only results in different levels of aggregate income or GDP – the 'growth' impact – but also results in significant divergent shifts across factor returns – the distributive or 'inequality' impact. In order to appreciate the relevance of the distributive effect, we calculate an additional counterfactual distribution where incomes for all households are shifted according to the average growth effect, irrespective of their specific structure of income or pattern of consumption. This second simulated distribution has *almost* the exact same 'shape' as the initial one since *almost* no redistribution has occurred. The qualification is needed because under this distributionally neutral method, location specific growth rates are separately applied for rural and urban households. This method of calculating an additional simulated distribution is labeled the "distribution neutral" approach. A straightforward comparison between the full distribution and the distribution neutral results provides an assessment of

the distributive effect, excluding the significant distributive effects due to different average changes for rural and urban incomes.

For the trade reform scenarios analyzed here, the aggregate income change rates – consistently estimated by aggregation from the micro data shocked with the factor and goods prices changes – are shown in Table 14.

Table 14: Real income rates of change (percent) estimated by aggregation of the household surveys

	All	Urban	Rural
Equation (1) used for all households			
Full unilateral liberalization	**1.43**	**1.66**	**0.82**
CAFTA bilateral liberalization			
Nicaragua and US liberalize	**0.84**	**1.01**	**0.38**
Nicaragua liberalizes only	0.59	0.82	-0.01
US liberalizes only	0.24	0.19	0.38
Equations (1) and (2) used for different groups of households			
Full unilateral liberalization	**1.48**	**1.73**	**0.82**
CAFTA bilateral liberalization			
Nicaragua and US liberalize	**0.91**	**1.05**	**0.55**
Nicaragua liberalizes only	0.69	0.88	0.18
US liberalizes only	0.22	0.16	0.37

Table 14 highlights that trade liberalization is positive overall, however it tends to favor urban households more than rural ones. It also shows that calculating income changes for households headed by self-employed farmers with equation (1) creates a downward bias. Given the uncertainty linked to the imputation method implied by equation (1), we report poverty results when the income changes are estimated using the combined method of equations (1) and (2).[24]

These results are also clearly summarized in Figure 3: a gain of around 2% is the most likely change in income for a random household in the full liberalization scenario, and a gain close to 1% has the highest probability of occurring in the CAFTA case, which also shows less dispersion around this average gain.

[24] The figures in Table 14 are not fully consistent with those obtained from the CGE model. In fact even by modifying the SAM in accordance with the household survey, some discrepancies between the macro and micro databases remain. Besides, as already outlined, despite the segmentation in the factor markets of the CGE model, intra segment factors' mobility is allowed, and substitution across goods in consumption is permitted, whereas this is not case for the micro data. At the micro level, individuals never switch jobs and households' consumption patterns do not change: the parameters θ's are fixed.

