TRADE OPENING AND DISTRIBUTION IN COLOMBIA*
–A Time-Series Analysis of Colombia's Seven Principal Cities–

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ABSTRACT

This paper analizes the impact of trade liberalization upon the pattern of relative wages in Colombia's seven principal cities over 1976-1999. Consistent with prior work of the author's for Colombia and other developing countries, this paper finds that trade liberalization was not associated with a falling wage-skill gap, or relative wages. In contrast to the standard Stolper-Samuelson predictions for developing countries, as average tariffs rose over 1976-1990, relative wages fell; while as average tariffs fell after 1990, relative wages increased. In both periods, the relative supply of skilled workers was rising, contributing to the fall in relative wages prior to 1990, while this effect was dominated by rising relative demand after 1990. In addition, the real exchange rate appears to have played an important role in wage structure, with revaluation after 1990 raising relative wages and worsening the distribution of earnings. The initial rise in relative wages after 1990, documented in previous work by the author, was modest and has not tended to increase subsequently, in part due to the continued increase in relative supply which moderated the sharp increases in relative demand after 1990 that are documented in this paper.

Key Words: wage determination, trade liberization, demand for skilled labor, liberalization and distribution.

RESUMEN

Apertura comercial y distribución en Colombia: análisis de series de tiempo en siete ciudades.

Este artículo analiza el impacto de la apertura comercial sobre el patrón de salarios en las siete principales ciudades colombianas, entre 1976 y 1999. En corcondancia con trabajos previos del autor sobre Colombia y otros países en desarrollo, este trabajo encuentra que la apertura comercial no estaba asociada con una caída en la brecha de salarios por niveles de calificación por salarios relativos. En contraste con las predicciones tradicionales de Stolper-Samuelson para países en desarrollo, cuando los aranceles promedio aumentaron entre 1976 y 1990, los salarios relativos bajaron; mientras que cuando los aranceles promedio cayeron después de 1990, salarios relativos aumentaron. En ambos períodos la oferta relativa de trabajadores calificados crecía, hecho que contribuyó a la caída de salarios relativos antes de 1990, mientras que este efecto estuvo dominado por la creciente demanda relativa después de 1990. Además, se encuentra que la revaluación del peso después de 1990 influyó en el aumento de los salarios relativos en este período.

El aumento inicial de los salarios relativos después de 1990, documentado por el autor en trabajos previos, fue modesto en los últimos años, debido en parte al sostenido crecimiento de la oferta relativa que moderaba el fuerte crecimiento de la demanda relativa después de 1990, documentado en este informe.

Palabras clave: determinación de salarios, apertura comercial, demanda por trabajo calificado, apertura y distribución.

Introduction

This paper updates prior work of the author's concerning the impact of trade liberalization upon wage structure in Colombia. Prior work by the author, beginning in 1995, found that in Colombia trade opening was associated with rising relative demand for skilled versus unskilled workers, and hence deteriorating income distribution, rather than a fall in in relative demand, and hence improvement in wage distribution as many originally predicted. These results are consistent with findings of the author's for other Latin American countries and Taiwan.

The pivotal theoretic reference in studies of trade opening and wage structure is the Hecksher-Ohlin-Samuelson(HOS) model, and related Stolper-Samuelson and Rybczinski theorems. Before the current debate on trade and wages in the U.S., HOS was put forth in defense of trade liberalization in LDCs, on the grounds that trade liberalization in LDCs would not only raise efficiency but would also lower wage dispersion there. Trade liberalization would be relatively painless and lead to long-lasting gains in equality. However, until recent years there has been little careful empirical work on trade liberalization's impact on wages in LDCs.

This paper presents findings for Colombia relevant to the HOS model, presenting evidence that tends to go counter to the predictions of both the Rybcinzki and Stoler-Samuelson theorems. The Rybczinski theorem predicts that in open countries it is the global supply of factors that determines returns to factors, so that increases in the relative supply of more educated workers within a country should not affect domestic wage structure. Increases in domestic factor supply appear to have a first order negative impact upon relative wages. And while the Stolper-Samuelson theorem predicts that trade liberalization in developing countries lowers relative wages, or the wage of more versus less educated workers, in Colombia the opposite appears to have occurred. The real exchange rate also appears to have played an important role in Colombia. Revaluation is associated with higher relative wages and relative demand. This may be because devaluation spurs labor intensive exports in Colombia, while revaluation hinders such exports, raising relative wages and worsening the distribution of earnings. Furthermore, the potential interactions between exchange rate policies and trade liberalization require more attention in regards to both growth and distributional outcomes. In many countries trade liberalization has been coupled with real devaluation, in an effort to shift countries towards export-led development models. In Colombia, as was done in Argentina, trade liberalization was coupled with revaluation, which tended to lead to export stagnation.

The remainder of this paper is organized in four sections. Section 1 summaries the theory. Section 2 presents the data and empirical results. Section 3 concludes.

1. Theoretical framework and methodological considerations

This section summarizes the basic Hecksher-Ohlin Stolper-Samuelson (HOS) framework, the Factor Price Equalization (FPE), Stolper-Samuelson (SS) and Rybczinsky theorems.

The HOS framework assumes there are two countries, two goods and two factors. Those factors are domestically mobile but internationally immobile. Each country produces both goods with both factors. Here we assume those two factors as skilled and unskilled labor. We will refer to the assumption of two goods both using both factors as "product-factor-diversified trade" (PFDT). It is also assumed that technology is constant, subject to constant returns to scale and competitive product markets, and that the technology is either identical or similar[1] across countries, hereafter the "technology-competition" assumptions.

This framework is more flexible than it appears, admitting more than two countries, more factors of production and production of both traded and non-traded goods. As stressed by (Leamer, 1995), the tradeable sector need not be large; he argues that though 'trade dependence' (as defined by exports plus imports over GDP) is low in the U.S., the existence of a U.S. apparel industry made unskilled workers in the U.S. 'determined in Shanghai' (Leamer, 1995).

