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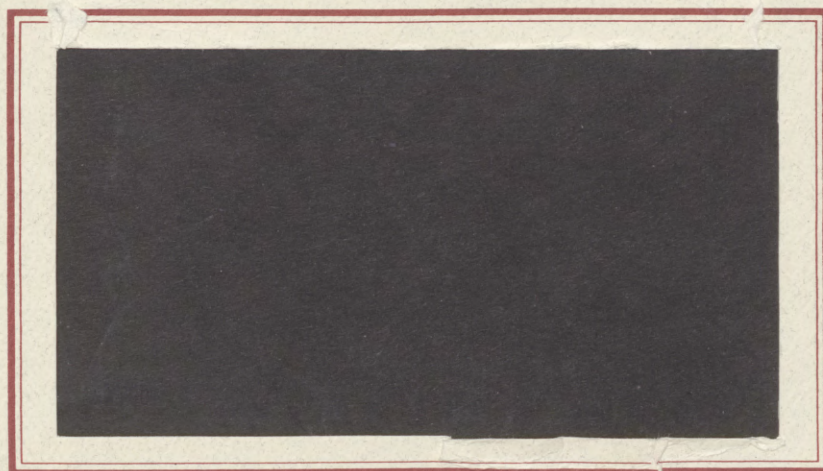
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TRADE LIBERALIZATION AND WAGES
IN COLOMBIA: 1976-1994**

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Development Discussion Paper No. 563

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**Stolper-Samuelson (Lost) In the Tropics?
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Colombia: 1976-1994**

Donald Robbins

Abstract

This paper examines the impacts of real devaluation, trade liberalization and the growing relative supply of skill on wage dispersion in Colombia's seven principal cities over 1976-1994. The Hecksher-Ohlin-Samuelson (HOS) framework predicts that while labor supply shifts and devaluation should not affect wage dispersion, trade liberalization should compress wages in LDC's. My findings differ: growth in the supply of skills lowers, and liberalization and real devaluation raise, wage dispersion. This is not due to failure of the HOS assumptions of factor-diversified trade or that Colombia is skilled relative to the world average. The data are consistent with non-HOS assumptions where devaluation and liberalization encourage capital and embodied technical flows.

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Introduction

How does trade integration and liberalization affect the level and distribution of wages? This issue has surged to the forefront of academic and public debate in recent years due to accelerating integration of markets, regional integration and unilateral trade liberalization. Raising the level and lowering the dispersion of wages is a central goal for most societies, and recent work suggests strong complementarity between trade liberalization and raising the level of wages. Trade liberalization and integration may lead to static gains and higher rates of economic growth [e.g., Sachs and Warner (1995); Berthelemy, Dessus and Varoudakis (1996)] but, at the same time concern is mounting that trade liberalization and integration may go counter to the goal of lowering wage dispersion across skill levels [e.g. Borjas, Freeman and Katz (1991), Freeman and Katz (1991), Revenga (1992), Murphy and Welch (1991), Sachs and Shatz (1994), Wood (1994)]. Stated starkly, the concern is whether trade integration will "immiserate the unskilled workers" in developed countries ("DCs" or the "North") [Bhagwati and Dehejia (1994)].

The theory guiding the debate on trade and wages has been the Heckscher-Ohlin-Samuelson ("HOS") structure and the Factor-Price-Equalization and Stolper-Samuelson theorems ("FPE" and "SS").¹ The standard application of this theory considers the North rich in skilled workers (H) and the South rich in unskilled labor (L). Hence the standard predictions are that in the North trade liberalization and economic integration will lower tariff and non-tariff barriers on unskilled-intensive imports, raising relative domestic producers' prices, and hence relative wages. In the South, trade liberalization lowers barriers on skill-intensive imports and hence relative wages. I will refer to these hypotheses as HOS-North and HOS-South, or HOS-N and HOS-S. Most research has focused on the U.S. There the issue is whether the widely documented rise in the relative wage of more to less educated workers since 1975 has been due in part to trade (hereafter I will use "relative" to refer to the ratio of more to less educated workers: hence relative demand, supply and wages) [e.g., Borjas, Freeman and Katz (1991), Freeman and Katz (1991), Revenga (1992), Murphy and Welch (1991), Sachs and Shatz (1994), Wood (1994)]. While there has not been major trade liberalization in the U.S. in recent decades, two variants of Stolper-Samuelson effects have been

¹ In this context the HOS framework is used considering the two factors of production to be unskilled and skilled labor or unskilled labor and capital-and-skill, based on the widely accepted premise that capital and skilled labor are complements in production [Griliches (1969), Hamermesh (1993)].

postulated. First, that revaluation of the dollar in the early nineteen-eighties raised the relative price of skill versus unskill-intensive manufactures (hereafter the "relative price") facing domestic U.S. producers² [Murphy and Welch (1991)]. More recently, the issue is framed in terms of rising global relative prices. They postulate that the entry of large labor-rich countries, e.g., China, to world markets - sometimes called 'globalization' - had raised international relative prices and so domestic producer prices and relative wages in the U.S.

The findings for the U.S. are highly contested [Berman, Bound and Griliches (1994); Bhagwati (1994); Borjas, Freeman, and Katz (1991); Lawrence and Krugman (1994); Lawrence and Slaughter (1994); Leamer (1995); Sachs and Shatz (1994)]. This may be due to the smaller share of trade in the U.S. economy³ or the absence of clear policy reforms or natural experiments shifting relative prices for domestic producers. In the South, however, traded goods often constitute far larger shares of GDP, and in recent years trade policy reforms have often been large and quickly implemented. Yet, trade and wages has only recently been studied for the South.

While theory predicts few tradeoffs between trade liberalization and welfare in the South, recent evidence raises questions about the validity of HOS-South. If GET and HOS-South are correct, then trade liberalization in the South should accelerate growth, raise unskilled workers' wages and lower relative wages in the South⁴. Recent studies on LDCs find that trade liberalization did not compress wages, and may often have widened wage dispersion across educational groups [Feenstra and Hanson (1995), Feliciano (1996), Revenga (1994) for Mexico; Robbins (1994a-d, 1995a; and 1996a-e.); Robbins and Gindling (1996); and Robbins, Gonzalez, Menendez (1996) for Argentina, Chile, Colombia, Costa Rica, Mexico, and Uruguay].