Figure 3: Kernel Distribution of Gains/Losses: National

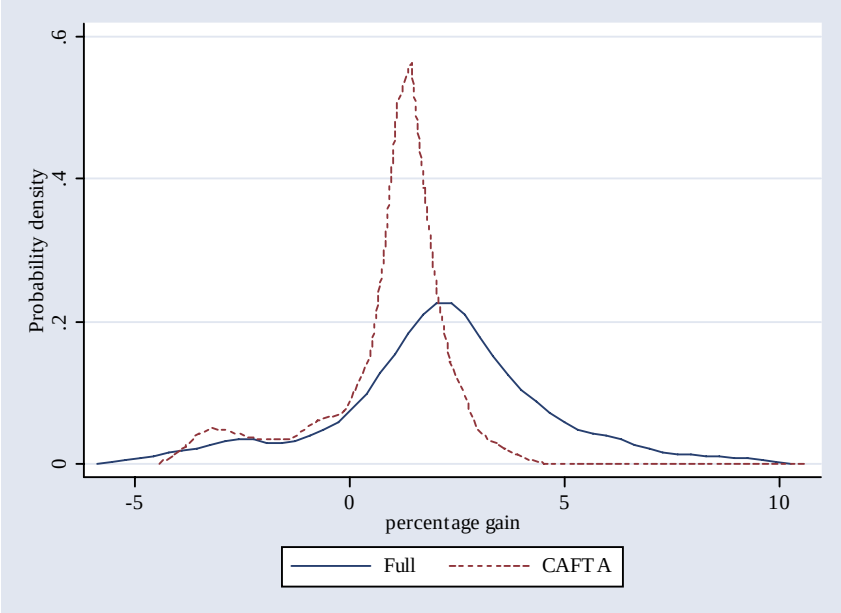


Table 15 shows the poverty effects estimated using the full distribution and the distributionally neutral approaches for the simulated unilateral non-discriminatory liberalization and CAFTA agreement. The initial poverty conditions in Nicaragua, as depicted by the indicators shown in the top panel of Table 15, are quite worrisome. Nicaragua is one of the poorest countries in Latin America with about half the population poor and more than 20% extremely poor. The situation looks even worse for the rural area where almost two-thirds of the population is poor and one-third is extremely poor. The poverty gap (PG) suggests that, for the whole sample, the perfectly targeted cash transfer needed to lift every poor person out of poverty is 21% of the poverty line, with considerable variations among the rural and urban portions of the sample. Inequality among the poor, measured by the severity index (P2), seems to be fairly high for the rural population. High population growth rates have offset the positive GDP growth rate of the last decade and in 2001 there were as many poor as in 1993. Nicaragua registers fertility rates that are twice the Latin American average, and its overall social situation is furthermore aggravated by high incidence of domestic violence, malnutrition, high

maternal and infant mortality rates and high prevalence of infectious and parasitic diseases.[25]

Table 15: Initial poverty levels[26] and percent changes due to trade reforms

			Initial distribution					
			H	PG	P2			
			Absolute levels					
Initial levels	**All**	**PovLine**	49.8	21.0	11.6			
		ExtremePL	21.0	6.9	3.3			
	Urban	**PovLine**	39.8	14.9	7.6			
		ExtremePL	12.5	4.1	1.9			
	Rural	**PovLine**	63.9	29.5	17.1			
		ExtremePL	32.9	10.9	5.3			
			Full distribution			**Neutral distribution**		
			H	**PG**	**P2**	**H**	**PG**	**P2**
			Percent changes from initial levels					
Full unilateral lib. (segmented)	**All**	**PovLine**	-1.6	-3.7	-4.9	-1.3	-2.0	-2.4
		ExtremePL	-4.4	-6.9	-9.6	-2.5	-3.0	-3.1
	Urban	**PovLine**	-2.5	-6.3	-8.4	-1.6	-2.8	-3.2
		ExtremePL	-7.0	-11.3	-15.5	-2.5	-3.5	-3.8
	Rural	**PovLine**	-0.9	-1.8	-2.8	-0.4	-1.0	-1.2
		ExtremePL	-3.1	-4.6	-6.7	-1.0	-1.6	-1.7
CAFTA bilateral lib. (segmented)	**All**	**PovLine**	-0.3	-1.2	-1.4	-0.7	-1.2	-1.5
		ExtremePL	-0.9	-1.8	-2.5	-1.1	-1.8	-2.0
	Urban	**PovLine**	-0.4	-2.3	-2.8	-1.2	-1.7	-2.0
		ExtremePL	-1.0	-3.4	-4.4	-1.3	-2.1	-2.4
	Rural	**PovLine**	-0.2	-0.4	-0.5	-0.3	-0.6	-0.8
		ExtremePL	-0.8	-1.0	-1.5	-0.7	-1.1	-1.2

In the long run, an open and transparent trade policy enhances growth opportunities by – among other things – facilitating access to new technologies, promoting foreign direct investment, and increasing incentives for pursuing balanced domestic macro policies. In general, it can help reduce poverty. Nonetheless, in this paper, only the short-term impacts of trade reforms on poverty are considered, focusing on the potential immediate problems or benefits for the poor, which helps formulate any compensatory measures.

Overall, both liberalization scenarios marginally reduce poverty in Nicaragua, with the non-discriminatory one being more pro-poor than CAFTA. A positive aspect is

[25] For a full analysis of the poverty situation and its evolution in the last decade see World Bank Report No. 20488 NI, titled "Nicaragua Poverty Assessment, volumes 1 and 2.