The basic intuition for the Factor-Price-Equalization and Stolper-Samuelson Theorems is that domestic producers'prices for tradeables will be determined by international prices, and technology maps these prices onto domestic factor prices in a similar way across countries. Factor costs in nontradeables sectors will be determined as a residual. In summarizing the key theorems the following notation is employed: the ratio of skilled to unskilled workers, or relative wages is "$\tilde{\omega}$"; the relative price of skilled to unskilled tradeable goods is "$\tilde{p}$"; the relative supply of labor is "$\tilde{s}$"; tariffs are "τ"; and the real exchange rate is "ε".

1.1 *Factor price equalization*

The Factor Price Equalization Theorem argues that, under the HOS assumptions with identical technology across countries, free trade leads to the equalization of factor prices across countries. The international relative price of traded goods, $\tilde{p}_I$, is determined by global supply and demand:

$$\tilde{p}_I = f\left(\tilde{s}_I, \tilde{d}_I\right) \tag{1.1}$$

Relative domestic tradeable goods' prices - or just "domestic relative prices", $\tilde{p}_d$, - are equal to and determined by international prices:

$$\tilde{p}_d = \tilde{p}_I \tag{1.2}$$

Given the technology assumptions, the domestic relative price of tradeable goods uniquely determines domestic factor prices, which in turn are determined by international relative prices:

$$\tilde{\omega}_d = \gamma \tilde{p}_d = \tilde{p}_I \gamma > 0 \tag{1.3}$$

Thus, with identical technology across countries factor prices are equal across countries.

[1] What is required is that there are no factor-intensity reversals.

1.2 *Tariffs*

The Stolper-Samuelson Theorem considers the effects of adding tariffs. With tariffs relative domestic prices are equal to international relative prices times one plus the tariff rate, τ, where tariffs are levied on the traded goods in which the country does not have a comparative advantage:

$$\tilde{p} = p_I (1+\tau)^m$$

where:

m = -1 or 1, as the country 'i' is Northern or Southern,

or $$m = \left(s_i - s_g\right) \Big/ \left|s_i - s_g\right|$$

s_i = relative labor supply in country 'I'

s_g = relative global labor supply

Thus, skill-rich Northern countries levy tariffs on imports of unskilled-intensive goods; and vice-versa for the South.

As before, relative wages in country "i" are an increasing function of domestic relative tradeable goods' prices, though now may differ over countries because technology is not identical:

(1.2) $w_i = \gamma_i \cdot P_d, \ \gamma_i > 0$

so that $dw_i / dp_d > 0$

By the "magnification effect" (Jones,1965), γ_i is greater than 1. Lowering tariffs in the North will lower the cost of importing unskilled-intensive goods, raise domestic relative prices and hence raise domestic relative wages. The opposite occurs in the South, where lower tariffs reduce the price of skill-intensive tradeable goods, domestic relative prices and hence lower relative wages.

(1.3) $dw/d\tau < 0$, for the North

$dw/d\tau > 0$, for the South.

1.2.1 *Relative Factor Supply Shifts and the Rybzinski Theorem*

Many labor economists' studies of trade and wages have tried to net out the impact of shifts in the relative supply of labor upon wages to identify shifts in domestic relative demand, which in turn may be related to trade factors. Trade economists have criticized this methodology as failing to reflect the Rybczinski Theorem (*e.g.* Leamer, 1995). According to the Rybczinski Theorem, if countries are small on the global scale, shifts in domestic relative supply of labor will not alter domestic factor prices, or $d_d / d_d = 0$, though such relative supply shifts will lead to the sectoral reallocation of production towards the sectors more intensive in the newly more plentiful factor. Global supply and demand determine relative domestic factor prices. Shifts in domestic relative supply are small relative to global relative supply, so domestic supply shifts will not measurably alter international relative prices. Only changes in domestic relative tradeable goods' prices will change domestic relative wages. With constant tariffs, shifts in relative domestic labor supply will not affect domestic relative wages.

Leamer (1995) translates this argument into the relative demand curve for labor showing that, under the suitable conditions, trade implies that a country's relative demand for labor is horizontal: shifts in domestic relative supply leave relative wages unchanged.[2] One implication of this is that the common practice of labor economists, of netting-out the impact of relative supply shifts on relative wages to measure relative demand shifts potentially associated with trade, is inappropriate.

Note as well that changes in real exchange rates will not affect relative factor prices because changes in the exchange rate affect the numerator and denominator of $\tilde{p}_d$ symmetrically, leaving $\tilde{p}_d$ unchanged. Summarizing, if we let X represent the vector of tariffs, domestic relative supply and the real exchange rate, or $[\tau, s, \varepsilon]$, under the assumptions of the Stolper-Samuelson theorem, we expect the following results:

(1.4a) $dw/dX = (-, 0, 0)$ for the North,

(1.4b) $dw/dX = (+, 0, 0)$ for the South.

In LDCs, a fall in tariffs should lower relative wages, while neither relative supply shifts nor exogenous changes in the real exchange rate affect relative wages.

In what follows, evidence bearing on both the Rybczinski and Stolper-Samuelson Theorems from Developing Countries is examined.

2. Data And Results

2.1 *General Background*

In Colombia, over the 1976-1999 period studied, tariffs first increased and then fell. Tariffs rose from 12 to 20 percent over 1976-1980, were stable through 1984, rose to 30 percent in 1987 and then fell to below 13 percent after 1992. Over the 1984-1990 period tariff changes were also accompanied by a nearly 50 percent devaluation of the real exchange rate, after which the real exchange rate appreciated significantly, and then began to devalue after 1997.

2.1.1 *Data And Central Results*

This section begins by describing the data and then summarizes the methodology employed to construct wage and quantity measures that are comparable over time. It then describes the methodology for aggregating those data into time-series. Initial examination suggests that in periods of constant tariffs increases in relative supply had large negative effects upon relative wages, and that trade liberalization is associated with increases in relative wages.