There is little work on trade and relative wages in Colombia. Robbins (1995a) examines the 1976-1989 period arguing that while this preceded Colombia's recent dramatic trade liberalization, the devaluation of its exchange rate could be treated as a proxy for trade liberalization, and finds the

² The phenomenon was perhaps first conceived in terms of merchandise flows of manufactures, noting that the share of domestic manufactures rose in the 1980's (Murphy and Welch(1991); Borjas, Freeman and Katz(1992). Subsequently trade economists have subsequently emphasized that only prices, not flows matter [e.g. Lawrence and Slaughter(1993); Deardorf and Hakura(1993); Bhagwati(1994)].

³ Strictly speaking this is incorrect, if we take real trade theory literally (see note 3 and Leamer(1995)).

⁴ If the variance in the distribution of education grew, this would counter-act the equalizing forces of HOS-South.

real exchange rate to be positively related to relative wages after controlling for relative supply shifts. However, that work suffers from several problems. First, according to trade theory real exchange rate changes should not change domestic producers' prices of skilled versus unskilled tradeables, and hence not affect relative wages. Second, that work netted out relative supply changes, while under HOS assumptions these should not affect relative wages. Third, that paper examined the relation between estimates of relative demand shifts and trade flows, while trade flows are endogenous.

The current paper addresses these limitations by extending the period studied to include recent trade liberalization, addressing explicitly the legitimacy of netting out relative supply effects, explicitly discussing the role of exchange rates, and by examining the relation between relative wages and exogenous policy variables instead of trade flows. This work also considers a richer group of alternative explanations. This longer period includes striking changes in tariffs: both rising in the 1980's and falling suddenly after 1990. The figure below plots tariffs from 1970 through 1992. Average tariffs rose from about 10 percent in 1978 to 30 percent by 1988. Then, over 1990-1992 average tariffs fell to only six percent (see the figure 1.1 below). According to HOS-South, relative wages should have risen and then fallen with these tariff movements. I use household surveys for Greater Bogotá and Colombia's six other principal cities over 1976-1994 to determine that the impact of changes in tariffs upon relative wages rose and fell with tariffs. While emphasizing the time series data, I use a non-parametric approach to construct the wage series. I also employ aggregation schemes to maximize the comparability of measures through time. I aggregate wages using fixed demographic weights and I aggregate quantities using productivity weightings⁵. Consistent with Robbins (1996c) for Colombia and Robbins (1994a and b; 1995a; 1996a), I not only find no evidence supporting HOS-South, but find that tariffs are negatively associated with relative wages. Also inconsistent with HOS-South, the real exchange rate is strongly positively associated with relative wages. And, consistent with findings for other countries [e.g., Robbins (1996a)], I find that shifts in domestic supply have first order (negative) impacts on relative wages.

⁵ This approach follows Welch (1979), Murphy and Welch (1991) and Katz and Murphy (1992). See Robbins and Menendez (1996) for a discussion of the problems arising from using cruder measures.

I argue these findings are consistent with a model where trade liberalization and devaluation accelerate imports of machinery bundled with newer technology that is biased toward more skill-intensive sectors. In addition, though the direct evidence does not appear to support the Specific Factors interpretation, my findings of strong domestic supply impact on relative wages suggest forces consistent with some variant of Specific Factors models.

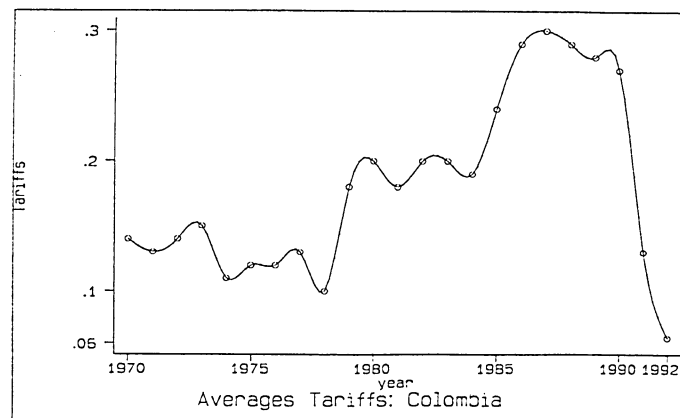


Figure 1.1

The remainder of the paper is organized in five sections. Section I briefly reviews the theoretic framework. Section II discusses the data, methodology and basic results. Section III discusses alternative theories. Section IV evaluates these for Colombia. Section V concludes.

Section I. Theoretic Background

The HOS framework assumes two countries, each producing two goods whose production requires both factors. In this context we may think of these as unskilled and skilled labor (or skilled labor and capital). It is useful to organize the HOS assumptions in two groups. I will refer to the assumption that there are two tradeables goods produced in both countries both using inputs from the two factors as assumption "A," or factor-diversified-trade ("FDT"). The HOS framework also assumes constant, identical technologies, constant returns and hence competition. Let me refer to these latter as assumptions "B," or 'constant, identical, constant-returns technology' (or "CC-TEK").

It will also be convenient to consider the immobility of physical capital as part of assumptions 'B', or "CC-TEK."

This framework is not nearly as inflexible as it appears. While identical technologies are required for FPE, this assumption may be relaxed to permit different but similar technologies across countries without invalidating the SS theorem⁶. Moreover, allowing for more than one country, inclusion of other factors and of traded and non-traded goods is consistent with the SS theorem. The key requirement is that there be two traded goods produced that use constant technologies that are similar to competitors', and that the production of both goods requires both factors. This is sufficient for domestic producers' prices of these goods to be determined by the international factor supply via prices. Then, given fixed technology, domestic factor prices are uniquely determined. Given these conditions, for example, we may add a non-tradeable sector using only unskilled labor and a natural resource export sector using a natural resource input and none or one type of labor without invalidating FPE or SS.

Similarly, it is important to emphasize that the tradeable sector need not be large for FPE and SS to be valid. Leamer (1995), hereafter L95, has recently emphasized this point⁷. This is related to the irrelevance of the size of trade flows for wage determination e.g., Bhagwati and Kusters (1994). Thus, for example: even 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 makes unskilled

⁶ What is required is that there are no factor-intensity reversals.