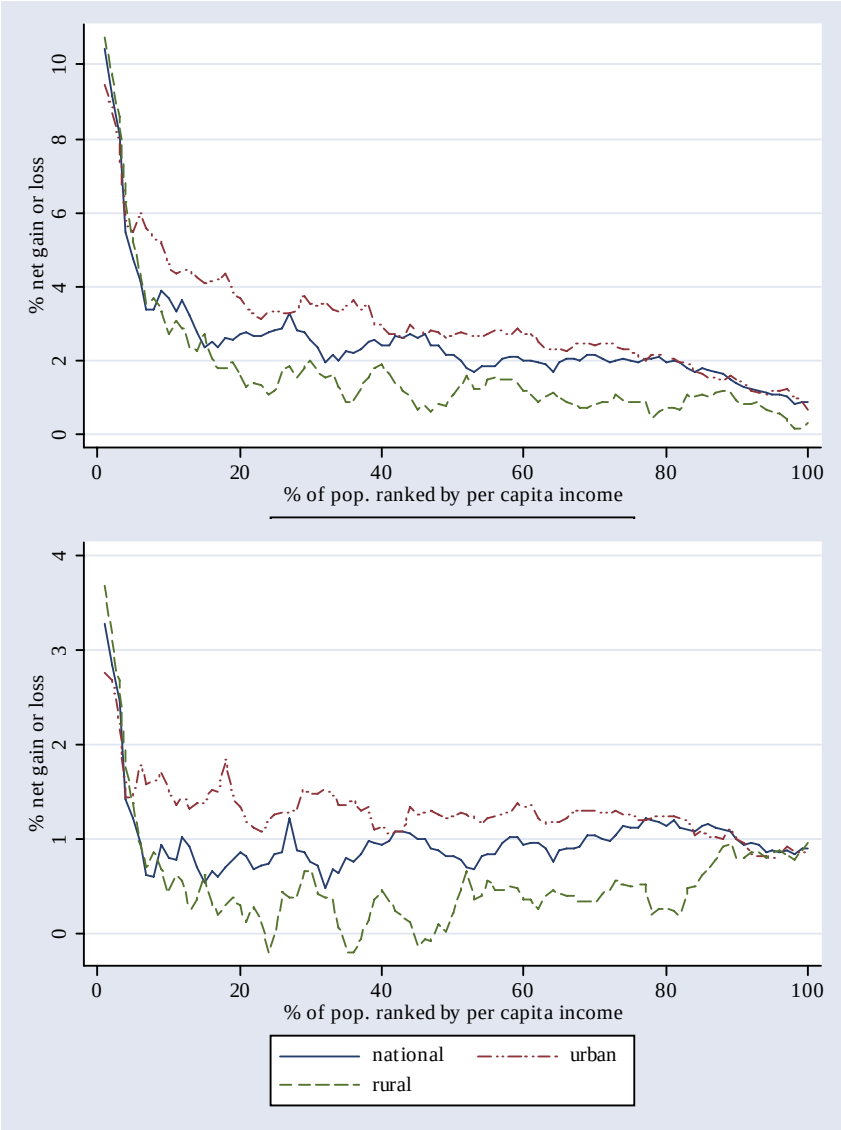
[26] Although informative, the rural and urban poverty measurement obtained using a single national poverty line may be to some extent misleading. Price levels and the corresponding purchasing powers in the rural and urban sectors of the economy can be quite different so the zone specific poverty lines should be used to guarantee more accurate estimates.

that percentage reductions are larger when poverty is measured at the extreme poverty line than at the normal one.

Both trade liberalization scenarios induce larger poverty reductions for the urban than the rural population. However, the two scenarios differ in their distributive impacts. For the non-discriminatory liberalization, poverty reductions (across all categories) are actually higher in the full distribution approach than in the distribution neutral one, suggesting that this type of trade reform induces a pro-poor distributional shift. The opposite happens in the CAFTA scenario. Notice that comparing the full and the neutral distributional approaches accounts only for the distributive shift that is left after the different 'growth' effects from Table 14 are applied to the urban and rural areas. This *net* distributive shift is due to what happens *within* the urban and rural areas and is caused by anti- or pro-poor changes in factor relative prices and inputs or output commodity prices. Incomes of poor people are determined, on the one hand, by transfers, auto-consumption and other transactions unaffected by changes in market prices, and, on the other hand, by unskilled labor wages, or profits for the self employed farmers (besides the changes in the costs of final consumption). In the case of the full unilateral liberalization experiment, as shown in Table 5, unskilled labor wages, in the farm segment, are declining more steeply than returns of the other factors; however they are increasing more rapidly in the non-farm segment. In the CAFTA scenario, the farm unskilled wages contraction is about the same as in the full liberalization (see the last column of Table 9) and, for the same type of labor, this is not compensated by a higher increase in the non-farm segment. Besides in the farm sectors, the ratio of output to input prices tends to be more favorable to the self-employed farmers in the non-discriminatory liberalization than in the CAFTA case.

The complete distributional effect can be seen in Figure 4, which plots incidence curves for the two trade policy reforms, and for the total, urban and rural populations. These graphs confirm the observations based on the more aggregate indicators of the previous table: the urban population enjoys larger gains and the full liberalization scenario is more progressive than CAFTA.

Figure 4: Mean Percentage Gains by Per Capita Income Percentile: Full Liberalization (top graph), CAFTA liberalization (bottom graph)



An additional way of examining the impacts of trade policy reforms on poverty is offered in Table 16. In particular this table highlights the small proportion of individuals losing because of the reforms: 15% and 18% for the two cases considered. It also signals what we have already reported, namely that there are potential risks for the rural poor: within this specific category, the share of people experiencing income losses can reach more than 33%.

