FTAA and Colombia:
Income Redistribution across Labor Groups

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Colombia is set to enter the Free Trade Agreement of the Americas and internal income redistribution can be anticipated. A specific factors model of production with seven skilled groups of labor is applied using projected price changes for the three major sectors of the economy. All labor groups except production labor are projected to lose. Manufacturing capital gains at the expense of capital in agriculture and services. Predicted effects are large, suggesting economic policy should begin to focus on the pending adjustment to FTAA.

Free trade increases global efficiency and aggregate income but income redistribution continues to dominate the political debate. Some productive factors stand to lose real income with free trade, at least prior to retraining and long run economic growth. The present paper examines the potential impact of the Free Trade Agreement of the Americas (FTAA) in Colombia in a comparative static specific factors model with various skilled labor groups. Thompson (1994) develops a similar model for the Japanese economy, and

Thompson and Toledo (2001) examine the potential income redistribution in Bolivia due to a merger between the Andean Market and MERCOSUR.

FTAA is expected to become effective by 2005 and the potential impacts on individual economies can be examined in general equilibrium models of production and trade. The basic method is to simulate the effects of changing prices on factor prices and outputs. There is little doubt that FTAA will expose Colombian firms in all sectors to international competition, increasing efficiency and stimulating growth, but there is concern about how trade liberalization will redistribute labor income and affect income inequality.

The simulations are based on factor shares and industry shares across the three major aggregates of output derived from data provided by the National Household Survey of Colombia (La Encuesta Nacional de Hogares). Labor is disaggregated into seven different skill categories and capital is assumed to be sector specific. Assumptions of the model include full employment with labor perfectly mobile across sectors and perfect competition with cost equal to price. Constant elasticity production functions and constant returns to scale are assumed. The model generates general equilibrium elasticities of factor prices with respect to prices of agriculture, manufacturing, and services. A new measure of factor intensity is shown to anticipate the income redistribution elasticities.

Policy implications are discussed. The mistrust and insecurity of some labor groups are based on the anticipation that there is a lot at stake with FTAA. The move towards free trade is perhaps politically more complicated in Colombia than in other Latin American countries. Forty years of civil conflict have created millions of internal refugees, "the displaced" moving from rural to urban areas to escape the threat of guerrilla fighting. Unemployment has reached 17% but including street vendors and subsistence self-employment it could be over 50% according to estimates of the Colombian Statistical Authority (DANE, 2002). The same study estimates that close to half of the population lives in absolute poverty. This delicate situation raises the question of whether the economy can undertake pressure from foreign competition. While there is no question regarding long term gains from trade, the transition process should avoid social conflict and increased temporary poverty. A look at the potential impact of FTAA on income redistribution across labor groups may contribute to policy that would smooth the transition to free trade.

1. Factor Shares and Industry Shares in Colombia

Table 1 presents the total payment matrix for capital, derived as a residual, and each skill group of labor:

Professionals
Managers
Clerks
Sales
Service
Agriculture
Production

* Table 1 *

Table 2 presents the related factor shares, the share of each factor in the revenue of each sector. Summing down a column in Table 1 gives total sector revenue. For instance, total revenue of agriculture is 19,181 million pesos and the capital share is 9,840/19,181 = 0.513 = 51.3%, implicitly including land. Capital is the largest factor share in each sector. The largest labor shares go to agriculture workers in that sector, production workers in manufacturing, and professional workers in services.

* Table 2 *

Industry shares are in Table 3. Summing across rows in Table 1 gives total factor incomes. Assuming perfect labor mobility, the wage of each labor is the same across sectors, and the share of each factor employed in each sector, the industry shares, can be derived. For instance, the total income of professionals is 5,162 million pesos, and 4,325/5,162 = 0.838 = 83.8% of professionals work in services. Very large shares of professionals, managers, and service workers are in the service sector, and production workers in manufacturing. Agriculture workers are virtually sector specific.