⁷ This is related to trade economies assuming that trade grows and hence factor content studies are irrelevant to FPE and SSs.

workers in the U.S. 'determined in Shanghai' [Leamer (1995)]. While perhaps overstated, this conveys the essence of the argument.

Two corollaries of FPE and SS require emphasis. First, domestic labor supply has no role in wage determination given the HOS assumptions. Leamer (1995) emphasizes this, and phrases this in terms of the demand curve for labor. He argues that under these assumptions the demand for labor (and the relative demand for skilled versus unskilled labor) is infinitely elastic⁸. For example a rise in relative supply of labor endowments will increase relative production towards the skill-intensive good - the Rybczinski theorem- while leaving relative wages unchanged. This has the practical implication that the trade induced demand shifts are directly discernible from the factor price changes. In this case we should be able to examine relative wage shifts directly without, as has been the practice by labor economists studying trade and wages for the U.S., netting out relative supply shifts.

The second corollary is that exchange rate changes should not affect relative wage changes. Changes in the exchange rate will symmetrically affect the prices of labor and skill-intensive tradeables, leaving the corresponding relative goods prices unchanged. Following this, the initial work on trade and wages by Murphy and Welch (1991) that emphasized the revaluation of the U.S. dollar in the early 1980's and Robbins (1996c) for Colombia were based on a false premise.

To summarize these arguments succinctly, I express the determination of relative wages of skilled to unskilled workers, 'w' in terms of 'p', the relative price of skilled to unskilled tradeable goods, 's' the relative supply of labor, the real exchange rate, ϵ , and tariffs, τ . Given identical, constant-return technologies and FDT, under free-trade domestic producers' prices of tradeables, p , equal relative international prices, p^I , or $p \equiv p^I$. The levels of real wages equalize across countries (FPE). In this HOS structure relative wages are a function only of the given relative producers' prices of tradeable goods:

⁸ 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), discussed further below.

Section II. Data, Empirical Strategy and Basic Results

The employed data are representative annual household surveys for Greater Bogotá from 1976 through 1994 conducted by the National Statistical Office (DANE). For the first part of the analysis I also analyzed the corresponding data for Colombia's six other major urban areas⁹. Sample sizes for the potential labor force range between five and fifteen thousand persons per city. The survey includes information on all household members, whether active or not and include the modality of attachment to the labor force: i.e., whether workers are employed, self-employed, unemployed, discouraged, or inactive. I consider the active labor force to include persons fifteen years old or older. This data allows us to measure labor force supply narrowly to very broadly: from just including employed and self-employed workers, to including the entire potential labor force (employed, self-employed, unemployed, discouraged and inactive workers). For comparability wages are calculated using employed workers.

Empirical Strategy

To Control or Not to Control for Supply? - Most studies of trade's impact on relative wages in the U.S. assume that demand shifts from trade liberalization can only be identified after netting out domestic relative supply shifts, and concluded that the large relative supply shifts experienced in recent decades have had first-order effects on relative wages.

Residual wage changes have been attributed to demand shifts. One contender for explaining these shifts has been trade. However, trade economists argue that where the HOS assumptions apply, this methodology is inconsistent with trade theory [e.g., L95]. Little evidence has been provided to substantiate this claim, however. In Robbins (1996a), I examine the empirical validity of this assumption for seven countries with high levels of trade dependence and find that relative supply shifts have first order effects tending to depress relative wages in all cases, save for Taiwan, where the effect is not identified. Given those results, in this paper my approach is to reject assumption (1a), that $w_s = 0$. I reflect this in my initial methodology where I seek to test the neutrality of demand shifts and then to estimate the time series of relative demand shifts.

⁹ In a forthcoming paper with Martin Gonzalez, however, we extend other aspects of this work to all seven cities (1996).

Thus I first construct disaggregated measures of relative wage and relative supply for years that are comparable over time. From these I generate time series of relative wages and relative supplies into two dimensions of skill. I do this by aggregating wages and supply into schooling groups, and then using the Linear Skills Synthesis approach of Welch (1979). This maps all workers into schooling into primary-complete and university complete equivalents. I then estimate the time-series of relative demand and examine its covariation with tariffs. To examine whether and how relative wages are affected by tariffs, relative supply and the real exchange rate I adopt a regression framework. This yields an estimated vector for dw/dX , which I compare to the predicted values in equation (1.4b), above. Finally I consider other factors that may affect the estimated dw/dX vector.

Methodology and Results

The approach used in the first phase of the work analyzes wages and quantities using detailed demographic cross-classifications of workers by sex, schooling and experience. This is a robust approach imposing little parametric structure upon the data. Following Welch [e.g., (1979)], Murphy and Welch [e.g., (1991)] and Katz and Murphy (1992), I first construct normalized relative wage and relative quantity vectors 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, and used as appropriate; 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 a constant demographic weight 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 .¹⁰

This method of aggregation maximizes comparability across time, and de-emphasizes outliers for the variables across which I am 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.¹¹

II.1. A Simple Test of Relative Demand Neutrality

This supply behavior appears largely consistent with the trend decline in relative wages, found above. However, this pattern is inconsistent with the rise in relative wages after 1987. Between 1987 and 1993, relative supply continues to rise, while relative wages also rise in 1987.

The inner product test of Katz and Murphy (1992) provides another test of the hypothesis that changes in relative supply alone are sufficient to explain changes in relative wage structure across various time periods. This test relies on the observation that, if relative demand is unchanged, then relative wage changes will move in the opposite direction from relative supply shifts. In this case,

¹⁰ Thus, for year t I 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, I 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:

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

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

To aggregate quantities across cells of differing productivities, and estimate efficiency units by the average relative wages across all years, W .