Table 16: trade induced gains and losses (percentages with respect to pre-liberalization levels)

	Full lib. (segmented)	CAFTA (N + US) (segmented)
Mean percentage difference between simulated and initial incor		
All	2.49	0.98
Poor-Urban	4.45	1.54
Poor-Rural	2.22	0.50
NPoor-Urban	2.13	1.13
NPoor-Rural	0.81	0.59
Mean percentage difference for gainers (%)		
Poor-Urban	5.06	2.10
Poor-Rural	3.67	1.68
NPoor-Urban	2.39	1.31
NPoor-Rural	1.86	1.33
Mean percentage difference for losers (%)		
Poor-Urban	-2.05	-1.90
Poor-Rural	-2.13	-1.83
NPoor-Urban	-1.97	-1.92
NPoor-Rural	-1.77	-1.64
Percentage of individuals with losses (%)		
All	15.08	17.94
Poor-Urban	1.99	3.25
Poor-Rural	6.67	8.96
NPoor-Urban	2.06	1.97
NPoor-Rural	4.37	3.77
Percentage of individuals with losses (% of each category)		
Poor-Urban	8.59	14.06
Poor-Rural	25.00	33.59
NPoor-Urban	5.87	5.61
NPoor-Rural	28.89	24.89

Note: Poor and non-poor are defined at the initial income level.
The results are the case of the "full distribution" approach.

Having identified some variation in the effects of trade liberalization across households, it would be interesting to see how these effects vary with observed household characteristics; identifying strong correlates should help in designing compensatory policies. To do that, the logarithm of the change in per capita incomes[27] under different scenarios considered above is regressed on the age, age squared, gender and education level of household head, the logarithm of household size, the ratios of number of infants (age 0-5) and children (6-12) to household size, urban and regional dummies, the ratio of number of workers to household size, and the ratios of number of agricultural and skilled

[27] These incomes are computed by separating out auto-consumption and using household-specific price indices. In addition, the simulated incomes are calculated under the full distribution approach.

workers to the total number of workers in the household.[28] They are estimated by Ordinary Least Squares and the results are summarized in Table 17.

Table 17: Regression for logarithms of income changes

	Full lib. (segmented)		CAFTA (segmented)	
	Coef.	Robust Std. Err.	Coef.	Robust Std. Err.
Household head's characteristics				
age	0.019	0.012	***0.030	0.011
age squared	-1.20E-04	1.14E-04	**-2.20E-04	1.04E-04
female	-0.035	0.061	***-0.174	0.057
education				
(no education)				
primary or less	***0.323	0.065	***0.414	0.063
secondary	***0.407	0.095	***0.423	0.093
technical	***0.428	0.149	***0.369	0.128
university or above	0.271	0.288	***0.994	0.146
Demographic variables				
logarithm of hhsize	***-0.363	0.071	***-0.235	0.064
ratio of no. of infants (0-5) to hhsize	-0.283	0.244	-0.245	0.221
ratio of no. of children (6-12) to hhsize	0.278	0.198	0.199	0.190
Geographic variables				
urban	0.021	0.092	*-0.140	0.079
regions				
(Managua)				
Pacific	***-0.296	0.070	***-0.381	0.065
Central	***-0.415	0.084	***-0.333	0.076
Atlantic	-0.142	0.102	0.059	0.098
Employment variables				
Ratio of wokers to household size	0.164	0.140	***0.894	0.132
Ratio of agri. workers to total workers	***-2.470	0.115	***-2.536	0.098
Ratio of skilled workers to total workers	**0.212	0.088	***0.405	0.083
Constant	***5.063	0.309	***3.735	0.285
R2	0.43		0.47	
No. of observations	4169		4169	

Note: The dependent variables are the percentage change from the initial income. Significance level of 1%, 5% and 10% are indicated by ***, ** and * respectively.

As expected, the two scenarios display similar results. Education variables unambiguously show that the more educated the household head, the larger the percentage gains of the household, which seems to coincide with the positive coefficient

[28] A similar regression analysis is found in Chen and Ravallion (2003).

on the ratio of skilled workers. This can be partly explained by the fact that more unfavorable effects on wage were observed for unskilled labor in the farm sector under both scenarios (see Tables 5 and 9 above).