* Table 3 *

2. Measuring Factor Intensity

Let a_{ij} represent the cost minimizing input of factor *i* in good *j*. With two factor and two products, good 1 uses factor 1 intensively if

$$a_{11}/a_{21} > a_{12}/a_{22} \tag{1}$$

Factor intensity is less transparent in the present model with various factors and goods. The factor intensity distance of Thompson (2003) is the Euclidean distance from the unit value of a factor to the intensity hyperplane of a product, derived as the intersection of intensity rays with the unit line a_{ij} = 1. The distance from to the ray for product *j* is a_{2j}/a_{1j} and good 1 uses factor 1 intensively if the distance from the point a_{11} = 1 to the ray for good 1 is smaller, $a_{21}/a_{11} < a_{22}/a_{12}$. For any number of factors, the Euclidean distance to the intensity hyperplane relative to factor 1 is a generalization of (1),

$$d_{1j} = \left(\left(a_{2j}/a_{1j}\right)^2 + \ldots + \left(a_{rj}/a_{1j}\right)^2\right)^{1/2} \tag{2}$$

The factor intensity distance for factor *h* in product *j* is

$$d_{hj} = \left(\Sigma_{i\sim h}\left(a_{ij}/a_{hj}\right)^2\right)^{1/2}. \tag{3}$$

Factor intensity distance generalizes the concept of factor intensity to any number of factors and goods. Good *m* uses factor *h* intensively relative to good *n* if $d_{hm} < d_{hn}$.

For each factor, goods are ranked by factor intensity distance. To eliminate the issue of different units for labor and capital, inputs are weighted by their averages across industries. For example, consider. The weight of the a_{ij} across industries is $\alpha_{ij} = a_{ij}/\mu_i$ where $\mu_i = \sum_j a_{ij}/n$ and *n* is the number of goods, resulting in ratios $\alpha_{ij}/\alpha_{hj} = \left(a_{ij}/a_{hj}\right)\left(\sum_j a_{hj}/a_{ij}\right)$. The α_{ij} are have no units and their ratios can be added as in (3).

Table 4 shows unit labor inputs per hundreds of pesos of value added across industries. Reading down the column for agriculture in Table 4, there is more input of agriculture workers per unit of output than any other type of labor. For manufacturing, production workers are the largest unit labor input, while service workers and professionals are the largest in services.

* Table 4 *

Distance factor intensities in Table 5 are derived with (3) but inverted and rescaled (multiplied by 4) making 100 the most intensive input. There are vast differences in factor intensity, with agricultural workers in agriculture the most intensive by far followed production workers in manufacturing. In agriculture, production and service workers are a distant second. In manufacturing, sales and managers are the next most intensive. There is less contrast in services, where service workers are followed by professionals,production workers, and managers.

* Table 5 *

Reading across industries for each input, service workers, professionals, and managers are much more intensively used in services than in manufacturing, and very little in agriculture. Similarly, production workers, sales, and clerks are used more intensively in manufacturing.   Factor intensity is a driving force in the comparative statics of general equilibrium as discussed by Thompson (1995).

3. A Specific Factors Model of Production for Colombia

Substitution elasticities describe the adjustment in cost minimizing inputs to factor price changes as developed by Jones (1965) and Takayama (1982).   Following Allen (1938), the cross price elasticity between the input of factor *i* and the payment to factor *k* in sector *j* can be written

$$E_{ij}^{k} = \hat{a}_{ij}/\hat{w}_{k} = \theta_{kj} S_{ij}^{k} \tag{4}$$

where ^ represents and percentage change in a variable and S_{ij}^{k} is the Allen partial elasticity of substitution. With Cobb-Douglas production, $S_{ij}^{k} = 1$. Homogeneity implies $\sum_k E_{ij}^{k} = 0$, and the own price elasticity E_{ij}^{i} is the negative of the sum of cross price elasticities. The cross price elasticity is a weighted Allen elasticity and with Cobb-Douglas production it equals the factor share. Aggregate substitution elasticities for the economy are the weighted average of the cross price elasticities for each sector. Elasticities are summed across industries to arrive at aggregate substitution elasticities, as described by Thompson (1994):

$$\sigma_{ik} \equiv \hat{a}_i / \hat{w}_k = \Sigma_j \lambda_{ij} E^k_{ij} = \Sigma_j \lambda_{ij} \theta_{kj} S^k_{ij} . \tag{5}$$

Factor shares and industry shares are used to derive the aggregate substitution elasticities in Table 6. Constant elasticity of substitution (CES) production would scale these elasticities. With CES of 0.5, for instance, elasticities would be half as large. The largest own substitution elasticity is for sales labor. There is generally less substitution for capital.