[2] More precisely, Leamer argues that demand is infinitely elastic within "cones of diversification", defined by sets of goods requiring similar factor endowments which in turn defines the countries in competition with one-another. He posits a hierarchy of cones of diversification leading to a downward sloping, serrated relative (and absolute) demand curve for labor. Modest changes of relative factor supplies lead to movements along the flat portions of the demand curve, and obey the Rybczinski theorem. Large increases in factor supplies lead countries across cones of diversification, and down the serrated demand curve. A similar formulation is developed by Donald Davis(1996) and discussed further below.

Next, time-series estimates are presented that examine the validity of the Rybzinski and Stolper-Samuelson theorems. Estimates using both time-trend relative demand proxies and tariffs find little support for these theorems, instead finding that increases in relative supply exerts strong downward pressure on relative wages and that trade liberalization is associated with rising relative wages. These results are robust to instrumenting relative supply. Cointegration tests suggest that the OLS and and Instrumental Variables estimates are consistent, though the shortness of the time-series calls for caution.

Data

Household survey data is used for Colombia's seven principal cities. These data include information on individuals' characteristics and their labor force participation. Those characteristics include: educational attainment, age, sex, and for –those working– their wages, occupation, and industrial activity codes. In all cases, the information includes the nature of attachment to the labor force, including: employed, self-employed, unpaid family worker, unemployed, discouraged unemployed, or out of the labor force. These are representative and comparable surveys carried-out by the same institutions. The coverage is for metropolitan Colombia, that is to say: Barranquilla, Bucaramanga, Bogotá, Cali, Manizales, Medellín, and Pasto.

2.2 *Relative Wage And Supply Shifts*

2.2.1 *Methodology and Results*

First, disaggregated normalized or relative wage and quantity measures are calculated for each year that are comparable through time. These relative wage and relative supply matrices are employed to construct aggregate time-series of relative wages and supply and in decomposition of employment shifts.

To construct the disaggregated relative wage and quantity measures, workers are organized into demographic cross-classifications by sex, schooling and experience. This approach imposes little parametric structure upon the data. Following Welch (*e. g.*,1979), Murphy and Welch (*e. g.*, 1991) and Katz and Murphy (1992), normalized relative wage and relative quantity vectors are constructed for each year from the cross-sectional household survey data, where the elements of the vectors are demographic cells. For the wage vectors, only full-time employees fifteen years or older are used in order to maximize comparability of wages across workers and over time. Several variants of the quantity vectors are constructed to confirm the robustness of results; these range from only employees to the total potential labor force (employees, self-employed, unpaid family workers, unemployed workers, discouraged (unemployed) workers, and out-of-labor-force persons). Relative quantity matrices are calculated both in hours worked and in numbers of persons, or counts, per cell.

The relative quantity matrix is the distribution of total hours (counts) worked across cells, $n_{i,t}$. The average of the quantity distributions over time, N, is used as constant demographic weights when aggregating across cells. The relative wage matrix, W, is composed of relative wage vectors that are the mean wages per cell divided by a weighted

annual average wage, where the weights are the vector N.[3] To aggregate quantities across cells of differing productivities, and estimate efficiency units by the average relative wages across all years, W.

This method of aggregation assures comparability across time and de-emphasizes outliers for the variables across which we are aggregating. For example, because mean wages for university graduates in year t, or $W_{u,t}$, use the average distribution over all years of university educated workers across sex and experience cells, outliers for sex and experience only affect the overall averages, and so have little weight.[4]

Time-Series of Relative Wages and Supply

It is useful to examine time-series of relative wages and relative supply at a higher level of aggregation. The approach used here is the method proposed by Welch —(1969) (see also Katz-Murphy (1992)—. The time-series of relative wages is the ratio of wages of university to primary-complete graduates through time, where these annual group averages are aggregated using the constant de-

[3] For year t we calculate the mean wages per cell and the total hours (counts) per cell divided by total annual hours(counts):

$mw_{i,t} \equiv$ mean (or median) wage for I-th cell and,

$n_{i,t} \equiv$ distribution of quantities (hours or counts) for the I-th cell.

The average distribution of employment over cells for all years, N, is:

$N \equiv \sum_{t=1}^{T} n_t / T$, where $T \equiv$ the total number of years of household surveys

Thus, the normalized wage vector for year t, w_t, is: $w_t \equiv mw_t / (N' mw_t)$

For comparisons of relative wages of sub-groups of cells, e.g. "university graduates", we typically want comparable price indices unaffected by the changing distributions of workers across cells. To construct such indices, when aggregating wages across cells into larger categories, we use the constant demographic weights, N. E.g. if "k" is university education, the fixed-demographic-weighted mean wage for university-educated workers w_u, is:

$$w_u \equiv \sum_{I \in u} w_i \cdot \left[N_{i,u} / N_u \right], \{ or w' N_i / N_u \}$$

where $N_u \equiv \sum_{I \in u} N_i$.

[4] Using dummy variables for educational group - here "k", or university-educated - in estimating an earnings function by regression techniques does not trim outliers, but the cell method does. To see this:

Let $w_{i,t} = a + \theta(t) * I_k$,

where: $I_K \equiv$ indicator variable for group k.