There also seems to be some geographical variation in the impacts of the reforms. It is rather puzzling to see the negative coefficient on the urban dummy under CAFTA, though significant only at a 10% level. But the coefficients on the regional dummies show that households in the capital Managua (the largest urban center) tend to gain more from trade liberalization. The negative coefficient on the logarithm of household size is not very intuitive given the food price declines. However, the greater the ratio of household members in the labor force, the more would the household benefit from trade reforms. Finally, given the price changes employed in these simulation exercises, the sign and significance of the coefficient on the ratio of household members working in the farm sector are self-explanatory. Some of the counter-intuitive results from these regressions emphasize the importance of using the full distribution of income, as opposed to just average poverty and inequality indicators, to fully understand what drives poverty dynamics and prepare government responses to possible anti-poor impacts.

4 Conclusions

This paper analyzes the income distribution and poverty impacts of various trade options currently under the scrutiny of Central American policy makers, and in particular, it assesses for Nicaragua the poverty effects of the DR-CAFTA recently signed between five Central American countries plus the Dominican Republic and the U.S. The methodology adopted here relies on a general equilibrium macro model, used to simulate various trade reform scenarios and to estimate the price effects of these scenarios, and a micro-module which maps the aggregate general equilibrium price changes onto variations of real incomes at the individual household levels. Among the various assumptions that make this complex analysis treatable, the main one consists of taking

into account just the short-term impacts. In fact, the simulations carried out in this analysis do no consider the gradual multi-year phasing in of the liberalization scenarios. The 'big-bang' implementation of the scenarios, where tariffs are eliminated in a single step, implicitly assumes that negatively affected parties have to adjust instantaneously to the new situation and it is useful because it permits highlighting potential problems linked to the new commercial policies. These potential problems may not materialize in the real world given that trade reforms, such as the current DR-CAFTA agreement, envision gradual phase out of tariffs and other protection measures over a 15 to 20 year time span. In such a time horizon, growth effects derived from investments in physical and human capital and increased flows of foreign direct investment (a potential important indirect benefit of trade reforms), as well as large consumption shifts toward services due to higher incomes per capita, can strongly enhance the adjustment capacity of economic agents and can even reverse initial negative results.

Notwithstanding these simplifications, important economic policy messages can be inferred from the analysis in this paper. The first is that different trade policy options can produce quite different aggregate and poverty effects. Due to the sectoral concentration of imports coming from the U.S. and the initial tariff structure, which is biased in favor of *Basic Grains*, a strong agricultural import inflow entailed by a regional agreement with the U.S. seems to raise some concerns for a short-term potentially unfavorable rural poverty effect in a big-bang scenario. This occurs as cheaper grains from the U.S. enter the Nicaraguan market and depress prices and factor returns of farmers. Adoption of a ('big-bang') regional liberalization should be counterbalanced in the short term – during which farmers cannot easily switch occupations or even crops they cultivate, and these difficulties are particularly serious for small poor farmers – by two additional policy interventions such as a further non-discriminatory trade liberalization and a compensatory transfers policy targeted toward poor farmers. Through the first, as shown in the unilateral full trade liberalization simulation, the sectoral imbalance in import inflows should be corrected and thus also the price bias against the rural factors. And the second transfer policy should temporarily assist farmers in their adjustment toward expanding sectors.

In fact this advice is fully consistent with a key policy recommendation that emerges from the literature on regional trade agreements,[29] specifically that benefits of regional agreements normally outweigh their costs when protection against outsiders is low. The poverty results produced in this paper appear to reinforce this view: to boost trade-induced poverty reductions, Nicaragua should consider enlarging its own liberalization to countries other than the U.S.

Another important conclusion is that factor price changes appear to have a more important role than goods price changes across the various transmission channels between trade reform and poverty. Therefore subsidizing consumption may be less effective than subsidizing employment or directly supporting income of the poorer, however, this should only be temporary and well targeted.

The results presented in this paper are broadly consistent with those obtained in other existing studies on DR-CAFTA, which illustrate the overall positive impact of DR-CAFTA on Central American economies based on CGE models (e.g., Brown *et al*., 2005; Hilaire and Yang, 2004; Francois *et al*., 2005). Francois *et al*. (2005), for instance, illustrate the further export specialization on the textile and apparel sector shifting resources away from agricultural sectors, which can generate significant adjustment strains. Given the increasing competition from China in the textile and apparel sector, they argue for the importance of implementing policies aimed at diversifying exports and increasing agricultural competitiveness. Moreover, Brown *et al*. (2005) also find that Central American countries would enjoy a larger welfare gain from unilateral free trade than CAFTA as shown in our simulation analysis.