¹¹ 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 $w_{i,t} = a + \theta(t) \cdot I_k$,

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

Then the regression coefficient on schooling is:

(i) $\theta_{i,t} = w_{i,t} \cdot I_k / [I_k \cdot I_{k,t}]$

(ii) $\theta_{i,t} = \sum_{i \in k} w_i / n_{k,t}$ 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) $w_k \equiv \sum_{i \in k} w_i \cdot [N_{i,k} / N_k]$, {or $w'N_k / N_k$ }

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).

the inner product between the vectors of changes in relative wage and quantity vectors would be negative.^{12 13} Thus, I test the pure supply hypothesis across the interval t to $t+m$ by calculating:

$$(w_{t+m} - w_t)'(n_{t+m} - n_t).$$

To test the pure supply hypothesis I also calculate a normalized inner-product. I normalize the inner-product by the length of the vector of supply changes.¹⁴ This allows us to compare the measures across intervals and, potentially, across countries. To minimize sampling error inner products are calculated using both annual and three-year centered averages of quantity and wage vectors [Similar results were found using annual data].

TABLE 1. Inner Product of Changes in Relative Wages and Relative Supplies
(Second number is t-statistic in absolute value)

YEARS	78-82	82-85	85-89	88-94
Counts	-0.009 (2.69)	-0.010 (3.03)	0.001 (1.94)	0.017 (2.23)
Hours	-0.008 (2.02)	-0.011 (2.94)	0.001 (1.95)	0.015 (1.65)
<i>Normalized (1)</i>				
Broad Supply	-0.27	-0.56	0.06	0.32
Potential Labor Force	-0.40	-0.56	0.07	0.36

(1) Inner Products divided by Length of Supply Change Vector

¹² Following Katz-Murphy(1992), with an aggregate production function of J labor input types We can write the factor demands as:

(1) $X_t = D(W_t, Z_t)$
where X_t , W_t , and Z_t are the vectors of labor inputs, wages and demand shift variables in year t . With concave production, the inner product of the vector of changes in wages with the vector of changes in factor supplies, net of demand shifts, will be negative:

(2) $dW'(dX_t - D_d dZ_t) \leq 0$.

Using this framework, I begin by examining the pure supply hypothesis, whereby only supply factors are responsible for changes in relative wage structure. According to this hypothesis increases in relative supplies should lead to decreases in relative prices. This may be formalized by saying that the inner product of the vector of wage and supply changes should be negative:

(3) $dW'dX < 0$,

where dW is the vector of wage changes for specific age-education groups over a given period, and dX is the corresponding vector of supply changes, measured by the respective employments.

¹³ It is possible that the labor market is in disequilibrium. Therefore, unlike the U.S. studies, alternative supply measures are examined, including unemployed workers, discouraged workers, and the total labor force.

¹⁴ Our approach differs in two respects from the KM92 work on the U.S.. First, a zero inner product corresponds to neutral demand shifts only if relative supply is unchanged. However, if relative supply has changed, a zero inner product then implies that there is a non-neutral relative demand shift that counter-balances the relative supply shift. Second, I examine alternative measurements of supply. KM92 assume full employment, and use the distribution of hours of employees and self-employed above age 15 to measure supply. To reflect the possibility of disequilibrium in the labor market, I test the robustness of the inner-product results using various supply measures, including total labor above over fourteen years old for the total potential labor supply, and intermediate measures for supply including employees, self-employed, unemployed and discouraged workers, or "broad" labor supply.

In Table 1, above, we see the Inner Products for counts and hours. For the intervals 1978-1982 and 1982-1985 all inner products measures are negative, supporting the interpretation that the rapid fall in relative wages over 1976-1985 was due principally to supply changes. However, the rise in relative wages after 1985 is hard to reconcile with the continued increase in the relative supply. Skill-intensive demand shifts would seem to be required to explain this rise in relative wages. Reflecting this, the inner-product for the 1985-1988 interval became weakly positive or zero and then positive for 1989-1993, indicating the relative demand was skill-biased during this period.

II.2. Estimating Relative Demand Shifts

The inner product test suggests that relative demand shifts became skill-biased after the mid-1980's. In this I estimate the time series of relative demand shifts. I next create a measure of the relative supply of university graduates to primary school graduates. Because not all workers fall into one of these two categories (for example, some have a secondary education), I create a composite index of relative supply that takes into account information from all workers, using the Linear Skills Synthesis hypothesis of Welch (1969). Welch suggested that while measures of differences in individuals' productive attributes could take on many, even infinite dimensions, skill differences could be characterized in terms of two or three dimensions. Welch characterized these dimensions as physical strength ("brawn"), agility and cognitive ability ("brain"). Individuals would be weighted averages of these two dimensions, and range from mostly "brawn" to mostly "brain." I proxy these two dimensions 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. The wages of persons with combinations of the two skill types should be weighted averages of their skill endowments and the returns to those polar skill types. Thus, I regress the time series of wages of these individuals - say workers with secondary educations - onto the time series of wages of workers with primary-complete educations and the wages of university-educated workers, and construct the weights from the estimated coefficients. I then use these weights to assign workers into the primary or university categories. For example, on this basis workers with secondary educations 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.¹⁵ These measures are robust to different definitions of supply. I focus on the relative supply measure that includes employees, self-employed, and unpaid family workers.

Relative Demand Estimates

Here I use the time-series of relative wages and supply to estimate relative demand shifts. To do this I examine the time-series of relative wages and the constructed time series of relative supply, then net out relative supply shifts from relative wage changes to get estimates of the time-series of relative demand shifts. I find rising relative demand after 1986, suggesting that relative demand became skill biased in the second half of the 1980's.

The approach employed builds upon Freeman (1975,1979,1980) and follows KM92. For a simple CES production function I may write relative wage shifts as a function of relative demand and supply shifts, and the elasticity of substitution between more (1) and less (2) skilled workers:

$$(2.1) \quad \log(W_{1,t}/W_{2,t}) = (1/\sigma) [d_t - \log(s_{1,t}/s_{2,t})],$$

$$\text{or} \quad w_t = (1/\sigma) [d_t - s_t]$$

where $W_{i,t}$ and $s_{i,t}$ are, respectively, wages and supplies of group i in time t ; and where w_t , s_t and d_t are relative wages, supplies and demand shifts at t , and σ is the elasticity of substitution between type one and two workers. Freeman originally estimated this equation using simple supply measures and manpower (fixed input-output coefficients) extrapolations of demand shifts. I incorporate a more complete supply measure and employ a different estimation strategy reflecting that both the elasticity of substitution and demand shifts are unobserved. I proceed in three stages. First I construct the time series of relative wages and supply (see previous section). Second, I estimate equation 2.1, above, approximating demand by a linear trend to obtain bounds on the elasticity of

¹⁵ Broader measures of supply adding unemployed and discouraged workers, and even the total potential labor force, follow similar paths. Similarly, simpler measures of relative supply, where I divide the absolute number (or hours worked) of university to primary school graduates, follow similar patterns.