Then the regression coefficient on schooling is:

(i) $\theta_{i,t} = w_t' I_{k,t} / \left[I_{k,t}' I_{k,t} \right]$

(ii) $= \sum_{I \in k} w_t / n_{k,t}$, where $n_{k,t}$ is the number observations in group k

To compare this with the cell method, assume for the moment that cells are defined as actual observations and that the number of observations across years is constant). Then the group-k weighted mean wage is:

(iii) $w_k \equiv \sum_{I \in k} w_i \cdot \left[N_{i,k} / N_k \right], \{ or\ w' N_i / N_k \}$

Comparing the dummy-variable regression estimate in (ii) to the cell estimate in (iii) we see that instead of using the arithmetic average of wages per group as in the regression, the cell estimate uses the weighted average with weights across other dimensions of observable variables (here experience and sex) equal to the average distribution of those cells across years. Thus, the cell method down-weights wage outliers in year t associated with outliers of the other observable variables (here sex and experience).

mographic weights from the disaggregated relative wage matrix presented earlier in Section 2. In order to create a composite index of relative skill (cognitive to physical). Welch argued that while measures of individual productivity, such as education, might vary over a range of values, the underlying skill differences could be characterized in terms of two or three dimensions, in particular physical versus cognitive ability. Individuals would possess weighted averages of these two skill types. To construct an aggregate index of relative supply in terms of efficiency units of skill, one needs the average productivity of the two skill types and measures of the quantities of each skill types each individual possesses. Welch argued that workers with intermediate levels of measurable skill would typically possess a weighted average of each polar type of skill, so the wages of these workers would be a weighted average of the wages of workers with the polar types of skill. By regressing the wages of these workers with intermediate levels of measurable skill, one could infer the amounts of each polar type of skill they possessed. Given these weights and the numbers of workers of each type one could then calculate the total amount of each type, of skill in a given moment. The relative supply of efficiency units of skill in a given year would be the ratio of the two skill aggregates in that year.

This strategy has been implemented by proxying the two dimensions of skill by those with primary-complete educations and those with university educations - holding other dimensions of skill constant. Workers with either primary complete or university educations are allocated entirely to their respective groups. Next, the time series of wages of individuals with intermediate levels of education are regressed; for example, workers with secondary educations onto the time series of wages of workers with primary-complete educations and the wages of university educated workers, and the weights from the estimated coefficients are constructed.[5] Then for each year the aggregate amount of university and primary-complete equivalents is calculated, with the ratio of the two being the relative supply for that year.

The Pattern of Relative Supply

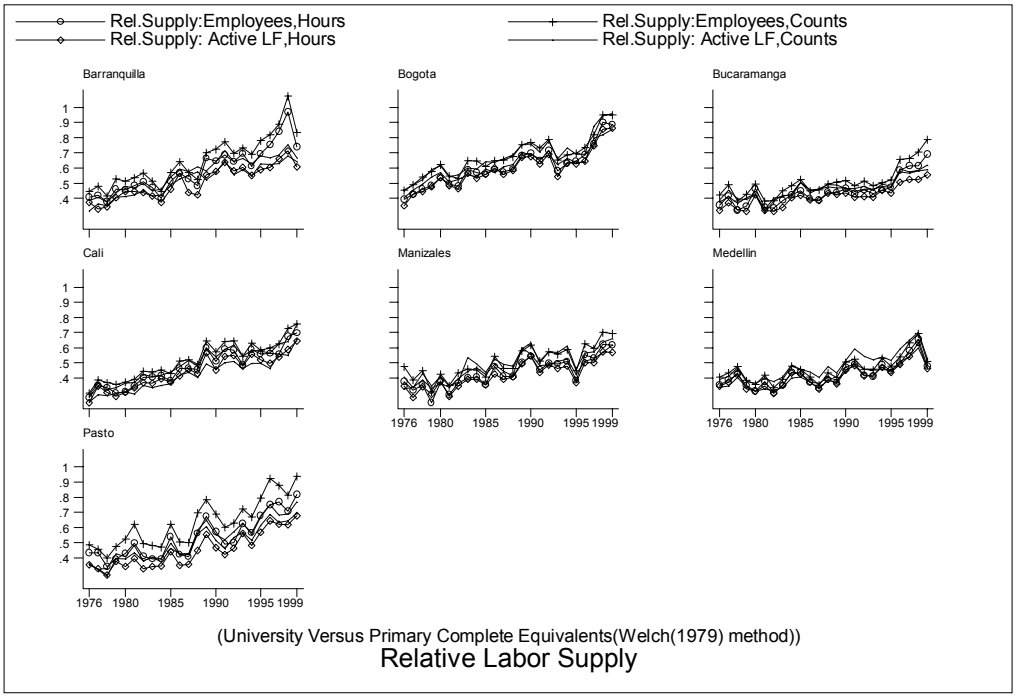
The measures of relative supply constructed in this fashion rise steadily throughout the 1976-1993 period. These measures are robust across different definitions of supply and are strongly correlated with simpler supply measures consisting of simply the ratio of the number of university graduates to the number of workers with less education, the ratio of university to primary-complete graduates. I focus on the relative supply measure that includes employees, self-employed, and unpaid family workers. Broader measures of supply adding unemployed and discouraged workers, and even the total potential labor force, follow similar paths. The figure below plots four measures of relative supply, each constructed using the Welch (1979) technique. The first is the relative supply for employees in

[5] For example, on this basis, Costa Rican workers with secondary education were allocated eighty-two percent to primary education equivalents, and eighteen percent to university equivalents; workers with special education were allocated eighty-eight percent to primary education equivalents, and twelve percent to university equivalents.

hours. The second is the relative supply for employees in counts, where counts weight each working person equally, regardless of hours worked. The third is the relative supply for the active labor force in counts, which includes unemployed workers. And the fourth is the relative supply for the potential labor force in counts, or the relative supply for all persons from 16 to 65 years of age.

The pattern of relative supply measures similar across different measures, though the rate of increase differs substantially across cities. Relative supply grew rapidly on trend for all cities, averaging 2.8 percent annual growth across cities. The average rate of growth of relative supply was 3.8, 4, 2.1, 2.6, 2, 1.7, 3.3 for Barranquilla, Bogotá, Bucaramanga, Cali, Manizales, Medellín and Pasto, respectively. Thus, to the extent that domestic relative supply affects domestic relative wages, it becomes crucial to control for the impact of supply on wages when examining the impact of trade opening upon wages.