* Table 6 *

Competitive pricing is stated $\Sigma_i a_{im} w_i = p_m$ and full employment $\Sigma_j a_{kj} x_j = v_k$, where x_j is the output of good j, v_k is the endowment of factor k, w_i is the price of factor i, and p_m is the price of good m. Fully differentiating leads to

$$\Sigma_i \sigma_{ki} \hat{w}_i + \lambda_{kj} \hat{x}_j = \hat{v}_k , \tag{6}$$

$$\Sigma_i \theta_{im} \hat{w}_i = \hat{p}_m , \tag{7}$$

where ^ represents percentage change as developed by Chang (1979) and Takayama (1982). The 10 equations in (6) and (7) are put into matrix form as

$$\begin{bmatrix} \sigma & \lambda \\ \theta' & 0 \end{bmatrix} \begin{bmatrix} \hat{w} \\ \hat{x} \end{bmatrix} = \begin{bmatrix} \hat{v} \\ \hat{p} \end{bmatrix} \tag{8}$$

where σ is the 10x10 matrix of substitution elasticities, λ is the 10x3 matrix of industry shares, and θ' is 3x10 matrix of factor shares. The 13x13 matrix in (10) relates exogenous changes in factor endowments *v* and prices *p* to endogenous changes in factor prices *w* and outputs *x* given full employment and competitive pricing in the comparative statics of the general equilibrium model.

The present focus is on price changes due to FTAA. Comparative static elasticities $\hat{w}/\hat{p}$ and $\hat{x}/\hat{p}$ are found by inverting (10). The $\hat{w}/\hat{p}$ matrix describes how prices affect factor prices and the $\hat{x}/\hat{p}$ matrix describes the local surface of production possibilities in which each output should be positively related to its own price while some other output declines given constant endowments.

4. Comparative Static Elasticities in the Colombian Specific Factors Model

Table 7 reports the $\hat{w}/\hat{p}$ elasticity matrix. Every 1% decrease in agricultural prices would lower professional wages by 0.02 %, agricultural wages by 1.04%, and the return to capital in agriculture by 1.05%. Lower agricultural prices decrease agricultural output and release labor to other sectors. Movements of workers to other sectors raise the return to capital in those sectors.

* Table 7 *

Every 1% increase in the price of manufactures would raise the wages of managers by 0.19% while the production wages would rise 0.99% and the return to manufacturing capital rises 1.16%. In services, professional wages and capital returns are most closely tied to price. Some factors benefit and others lose with any price change, and the effects are uneven. Price changes affect returns to specific capital more than shared labor, except for nearly specific agricultural labor.

Thompson and Toledo (2000) prove that the comparative static effects of price changes on factor prices are the same for all CES production functions. The degree of substitution, if constant along isoquants, has no effect on the general equilibrium elasticities of factor prices with respect to prices in competitive models of production. Comparative static elasticities in Table 7 extend to all CES production functions regardless of the degree of substitution.

The distance measure of factor intensity anticipates these $\hat{w}/\hat{p}$ elasticities. Assigning a distance intensity of 100 to specific capital, correlations are .998 in agriculture and .982 and manufacturing. In services, factor intensity differences are less pronounced and the correlation is only .371. Short of assumptions regarding production functions, distance factor intensity can be used to identify potential winners and losers to price changes.

Table 8 shows price elasticities of outputs along the production frontier, with a higher price raising output in a sector as it draws labor away from other sectors. The largest own output effect occurs in manufacturing, where every 1% price increase raises output 0.159%. All effects are inelastic with the smallest own effect in agriculture.

* Table 8 *

5. Projected Adjustments with FTAA

A study conducted by the National Council of Economic Policy (1998) of Bolivia reports expected FTAA price changes for countries in the Andean region. In Colombia, predictions include up to 30% higher prices for manufactures due to increased export demand. Import competition is projected to lower prices in agriculture by 12% and in services by 20%. The effect of changing prices on factor prices depends on the interplay of factor intensity and substitution as outputs adjust. Sensitivity analysis is discussed.

Projected price changes are multiplied by the matrix of factor price elasticities in Table 7 to find the vector of price adjustments in Table 9. Wages fall with FTAA with the exception of production wages, which rise with the higher relative price of manufactures. Manufacturing capital substantially benefits with a 37.8% increase in its return. Capital returns fall 12.6% in agriculture and 23.8% in services with the falling prices in those sectors.

* Table 9 *

Such large expected changes on factor prices will have serious implications for the Colombian economy. If labor loses, civil unrest is possible. If workers see wages falling, consumption spending in the aggregate would fall. As the economy adjusts to FTAA, recessions would seem likely.