The main limitation of these studies is, however, that Central American countries are treated as one entity and the differences in the economic structures and endowments within the region are not taken into account. Among the countries, the poverty rates vary from 20% in Costa Rica to 60% in Nicaragua (Francois *et al*., 2005) and the GNI per capita of Nicaragua was only US$790 in 2004 while it was US$4,670 for Costa Rica.[30] The latter also has a larger fraction of its industrial exports classified as high-technology products unlike the rest of the member countries (Francois *et al*., 2005).

[29] See for excellent surveys World Bank (2000): Trade Blocks, and World Bank (2005): Global Economic Prospects 2005: Trade, Regionalism, and Development.
[30] World Development Indicators 2005.

These differences highlight the need to evaluate the impact of DR-CAFTA on Central American economies individually, particularly from the poverty perspective. We hope that our analysis has contributed to the better understanding of the impact of DR-CAFTA on poverty by examining the case of Nicaragua where poverty is most severe in this region and by accounting for the heterogeneity of economic activities and preferences among individual households.

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6 Annexes

1 – The Social Accounting Matrix

The Social Accounting Matrix for Nicaragua has been estimated using the 2000 input output table provided by the Central Bank of Nicaragua as a starting point. The Central Bank base year for the national accounts is 1994 and the latest update for the input output table is the year 2000.

Given our interest in income distribution and trade, the input output table has been modified to include more factors of production and multiple trading partners. We have disaggregated the value added accounts and estimated payments from the various production sectors to three separate factors: skilled labor, unskilled labor and composite capital (which includes payments to land). The sectoral employment and average wages for these factors have been derived from the 2001 LSMS survey and the classifications of sectors used in the survey and the input output table have been merged in a consistent common classification shown below in the list of the SAM accounts. Using the household survey to modify the value added reported in the input output table is a crucial step given that the main link between the macro and micro modules is given by the sectoral factor returns. Inconsistencies in the estimation of value added between the input output and the household survey – each uses different definitions, sampling, and reference moments in time (recall for instance that the National Accounts are based on some technical coefficient estimated for the year 1994) – cannot be fully eliminated. However, our simple 'reconciliation' approach assures a minimum of compatibility across the two data source so that our macro-micro model can produce sensible results.

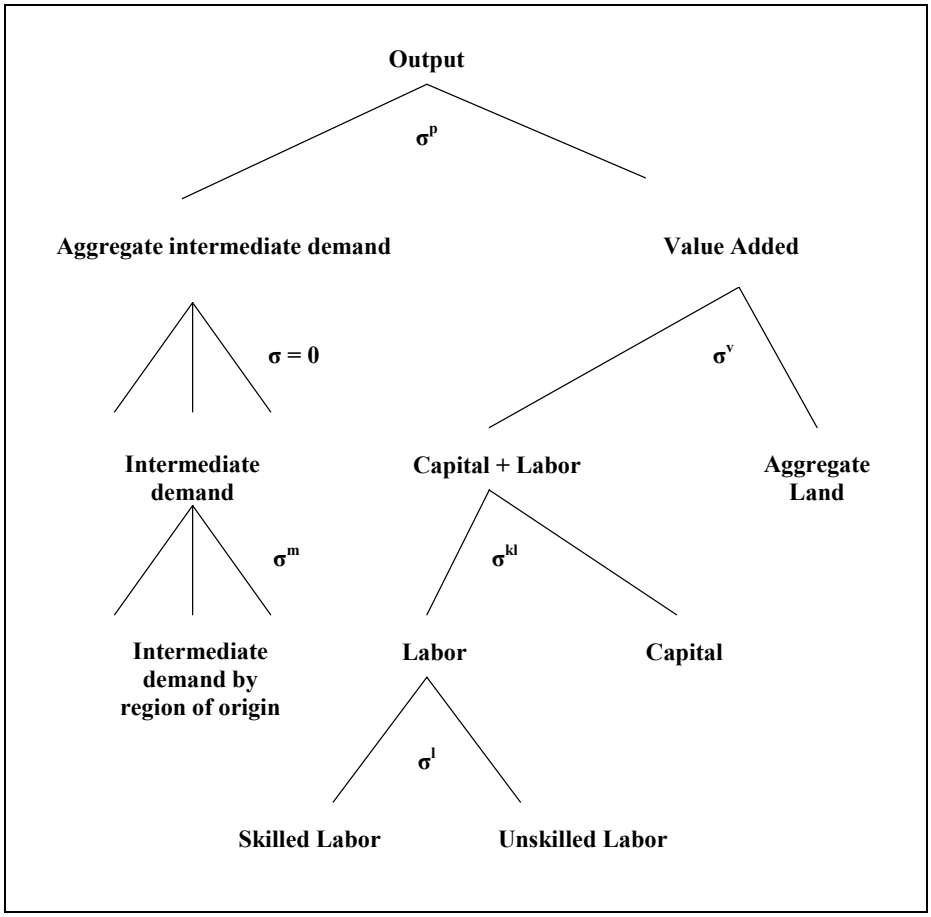
The imports and exports accounts as well as the tariff rates have been estimated using the UN Comtrade database for different trading partners, including the U.S., the rest of Central America, the European Union and others (although in the model version used here, we just distinguish between the U.S. and the Rest of the World). Tariff rates for the commodities included in the model have been calculated as weighted averages using imports flows as weights. Tariff revenues calculated with this procedure have been