Figure 1
Relative Labor Supply

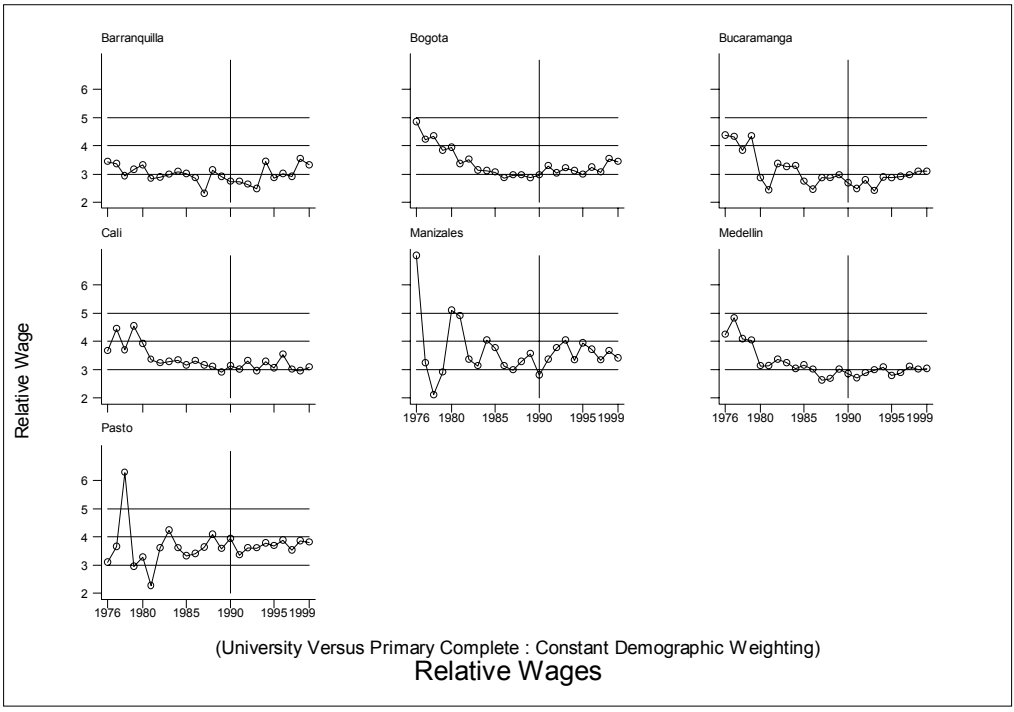


Source: Own Elaboration.

The Pattern of Relative Wages

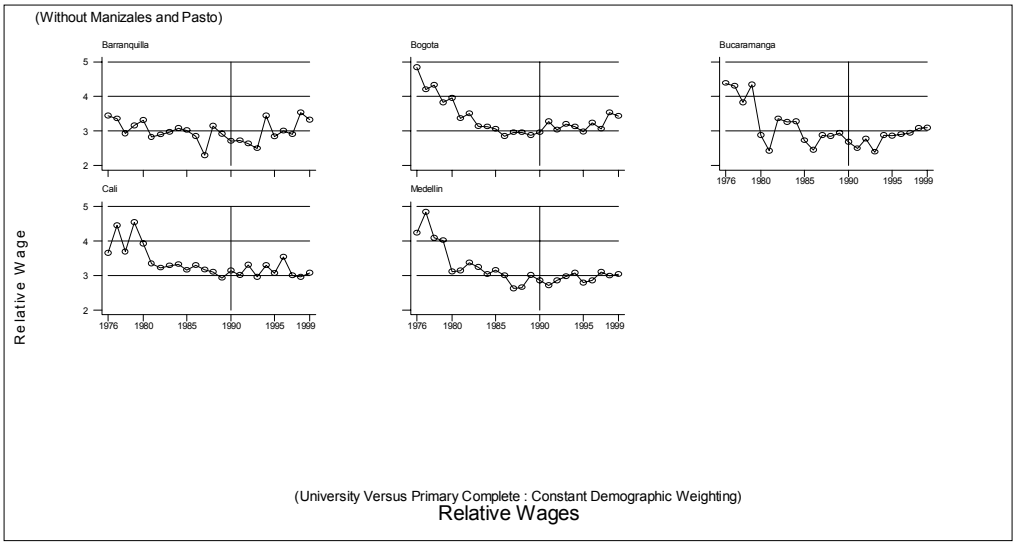
Relative wages tended to fall through 1990, and rise thereafter with trade liberalization. Figures 2 and 3 plot relative wages. Over 1976-1989 relative wages fell at an average rate of 2.3 percent annually and 3.3, 2.5, 3.1, 2.1, 1.5, 2.8, 1.2 percent annually for Barranquilla, Bogotá Bucaramanga, Cali, Manizales, Medellín and Pasto, respectively. After 1990, coincident with trade liberalization, relative wages grew on average .2 percent, though this masked considerable variation. After 1990 relative wages grew at an annual rate of 0.8, 1.2, 0.6, 1.1, 1.8, 0.8 and 1.9 percent for Barranquilla, Bogotá Bucaramanga, Cali, Manizales, Medellín and Pasto, respectively. The change in the overall trend in relative wages around 1990 is more clearly visible in Figure 3, where wages are plotted for Barranquilla, Bogotá Bucaramanga, Cali, and Medellín.

Figure 2
Relative Wages



Source: Own elaboration.

Figure 3
Relative Wages (Without Manizales and Pasto)



Source: Own Elaboration.

Time Series Evidence

It is useful to begin by examining the correlations between relative supply and relative wages in the pre-trade liberalization period and the correlation of relative wages and tariffs in the post-liberalization period (Tables 1 and 2, below), to shed some light upon the Rybczinski and Stolper-Samuelson theorems. In Table 1 we see that in the pre-trade libreralization period the increasing relative supply is typically strongly, negatively correlated with relative wages, and is suggestive of effects going counter to Rybczinski. It should be borne in mind, however, that tariffs were not constant, but rising, in this period. However, to the extent that the HOS framework work strictly true, we would expect the supply shift to have no effect and the rising average tariff levels to have depressed relative wages. Thus, Table 1 is broadly inconsistent with the HOS model.