The effects of FTAA on outputs are found by multiplying the output elasticities in Table 8 by the projected vector of price changes. Output declines by 6.0% in agricultural and 3.8% in services, while manufacturing output increases 7.8%. Agriculture represents about 13% of GDP and the service sector about 22% of GDP. Many firms in the agriculture and services will find it difficult to survive. Joint ventures or partnerships with foreign agricultural firms or mergers in services with more efficient foreign firms could be alternatives for Colombian firms.

Regarding sensitivity, factor price changes are proportional to the vector of price changes. For instance, if prices change only half as much factor price changes would be half as large as in Table 9. Further, factor price adjustments are identical with any degree of CES production and output adjustments are scaled accordingly. For instance, CES = 0.5 implies output adjustments half as large as in Table 9.

6. Conclusion and Policy Recommendations

Potential adjustments due to FTAA can be broken down into factor income redistribution using applied models of production and trade. The specific factors model provides some insight into the potential income redistribution in Colombia as a result of FTAA. The main lesson is that input markets adjust as the economy moves along its production frontier toward a new production pattern caused by changing prices. Colombian agriculture and services are projected to suffer falling prices and import competition, while manufacturing is projected to enjoy higher prices and expanded export opportunity.

The projected income redistribution is consistent with quantitative analysis in the literature. Attanasio, Goldberg, and Pavcnik (2002) investigate the effects of Colombian tariff reductions in the 1980s and 90s on wages and find that higher wages for skilled workers was driven by technological change stimulated by lower tariffs and increased foreign competition. This result is consistent with the present factor price adjustments due to higher manufacturing prices with free trade. Attanasio, Goldberg, and Pavcnik also find wages in the manufacturing sector decreased more in industries that experienced larger tariff cuts, again pointing to a dependency on prices.

Predicted output adjustments in the present model are only a few percentage points but projected factor price changes are quite large. Wages of all but production labor are projected to fall with FTAA, with the return to capital in manufacturing projected to increase. Returns to capital in agriculture and services are predicted to fall considerably.

With falling output in agriculture, an increase in the number of displaced workers could occur as more agricultural workers move from rural to urban areas. Urban unemployment could rise temporarily, deepening the economic crisis. Lost of income for agricultural workers would provide some motivation for joining guerrilla groups. The problem of underemployment should also be considered a potential short run cost of FTAA, as a larger informal sector would offer low pay and few benefits. Economic policy might be designed to provide farmers with alternative incomes and markets. Investment incentives to agricultural firms could be provided to acquire new technology. Red tape and excessive regulation in the financial sector could curtailed to facilitate mergers.

Increased investment in a competitive and more efficient Colombian economy could result in higher income in the long run for every factor of production. The present results are not an indictment of FTAA but might be used to recognize that various sectors and factors of production stand to lose with FTAA, at least short of investment, retraining, and relocation. Policies designed to anticipate the effects of income redistribution in Colombia should be considered to minimize potential losses that could result in social upheaval and destabilization. If such measures are taken, the political struggle to establish FTAA might be easier allowing the long term benefits of free trade to become apparent. These tangible results certainly exceed temporary losses, but political response can be anticipated during FTAA adjustment.

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Table 1. Factor Payment Matrix, 2000 (million pesos)

	Agriculture	Manufacturing	Services	Total
Professional	192	645	4,325	5,162
Managers	96	436	1,501	2,034
Clerks	77	285	1,787	2,149
Sales	58	133	429	619
Service	249	436	2,502	3,188
Agriculture	8,420	57	36	8,513
Production	249	5,596	643	6,488
Capital	9,840	11,381	24,522	45,742
Total	19,181	18,968	35,746	73,895

Source: *Departamento Administrativo Nacional de Estadistica, DANE (2001)*

Table 2. Factor Shares, θ_{ij}

	A	M	S
Professionals	0.010	0.034	0.121
Managers	0.005	0.023	0.042
Clerks	0.004	0.015	0.050
Sales	0.003	0.007	0.012
Service	0.013	0.023	0.070
Agriculture	0.439	0.003	0.001
Production	0.013	0.295	0.018
K_A	0.513	0	0
K_M	0	0.600	0
K_S	0	0	0.686