If the relative supply of skill were mis-measured, a biased estimate of relative demand shifts would result. This might occur because the definition of relative supply was too narrow. I tested this by using various measures of relative supply: first, including employed, self-employed, unpaid family workers and unemployed workers; second, adding discouraged workers; and third, adding all persons above fifteen years of age. I also controlled for the unemployment rate. The results were robust to these different supply measures and the inclusion of the unemployment rate.

substitution, and test the impact upon relative wages of some other time-varying variables. Third, I calculate the time-series of relative demand assuming differing elasticities of substitution.

Estimates of equation 2.1 assuming a linear trend for demand yield implied elasticities of substitution between 1.6 to 1.8. Broader supply measures including unemployed workers, or even the entire potential labor force had little affect on the estimates of the elasticities of substitution.

To impute demand I solve 2.1 for d_t and calculate d_t assuming a range of elasticities of substitution around the estimated values from Stage Two. The same pattern for relative demand shifts is seen for a wide range of elasticities.

$$(2.2) \quad d_t = \sigma \cdot w_t + s_t,$$

For simplicity, below I plot the imputed demand series using elasticity equal to 1.5 and 1.1 in the figures below for Bogotá and Colombia's six other major cities.¹⁶

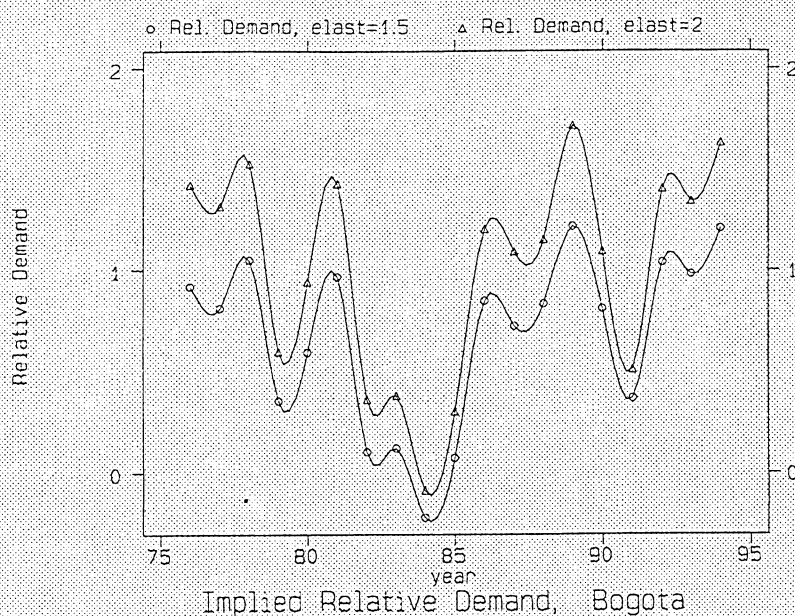


Figure 2.1

¹⁶ The same qualitative results hold for a wide range of elasticities.