Table 1
Correlations of Relative Wages and Relative Supply, Prior to Trade Liberalization

Barranquilla	Bogotá	Bucaramanga	Cali	Manizales	Medellín	Pasto
-0,5	-0,9	-0,7	-0,6	-0,1	-0,9	-0,2

Source: Own elaboration

Table 2 presents the correlations between relative wages and average tariff levels after trade liberalization. The correlations are typically positive. Here the HOS model would predict that the continued increase in relative supply would have no effect on wages while falling tariff levels would depress relative wages. Instead, falling tariffs were accompanied by rises in relative wages in all cities but Cali and Manizales. Clearly trade liberalization was associated on average with rising relative wages in urban Colombia. It is important to note, however, that the rise in relative wages was quite modest compared to more radical trade liberalizers such as Chile.

Table 2
Correlations of Relative Wages and Average Tariff Levels, Post Trade Liberalization

Barranquilla	Bogotá	Bucaramanga	Cali	Manizales	Medellín	Pasto
0,4	0,6	0,8	-0,05	-0,34	0,36	0,6

Source: Own elaboration

Time-Series Econometric Evidence

Additional evidence regarding the validity of the Rybzinsky and Stolper-Samuelson theorems can be derived from regressing the time-series of relative wages on relative supply and proxies for relative demand shifts or tariff levels. In a standard supply and demand model of the labor market and assuming a simple CES production function, relative wages can be expressed in terms of relative demand and supply shifts and the elasticity of substitution (Freeman (1975, 1979, 1980), Katz-Murphy (1992)):

$$\ln\left(W_{1,t}/W_{2,t}\right)=\sigma^{-1}\cdot\left[d_t-\ln\left(s_{1,t}/s_{2,t}\right)\right]+u_t \quad (2.1.a)$$

or $$\ln\left(w_t\right)=\alpha\cdot d_t+\beta\cdot\ln\left(s_t\right)+u_t \quad (2.1.b)$$

where w, d, s are relative wages, demand and supply.

Katz-Murphy (1992) estimated equations of this type for the United States arguing that Stolper-Samuelson related trade effects would be reflected in relative demand shifts and that to measure demand shifts the impact upon wages of shifts in relative supply must first be netted-out. However, as discussed above, Leamer (1995) argues that if the Rybzinski theorem is correct, equations (1a-b) are mis-specified because relative supply will not affect relative wages and the Katz-Murphy time-series empirical strategy is inappropriate.

Time-series estimates of (2.1.a) and (2.1.b) are examined to explore the validity of the Stolper-Samuelson and Rybczinsky theorems. For the South, under the null hypothesis of HOS, the coefficient on the time trend, in 1b, should be negative, while the coefficient on relative supply, β, should be zero:

$$H_0\left(HOS\right):\alpha<0,\beta=0$$

Failure of either, $\alpha < 0$ or $\beta = 0$ is sufficient to reject the underlying HOS model. Or in a more heterodox spirit, we may regard estimation of (1b) as separately testing the Stolper-Samuelson and Rybczinsky theorems.

Time-Series Results

Next, pooled time-series estimates for the entire period 1976-1999 are presented. Equations (2.1.a-b) are estimated by using the time-series of tariffs instead of a time trend proxy for demand. Under HOS for the South, the coefficient on tariffs is positive and, as before, the coefficient on log relative supply is zero:

$$H_O : \alpha > 0, \beta = 0$$

According to the magnification effect discussed earlier, relative wages should be proportionate to the relative price of domestic tradeable goods, where the factor of proportionality is greater than one. As domestic relative prices equal $(1+\tau)$ times relative international prices for LDCs, where τ is the tariff level, a one percent increase in $(1+\tau)$ leads to a greater than one percent increase in relative wages. Thus, the log of relative wages are also regressed onto the log of $(1+\tau)$ and the log of relative price variables. As before, if Rybczinski is valid, the coefficient on relative supply should be zero. And if Stolper-Samuelson and the magnification effect are valid here, the coefficient on the tariff variable should be positive and greater than one.

Table 3 presents the results for regressions of log relative wages onto log relative supply and other variables, including the log of average tariffs and the log of the real exchange rate. All specifications are estimated for both fixed effects and random effects, with similar results for both. One could argue that the random effects model is appropriate to the extent that the cities studied represent a sample of potential cities. Specifications controlling for a common trend and for city-specific trends are also estimated.

Table 3 shows that the estimated coefficients on relative supply are negative and statistically significant for specifications excluding trend terms, but typically insignificant when including trends. The reason for this is that relative supply grew at a nearly constant rate, so that it is highly colinear with the trend terms (the average correlation over cities is approximately .83). Excluding trend terms, the estimated coefficient on relative supply ranges from -.16 to -.25. With this reservation, this evidence is interpreted as going counter to the Rybczinsky theorem. This is supported by disaggregated data for Colombia, where it is found that within demographic cells, shifts in relative supply over short intervals are associated with opposite signed changes in relative wages, and by results for other countries.

Turning to the estimated effects of tariffs, one sees that for all specifications the estimated coefficients on the log of tariffs is negative and statistically significant. The estimated values range from -.05 to -.10, or an elasticity of relative wages to tariffs of (minus) 5 to 10 percent. It is interesting to note that these elasticities are consistent with

Table 3

Pooled Regressions: Relative Wages Regressed onto Relative Supply, Tariffs and Real Exchange Rate (Variables in Logs) (t and z statistic in parenthesis)

Fixed Effects (FE) Random Effects (RE)	Real Supply	Tariff	Real Exchange Rate	R^2/1
FE	-0,27	-0,06		0,12
	(-4,57)	(-3,20)		
RE	-0,25	-0,06		0,12
	(-4.45)	(-3,10)		
FE*	.10	-0,1		0,24
	(1.11)	(-4,92)		
RE*	.08	-0,1		0,24
	(.98)	(-4,92)		
FE **	.04	-0,1		0,31
	(.50)	-5,07		
RE **	-0,002	-1,1		0,26
	(-0,03)	(-4,97)		
FE	-0,17	-0,05	-0,23	0,16
	(-2,68)	(-2,38)	(-3,02)	
RE	-0,16	-0,05	-0,24	0,16
	(-2,62)	(-2,32)	(-3,14)	
FE*	0,1	-0,09	-0,09	0,24
	-1,06	(-4,03)	(-1,09)	
RE*	0,08	-0,09	-0,09	0,24
	-0,93	(-4,03)	(-1,10)	
FE **	0,04	-0,09	-0,09	0,31
	-0,44	(-4,14)	-1,16	
RE **	-0,006	-0,09	-0,09	0,27
	(-0,08)	(-4,06)	(-1,14)	

Source: Own elaboration.