Table 3. Industry Shares, λ_{ij}

	A	M	S
Professionals	0.037	0.125	0.838
Managers	0.047	0.215	0.738
Clerks	0.036	0.132	0.832
Sales	0.093	0.214	0.693
Service	0.078	0.137	0.785
Agriculture	0.989	0.007	0.004
Production	0.038	0.862	0.099

Table 4. Unit Labor Inputs

	A	M	S
Professionals	0.005	0.034	0.331
Managers	0.006	0.062	0.163
Clerks	0.001	0.031	0.024
Sales	0.004	0.080	0.032
Service	0.025	0.033	0.548
Agriculture	1.819	0.003	0.014
Production	0.025	0.754	0.169

Table 5. Distance Factor Intensities

	A	M	S
Professionals	.010	.143	1.39
Managers	.013	.267	.528
Clerks	.002	.127	.078
Sales	.009	.350	.101
Service	.055	.135	2.99
Agriculture	100	.011	.050
Production	.055	12.5	.610

Table 6. Cobb-Douglas Substitution Elasticities, σ_{ik}

	$\hat{w}_1$	$\hat{w}_2$	$\hat{w}_3$	$\hat{w}_4$	$\hat{w}_5$	$\hat{w}_6$	$\hat{w}_7$	$\hat{w}_A$	$\hat{w}_M$	$\hat{w}_S$
$\hat{a}_{Professional}$	-0.89	0.04	0.04	0.01	0.06	0.02	0.05	0.02	0.08	0.58
$\hat{a}_{Managers}$	0.10	-0.96	0.04	0.01	0.06	0.02	0.08	0.02	0.13	0.51
$\hat{a}_{Clerks}$	0.11	0.04	-0.96	0.01	0.06	0.02	0.06	0.02	0.08	0.57
$\hat{a}_{Sales}$	0.09	0.03	0.04	-0.99	0.06	0.04	0.08	0.05	0.13	0.48
$\hat{a}_{Service}$	0.10	0.04	0.04	0.01	-0.94	0.04	0.06	0.04	0.08	0.54
$\hat{a}_{Agriculture}$	0.01	0.01	0.00	0.00	0.01	-0.57	0.02	0.51	0.00	0.00
$\hat{a}_{Production}$	0.04	0.02	0.02	0.01	0.03	0.02	-0.74	0.02	0.52	0.07
$\hat{a}_A$	0.08	0.03	0.03	0.01	0.05	0.10	0.09	-0.49	0.00	0.00
$\hat{a}_M$	0.03	0.02	0.02	0.01	0.02	0.00	0.30	0.00	-0.40	0.00
$\hat{a}_S$	0.12	0.04	0.05	0.01	0.07	0.00	0.02	0.00	0.00	-0.31

Table 7. Price Elasticities of Factor Prices

^	p_A	p_M	p_S
$w_{professional}$	0.02	0.08	0.90
$w_{managers}$	0.03	0.19	0.77
w_{clerks}	0.02	0.09	0.89
w_{sales}	0.08	0.20	0.72
$w_{service}$	0.07	0.10	0.84
$w_{agriculture}$	1.04	-0.01	-0.03
$w_{production}$	0.02	0.99	-0.01
r_A	1.05	-0.02	-0.03
r_M	-0.02	1.16	-0.14
r_S	-0.02	-0.07	1.09

Table 8. Elasticities of Outputs with Respect to Prices

	p_A	p_M	p_S
x_A	0.05	-0.02	-0.03
x_M	-0.02	0.16	-0.14
x_S	-0.02	-0.07	0.09

Table 9. Trade Liberalization with Projected Price Changes

Predicted %Δp		Factor prices		Outputs	
$\hat{p}_A$	-12 %	$\hat{w}_{Professional}$	-15.7 %	$\hat{x}_A$	-6.0%
$\hat{p}_F$	30 %	$\hat{w}_{Managers}$	-10.0 %	$\hat{x}_M$	7.8 %
$\hat{p}_S$	-20 %	$\hat{w}_{Clerks}$	-15.3 %	$\hat{x}_S$	-3.8%
		$\hat{w}_{Sales}$	-9.5 %		
		$\hat{w}_{Service}$	-14.5 %		
		$\hat{w}_{Agriculture}$	-12.3 %		
		$\hat{w}_{\mathrm{P}roduction}$	29.7 %		
		$\hat{r}_A$	-12.6 %		
		$\hat{r}_M$	37.8 %		
		$\hat{r}_S$	-23.8 %		