compared with those reported by the Central Bank and the resulting discrepancies were negligible.

Table 18: List of accounts for Nicaragua SAM (2000)

	English short label	English label	Spanish label
1	ACoffee	Coffee	Café oro
2	ASugarCane	Sugar Cane	Caña de azúcar
3	ABasicGrain	Basic Grains	Granos básicos
4	AOthAgrPr	Other Agricultural Products	Otros productos agrícolas
5	ALivestock	Livestock	Animales vivos y productos animales
6	AForestry	Forestry	Productos de la silvicultura y extracción de madera
7	AFishery	Fishery	Pescado y productos de la pesca
8	AMining	Mining	Productos mineros
9	AEleGasWat	Electricity Gas Water	Electricidad, gas de ciudad, vapor y agua caliente
10	AWatDistr	Water Distribution, Sewers	Agua y alcantarillado
11	AMeatFishPr	Meat Fish Products	carnes y pescados
12	ASugarPr	Sugar Products	Azúcar
13	ADairy	Dairy	Lácteos
14	AOthFood	Other Food	Otros alimentos de origen industrial
15	ABever	Beverages	Bebidas
16	ATobacco	Tobacco	Tabaco
17	ATextClotLeat	Textiles Clothing Leather	Hilados, tejidos, prendas de vestir, productos de cuero y calzado
18	AWoodPr	Wood Products	Productos de madera, muebles y otros productos transportables
19	APaperPrint	Paper Print	Pasta de papel, papel y productos de papel, impresos y artículos análogos
20	ARefOil	Refined Oil	Productos de petróleo refinado
21	AChemPr	Chemicals and other Products	Productos químicos básicos y elaborados: Productos de caucho y plásticos
22	AGlassNoMetPr	Glass Non Metal Products	Vidrio, productos de vidrio y otros productos no metálicos n.c.p.
23	AMetPr	Metal Products	Metales comunes y productos metálicos elaborados
24	AMachEqp	Machinery and Equipment	Maquinaria y equipo de transporte
25	AConstruct	Construction	Construcciones
26	ACommerce	Commerce	Comercio, reparaciones de automóviles y productos de recuperación
27	AHotRest	Hotels and Restaurants	Servicios de hoteles y restaurantes
28	ATrspServ	Transport Services	Servicios de transporte
29	ACommtServ	Communication Services	Servicios de correos y comunicaciones
30	AFinServ	Financial Services	Servicios de intermediación financiera y servicios conexos
31	ARealEst	Real Estate	Servicios inmobiliarios y alquileres de vivienda
32	ABusinServ	Business Services	servicios empresariales
33	APAServ	Public administarion Services	Servicios de administración pública
34	AEducPrv	Private Education	Servicios de enseñanza de mercado
35	AEducPA	Public Education	Servicios de enseñanza de no mercado
36	AHealthPrv	Private social and health services	Servicios sociales y de salud de mercado
37	AHealthPA	Public social and health services	Servicios sociales y de salud de no mercado
38	AAssocServ	Other Services	Servicios de asociaciones, esparcimiento y otros servicios
39	ADomServ	Domestic Services	Servicios domésticos
40	LABUS	Skilled Urban Labor	
41	LABUU	UnSkilled Urban Labor	
42	LABRS	Skilled Rural Labor	
43	LABRU	UnSkilled rural Labor	
44	KAPU	Urban Capital	
45	KAPR	Rural Capital	
46	PRDTX	Production Taxes	
47	INDTX	Indirect taxes	
48	DIRTX	Direct Taxex	
49	IMPTX	Import Tariffs	
50	hh	Households	
51	GOVNT	Government	
52	INVST	Investment	
53	DELST	Variation of stocks	
54	ROW1	US	
55	ROW2	Rest Of the World	
56	BOP	International Financial Account	
57	tot	Total	

2 – The production nesting structure



Note: Although the model allows substitution between Land and the other primary factors, given that the data for separating land and other factors contributions to value added was not available, the nesting structure actually active in the current model does not include Land as a separate factor.