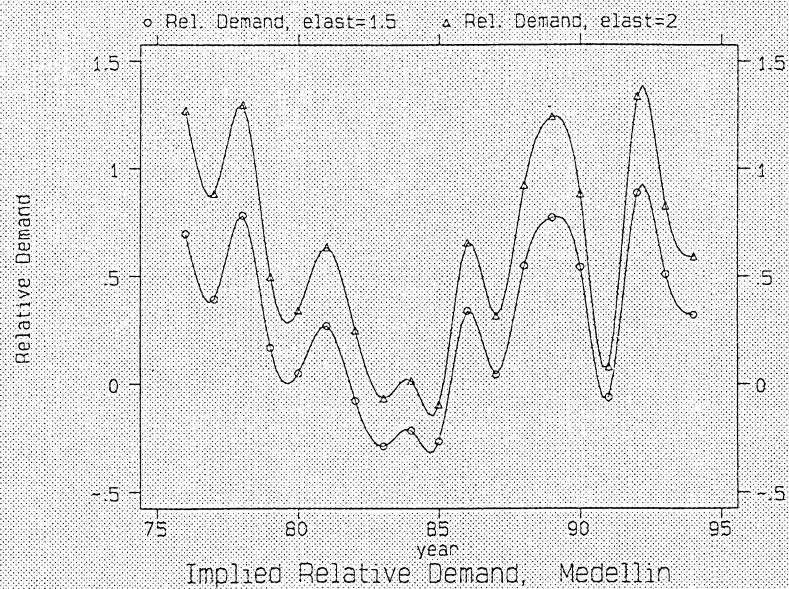


Figure 2.2

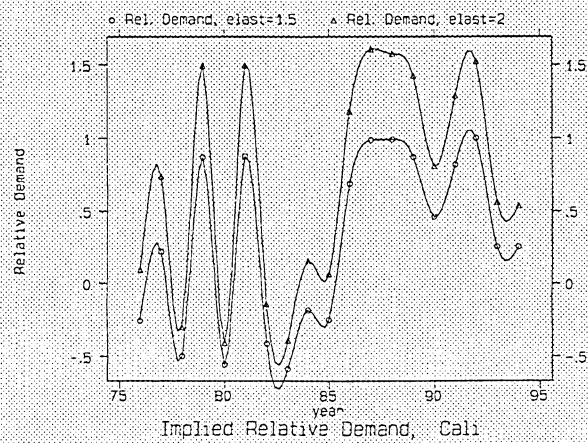


Figure 2.3

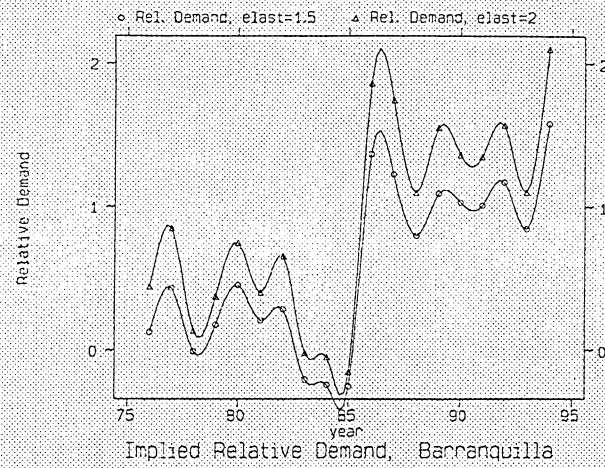


Figure 2.4

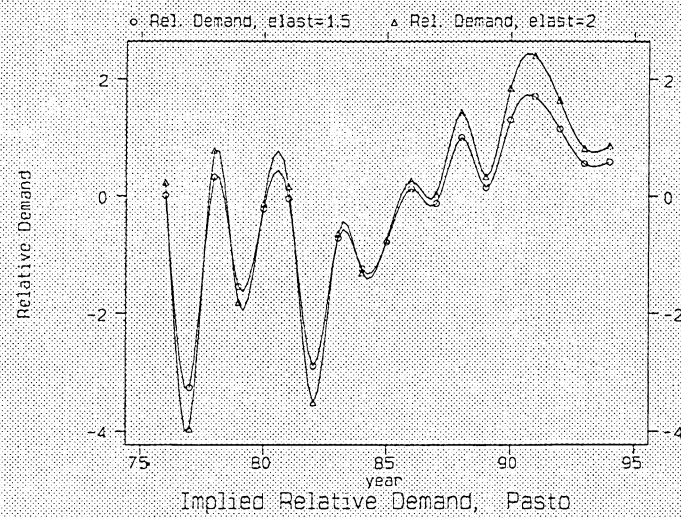


Figure 2.5

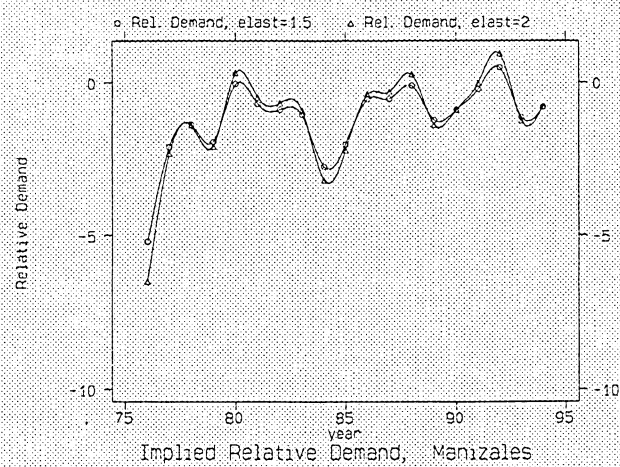


Figure 2.6

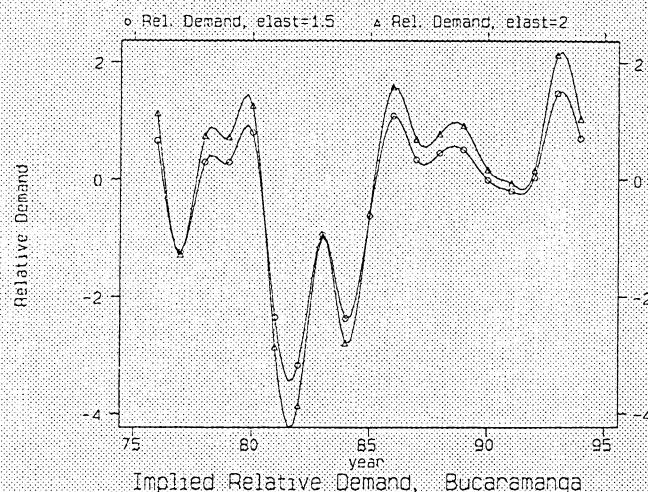


Figure 2.7

The pattern of relative demand shifts for Colombia's principal cities goes counter to HOS-South. Estimated relative demand fell through the mid-1980's. These demand shifts complemented the downward pressure on relative wages from rising the relative supply. However, in 1987 the relative demand shifted upwards. After the mid-1980's relative demand rose through 1994.

Skill Composition of the Unemployed; Minimum Wages; Unions and Educational Quality

Here I examine potential explanations that might reconcile the estimated demand shifts with HOS-South. If educational quality for university educated workers rose rapidly over this period, if I over estimated the rise in the relative supply of skill workers, our estimates of relative demand shifts would be biased upwards. Similarly minimum wage shifts and changes in union strength might affect the measured relative demand shifts. I find little to support these explanations.

Minimum Wages and Unions - Inclusions of minimum wages in the regression of log relative wages on log relative supply find that minimum wage shifts were did not affect relative wage behavior. Similarly, there were no changes in union coverage or strength corresponding with the relative wage changes.

Skill Composition of the Unemployed (Mis-measurement of relative supply) - If the relative supply of skill were mis-measured, a biased estimate of relative demand shifts would result. This might occur because the definition of relative supply was too narrow. I tested this by using various measures of relative supply: first, including employed, self-employed, unpaid family workers and unemployed workers; second, adding discouraged workers; and third, adding all persons above fifteen years of age. I also controlled for the unemployment rate. The results were robust to these different supply measures and the inclusion of the unemployment rate.

Educational Quality - If the relative quality of university education rose after 1986, this could explain rising relative wages and the estimated relative demand. If this were the case I would not expect to see rising relative wages after 1986 for workers in the same age cohort. Table 2 reports relative wages over time for the cohort of males and females entering the labor force in 1976. In the case of men I see relative wages rose after 1986, while females' relative wages remained almost constant. It is unlikely that schooling quality changes can explain rising relative wages and estimated relative demand after 1986.¹⁷ This interpretation is further strengthened by noting that the relative supply of university educated females was rising considerably faster than that of males.

TABLE 2. Ratio of University to Primary Wages for the Cohort of 1976 Labor Force Entrants.

	1976	1980	1986	1992
<i>MALES</i>	8.55	4.13	3.36	4.16
<i>FEMALES</i>	13.29	7.23	4.87	4.15

Note: Calculated from desegregated normalized wage matrix, aggregating across experience and sub-groups of schooling using constant demographic weighting.