Note: 1. R^2 for within data.

2. * Includes common trend

3. ** Includes city trend

results for Chile, but are only one half of those estimated for that country, where trade liberalization was arguable more extensive and more thoroughly implemented. These results go counter to the common predictions, based on the Stolper-Samuelson theorem as applied to developing countries, that trade liberalization leads to a fall in relative wages and hence contributes towards a better distribution of wages.

The estimated coefficients on the log real exchange rate are negative, averaging -.23, for regressions without trend, but insignificant for regressions with trend terms. While the real exchange rate fluctuated significantly over this period, nonetheless, it is correlated with the trend term (correlation .73) due to the huge devaluation over the 1982-1990 period. These results suggest that devaluation in Colombia tended to lower relative wages, while the revaluation after 1990 tended to increase relative wages. More research is needed to corroborate and extend these results, but this could be due to devaluation spurring exports of labor-intensive exports, and thereby lowering relative wages and improving the wage distribution, while revaluation tended to suppress labor-intensive exports and hence raise relative wage and worsen the wage distribution.

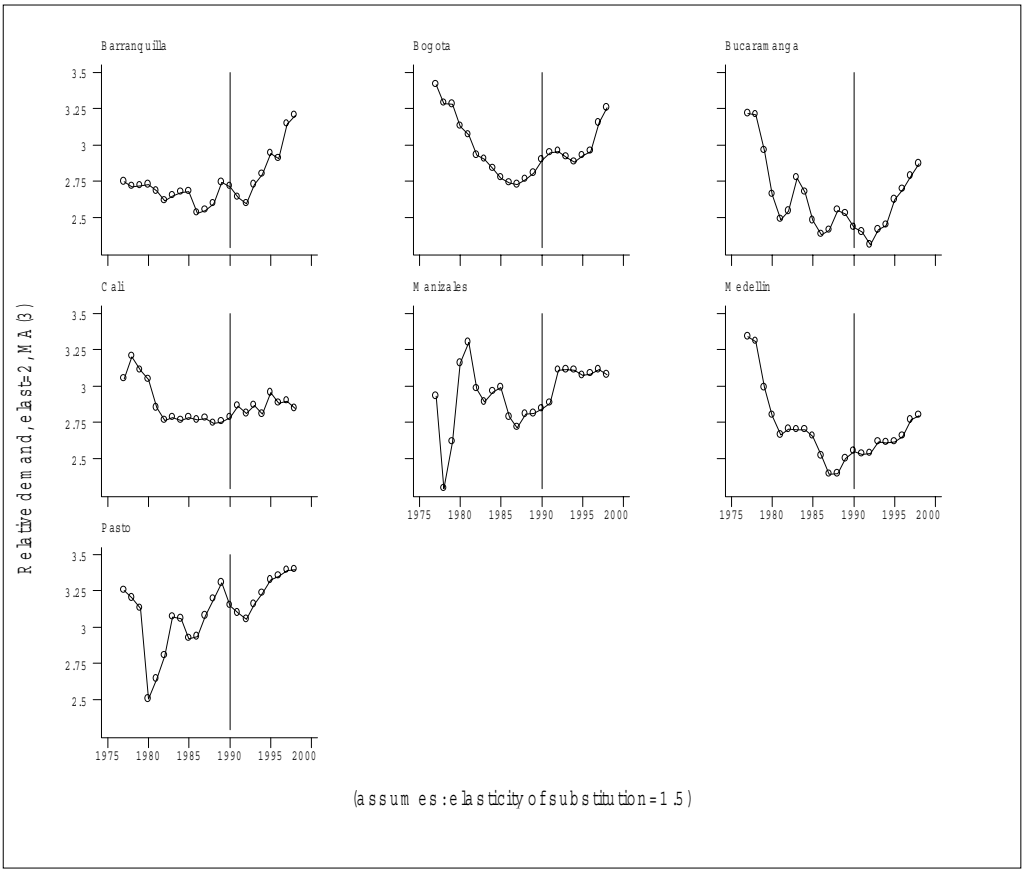
Relative Demand

This evidence suggests that the naive supply and demand model of Katz-Murphy (1992) may be valid even in small open-economy LDCs and to the extent this is true, their technique for estimating relative demand shifts may be appropriate. They estimated equation (2.1.a) using a time trend to proxy relative demand shifts. This produced estimates of the elasticity of substitution. They then solve (2.1.a) for the relative demand shifts for varying the elasticity of substitution around the estimated values. Using this technique, relative demand shifts are estimated by city. Figure 4 plots representative relative demand results for an elasticity of substitution of 1.5. We see that the imputed relative demand shifts tended to fall with rising tariffs and to rise after trade liberalization, counter to what we might expect from Stolper-Samuelson.

Table 4 presents results the estimates for regressions of relative demand onto log tariffs and log real exchange rate. Because relative demand series were often trended prior to trade liberalization we would be interested in the effects of tariffs upon changes in relative demand around its trend. Therefore, focus is made on regression including trends. The results are similar to those above. The estimated coefficients on tariffs are negative and significant, yielding an average elasticity of relative demand to tariffs of about minus 18 percent. For the real exchange rate the estimated coefficients were also negative and significant, yielding an average elasticity of relative demand to tariffs of about minus 14 percent.