3 – Formal derivation of poverty effects in the micro module

The indirect utility function of household h is a function of the income y_h and of a vector of prices of goods, **p**.[31] That is:

$$v_h = v_h(y_h, \mathbf{p}) \tag{1}$$

Totally differentiate (1):

$$dv_h = \frac{dv_h}{d\mathbf{p}} d\mathbf{p} + \frac{dv_h}{dy_h} dy_h \tag{2}$$

Dividing both sides by the marginal utility of income $\left(dv_h / dy_h\right)$ and using Roy's identity, we obtain:

$$\frac{1}{dv_h / dy_h} dv_h \equiv dw_h = \sum_g - c_{h,g} dp_g + dy_h \tag{3}$$

where dw_h is the monetary value of the change in indirect utility, $c_{h,g}$ is the consumption of good g by household and dp_g is the change in price of good g. Income of household h is given by the sum of labor income, remittances (which are a function of wages), profits associated with production of a particular good and income obtained through government transfers (partly tariff revenue):

$$y_h = \underbrace{w\ell_h}_{labor\ \text{income}} + \underbrace{R_h(w)}_{remit\ \text{tances}} + \underbrace{\pi\ Kap_h}_{profits} + \underbrace{G_h + \phi_h \sum_g t_g p_g^w m_g}_{government\ \text{transfers}} \tag{4}$$

[31] The following formalization is just an adaptation of that found in Nicita and Olarreaga (2004) "Trade, Trade reforms and Poverty in Ethiopia".

where w is the wage rate, ℓ_h is the (net) amount of labor sold in the market by household h; R_h are remittances received by household h, π_h is the rental rate and Kap_h is the amount of land or other physical capital own by the household (and used in the household production of goods directly sold in the market); G_h are government transfers to household h not associated with tariff revenue, ϕ_h is the share of tariff revenue redistributed to household h and the sum that follows is the tariff revenue collected over all goods g .

To be consistent with the CGE model three further assumptions follow: i) households choose optimally the amount of labor to sell in the labor market; ii) households choose optimally the amount to produce in their own business and iii) all remittances are associated with transfers from non-poor individuals who obtained their income in the labor market, i.e., $R_h = w\ell^R_h$ where ℓ^R_h is the (net) amount of labor that gets transferred to household h as remittances. Then, differentiating (4) using Hotelling's Lemma and the Envelope theorem, yields:

$$dy_h = dw\ell_h + dw\ell^R_h + d\pi K_h + \phi_h \sum_g dt_g p^w_g m_g + \phi_h \sum_g t_g p^w_g dm_g \qquad (5)$$

Substitute equation (5) into (3), divide everywhere by income of household h assuming that income equals expenditure, and rearrange terms to obtain:

$$\frac{dw_h}{y_h} = \underbrace{\sum_g -\theta^c_{h,g}\dot{p}_g}_{consumption} + \underbrace{\theta^\ell_h \dot{w}}_{labor\ \text{income}} + \underbrace{\theta^R_h \dot{w}}_{remit\ \text{tances}} + \underbrace{\theta^{kap}_h \dot{\pi}}_{profits} + \underbrace{\sum_g \theta^T_{h,g}\left(\dot{t}_g + \dot{m}_g\right)}_{tariff\ \text{revenue}} \qquad (6)$$

where a "dot" on top of the variable expresses percentage changes; $\theta^c_{h,g} = p_g c_{h,g} / y_h$ is the share of expenditure (or income) spent on good g by household h; $\theta^\ell_h = w\ell_h / y_h$ is the share of income spent obtained in the labor market by household h; $\theta^R_h = w\ell^R_h / y_h$ is the share of income that household h obtains as remittances; θ^{kap}_h is the share of income of household h obtained from running the household business; $\theta^T_{h,g} = \phi_h t_g p^w_g m_g / y_h$ is the

share of transfers from the government to household h associated with tariff revenue in good g on total income of household h.

Because we are interested on the impact of tariff reforms on the welfare of poor households, to apply equation (6) we need the changes in p_g, w and π_h that follow a trade reform and these are given by the general equilibrium prices obtained in the CGE. Notice also that the estimates obtained by using equation (6) take into account only first order effects. Indeed household substitute goods in their consumption bundle, enter and exit the factor markets, and, therefore, full effects should also consider changes in the shares θ_h^{kap} $\theta_{h,g}^{c}, \theta_h^{\ell}$ (but these require a fully blown micro-simulation model).

In order to express the change in welfare in monetary units, one simply needs to multiply the expression in (6) by household income, then usual estimates of poverty effects are straightforward.