In sum, the estimated time-series of demand is not consistent with the HOS-South hypothesis. Relative demand falls while tariffs were rising, and then when tariffs are reduced beginning in 1990, relative demand does not fall.

¹⁷ I also calculated relative wages for other cohorts. The results, generally, support the conclusion that it is unlikely that schooling quality changes can explain rising relative wages after 1985.

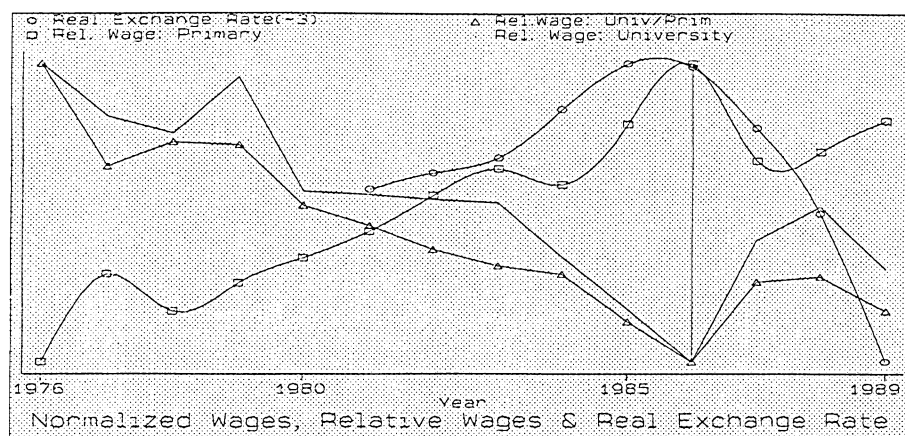


Figure 2.8

II.3. A Heterodox Empirical Framework

In this section I broaden the examination of relative wage determination by regressing the log of relative wages onto tariffs, the real exchange rate, and relative supply. This approach has an advantage over similar attempts (e.g. Katz and Revenga 1989 (see Deardorf & Hakura)) that regress wage measures onto trade flows. Such estimates are less firmly based on theory, and likely suffer from simultaneity bias because trade flows are endogenous. The current approach is limited by the short time series, and because the exchange rate could be endogenous. However, the latter problem is diminished by using lagged values of the real exchange rate.

We know from trade theory that under HOS, the sixty percent devaluation of the real exchange rate that induced a near doubling of the export/GDP ratio over 1984-1989 should be irrelevant to domestic wages in Colombia. However, the evidence suggests otherwise. This can be seen in the figure below where I plot the time series of normalized wages of university and primary graduates, relative wages, and the lagged real exchange rate (graphs are resolved to overlap; I measure the real exchange rate in terms of pesos per dollar). There is a strong negative association between the lagged real exchange rate and relative wages. For this reason below I include the real exchange rate as a possible explanatory variable determining relative wages.

Table 3, below, presents representative regressions of log wages onto tariffs, the log real exchanges rate (in pesos to dollars), and log supply. Where Durbin-Watson statistics deviated significantly from two, I also include estimates using Cochrane-Orcutt for the same specifications with little change in the estimated coefficients. The estimated coefficients on tariffs are negative,

indicating that a fall in tariffs is associated with a rise in relative wages. This is consistent with the pattern of the time series of relative demand and tariffs discussed above. The estimated coefficients on relative supply are always statistically significant and negative. The estimated coefficients on the real exchange rate are positive and significant.

Table 3. The Correlates of Relative Wages: Tariffs, Supply and The Real Exchange Rate

Independent Variables (In logs)	Dependent Variable: Log Relative Wages						
	1	2	3	4	5	6	7
Relative Supply	-.85 (8.93)	-.48 (3.10)	-.53 (4.39)	-.55 (4.89)	-.54 (4.35)	-.57 (5.13)	-.52 (4.47)
Tariffs	-.01 (0.48)	-.13 (1.50)	-.32 (4.91)	-.26 (3.70)	-.26 (3.46)	-.19 (1.24)	-.22 (1.54)
Real Exchange Rate (t-2)				-.22 (1.78)	-.20 (3.64)	-.41 (2.14)	-.42 (2.28)
Terms of Trade			-.30 (2.10)	-.15 (0.95)	-.16 (0.93)		
Tariffs * Real Exchange Rate						.15 (0.86)	.20 (1.16)
R-Squared (adjusted)	.82	.36	.83	.85	.83	.76	.74
F-statistic	40.5	5.51	25.6	23.5	18.7	14.5	12.6
Durbin-Watson	1.80		2.07	2.18		2.16	
Estimation Method	OLS	C-O	OLS	OLS	C-O	OLS	C-O

N = 18
Note: C-O Cochrane-Orcutt.
Absolute value T-statistics in parentheses.

These results go counter to the predicted results of HOS-South. As we saw in equation (1.6b), those results predict the following outcomes, where X is the vector $[\tau, s, \epsilon]$:

$$(1.6b) \quad dw/dX \quad \text{or} \quad [w_\tau, w_s, w_\epsilon] = (+, 0, 0),$$

whereas I find

$$dw/dX = (-, -, +).$$

Despite the short time-series, the results appear quite robust, and accord with a visual comparison of the time series of relative demand, tariffs, and the real exchange rate.

Conclusion

This section examined the evidence for HOS-S in several ways, finding no support for that hypothesis. Contrary to HOS-S, I found that inner-products were positive after trade liberalization. The time series of relative demand rose instead of falling with tariffs. And the estimated vector differed in each of its elements from the HOS-S prediction. Not only do I fail to find support here for HOS-South, but I find that falling tariffs are associated with rising relative wages, and that the corollaries of HOS do not hold: domestic labor supply and the exchange rate have statistically and economically large effects on relative wages.

Section III. Alternative Theories

To explore why the results for Greater Bogotá, Colombia go counter to the HOS-South predictions, in this section I examine alternative theories. The three main results which such theories should explain are summarized by dw/dX vector ($=w_\tau, w_s, w_e$) = (+, -, +), or:

w_τ	>	0	for some countries in the South
w_s	<	0	for even small open countries
w_e	>	0	for some countries in the South.