In Figure 5, detrended relative demand is plotted for Bogotá, along with the average tariff rates. It can be see, that the detrended relative demand fell through 1990 with rising tariffs and then rose sharply after 1990 with falling tariffs. This is consistent with the results presented above in Table 4, and appears strongly counter to the standard Stolper-Samuelson theorem's predictions

Figure 4
Relative Demand



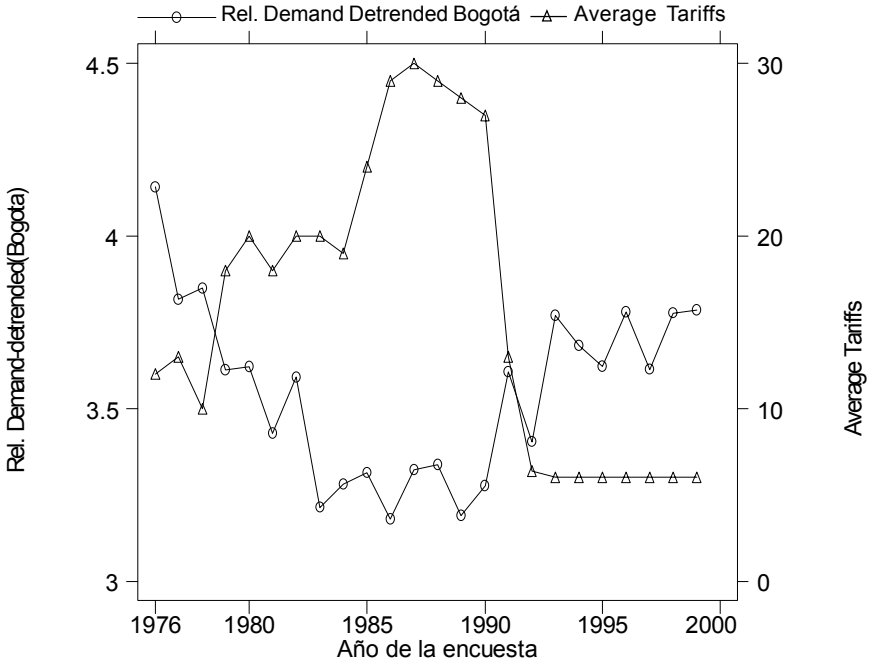
Source: Own elaboration.

Table 4
Pooled Regressions: Relative Demand Regressed onto Tariffs and Real Exchange Rate

Fixed Effects (FE) Random Effects (RE)	Tariff	Real Exchange Rate	R^2/1
FE*	-0,16		0,61
	(-4,50)		
RE*	-0,16		0,61
	(-4,50)		
FE	-0,16		0,63
	(-4,56)		
RE	-0,16		0,58
	(-4,27)		
FE*	-0,19	-0,14	0,55
	(-3,94)	(-0,85)	
RE*	-0,19	-0,14	0,55
	(-3,94)	(-0,85)	
FE	-0,19	-0,14	0,58
	(-4,00)	(-0,87)	
RE	-0,19	-0,15	0,53
	(-3,79)	(-0,84)	

Source: Own elaboration
Note:
1. R^2 for within data.
2. * Includes common trend
3. ** Includes city trend

Figure 5
Detrended Relative Demand and Average Tariffs (Bogotá)



Source: Own elaboration

Conclusion

Consistent with earlier work of the author, beginning in 1995, results indicate that increases in domestic factor supply appears to have a first order negative impact upon relative wages. This goes counter to the Rybczinski theorem derived from the HOS model. While the Stolper-Samuelson theorem predicts that trade liberalization in developing countries lowers relative wages, or the wage of more versus less educated workers, in Colombia the opposite appears to have occurred. The real exchange rate also appears to have played an important role in Colombia. Revaluation is associated with higher relative wages and relative demand. This may be because devaluation spurs labor intensive exports in Colombia, while revaluation hinders such exports, raising relative wages and worsening the distribution of earnings. Furthermore, the potential interactions between exchange rate policies and trade liberalization require more attention in regards to both growth and distributional outcomes. In many countries, trade liberalization has been coupled with real devaluation in an effort to shift countries towards export-led development models. In Colombia, as was done in Argentina, trade liberalization was coupled with revaluation, which tended to lead to export stagnation.

The policy implications of this work, however, must be seen in a broader context than simply the short and medium-run impact of trade opening upon distribution. Distributional outcomes may worsen while all incomes rise. If trade opening leads to higher growth rates (*e.g.,* Sachs and Warner (1995), though Rodrik (2000) has a dissenting opinion), then real wages of all workers may rise accompanying a worsening distribution of wages. Moreover, there are many other factors hindering economic growth, so that the poor growth performance since 1985 and particularly after 1995, cannot be easily related to trade policy. Among the important factors affecting growth are the real exchange rate, the real interest rate and industrial and financial concentration. As mentioned previously, many countries pursuing trade opening have done so coupling trade liberalization with devaluation. Colombia followed precisely the opposite path, and this almost certainly sharply muted potential positive output effects of trade opening. Countries, such as Chile over 1973-1982 and Argentina, that initially combined trade opening with revaluation, experienced stagnation in exports and output, but those (including Chile after 1984) that combined trade liberalization with devaluation often experienced rapid growth in exports and output. In Colombia, it is likely that the sharp rise in the real exchange rate after 1990 through 1997 explains part of the poor growth performance in recent years, rather than trade opening. The real interest rate rose precipitously between 1975 and 1985, remaining high since then. And while satisfactory studies of industrial and financial concentration have been made impossible in Colombia, because the DANE will not make firm level data available (the only studies available use plant level data), it appears that concentration rates are extremely high in Colombia, and this would lead to technological stagnation and low growth.

To the extent that trade opening does tend to widen wages and worsen distribution, if the growth consequences are positive, then trade opening may be pareto-improving and worth-while. But there are also complimentary policies that can counter-act the potential adverse distributional effects of trade opening. Widening wage differentials and the reproduction of wage inequality over generations may be counteracted effectively by policies designed to encourage human capital formation. The ensuing acceleration in the growth of relative supply would have a major downward impact upon relative wages and wage inequality.

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