I organize the principal alternative theories into four groups. Recall from Section I, that we grouped HOS assumptions into group A, or Factor-Diversified-Trade("FDT"); and group B, or 'identical-constant-returns technology' ("CC-TEK"). Accordingly, I begin by examining the cases: $\sim A$, $\sim B$, and $(\sim A \cap \sim B)$. The first group of alternative theories challenges group A, or the FDT assumptions. The second group challenges group B, or the CC-TEK assumptions. The third group involves challenging assumptions A and B, and examining potential interactions that arise. The fourth group does not challenge the validity of the theorem, but the tendency to organize the world into two

monolithic groups of North and South according to relative abundance in capital and skill and unskilled labor. The fifth alternative is a theory where global FPE fails.

Group 1: The Absence of Factor-Diversified-Trade (~A, or ~FDT)

The HOS predictions, HOS-N/S, collapse immediately upon denying the assumption that the country produces two tradeable products each using both factors. This is also called "Specific Factors Models" (or "SF"), where at least one tradeable good uses only one factor, so that one or both factors is specific to one good.

Conceptual and Empirical Ambiguity - The problem in adjudicating the validity of this explanation for non-HOS results is conceptual and practical. As emphasized in Section I, the validity of FDT does not require the absence of a non-tradeable sector, or other exports, such as natural resource products or agricultural products using land or a natural resource input and labor. Nor must the FDT tradeable goods dominate the economy: as L95 emphasizes, only a small window of FDT trade is needed to lock-in domestic wages to international supplies, via international prices.

While these conditions are very unrestrictive, they are also ambiguous. How small can the FDT sectors be for HOS-N/S to still apply? Current theory and practice are not very informative on this point. This problem is compounded when we consider that, even though in the long-run production may be FDT, if short-run movement of factors across sectors is sluggish, then SF models, not HOS, apply. In summary, there are three sources of ambiguity: first, concerning how large FDT sectors need to be; second, whether short-run factor movements are sluggish; and third, how long the short-run is. These three ambiguities make it difficult to test the validity of the HOS framework and identify what part of the HOS assumptions might not apply.¹⁸

Specific Factors Models - Once we deny the validity of FDT, domestic wages are no longer determined uniquely by international prices. Domestic labor supply matters, as may the exchange rate for wage determination. To take a simple example, one can argue that if devaluation lowers the relative prices of non-tradeables versus tradeables, and if non-tradeables are more intensive in

¹⁸ As an example of the complexity arising from the ambiguity in time-frames, example, while arguing that the time-frame for SS effects is decades, L95 argues that the U.S. significantly diversified its production away from foreign competition within the "Stolper-Samuelson decade" of the 1970's. Yet such a reallocation of production suggests rapid reallocation of factors across sectors. Future research needs to address these questions.

unskilled labor, then this would raise relative wages. I will refer to this as the T/NT Specific Factors model.

Another variant of Specific Factors models is found in Sachs (1996). He posits a domestic non-tradeable sector that may include manufactures. Manufactures are effectively non-tradeables because of quantitative restrictions. High levels of resource endowments lead to Dutch-disease like effects that restrain output growth. Natural resource wealth leads to perennially overvalued exchange rates that make (unskilled-intensive) labor-intensive exports of manufactures unviable and constrain growth. High unskilled workers' wages lead to high capital intensities. Relative wages may be high because of the capital-intensive nature of this non-tradeables sector. Real devaluations large enough to lower unskilled wages to internationally competitive levels cannot be easily achieved or sustained, leaving these resource-rich countries in a low-growth - and perhaps high relative wage - trap.

Endogenous Product Diversification, or Endogenous Specific Factors - Local firms may be able to diversify or change products within apparently competitive 'cones of diversification' in a way that partially insulates them from international price competition. For example, L95 argues that during the 'Stolper-Samuelson' decade of the 1970's, the U.S. largely diversified production away from direct competition with low-wage imports. The survival of trade liberalization by Chile's textile industry may offer another example. Despite fierce competition from imports after trade liberalization, textiles constituted 11 percent of employment in Greater Santiago over 1957-1965 and over 1985-1990, or roughly 4-5 percent of national employment [Robbins(1994b)]

Group 2. Challenging the Technology and Immobility of Physical Capital Assumptions of HOS (~B, or ~ CC-TEK)

Feenstra and Hanson (1994) present a model of capital mobility where trade liberalization leads to shifting production from the North, where the products are relatively unskilled, to the South where these products are relatively skilled. This raises relative wages in both the North and South. While applicable to countries such as Mexico with large FDI, much of trade-liberalizing Latin America did not receive substantial FDI in the 1980's.

If traded goods are factor diversified (FDT), but the technology assumptions of HOS do not apply, then HOS-N/S will not obtain. However, this will be for very different reasons from those discussed in Group 1, above.

Technology Flows - Unlinked to Trade Flows - Discussion of the rise of relative wages in the U.S. has shifted toward emphasizing the hypothesis that technology has become increasingly skill-intensive. This is supported by within-sector occupational upgrading [e.g., KM92; Berman, Bound and Griliches (1994)]. L95 argues that this explanation is incorrect unless the technical change is global. Thus, one argument for rising relative wages in LDCs is that global technology changes are skill biased.

However, what is the transmission mechanism of such changes in technology? LDCs are not typically participants in global R&D and technology innovation, but rather import technology from the North in some fashion. It seems most likely that technology transmission will be intimately linked to trade flows.

Skill-Enhancing-Trade ("SET") - Machinery and Technology Flows Accelerated by Trade Liberalization

If greater trade accelerates technology diffusion from North to South, then trade can be skill-enhancing. Recent evidence finds technology transfer to occur via trade. As I have argued elsewhere, trade liberalization may raise relative wages in some LDCs by inducing rapid adaptation of modern skill-intensive technologies from the North. Trade liberalization, and the exchange-rate devaluations that frequently accompany it, increase trade flows. It is well known that real devaluations typically raise the current account surplus, permitting higher levels of machinery imports. Heightened competition from trade liberalization leads to pressures to modernize via importing state-of-the-art machinery. Technology is bundled with this machinery. In LDCs emerging from Import-Substitution industrialization strategies that stifled adoption of foreign technologies, this will lead to an initial large jump to more modern and skill-intensive technologies. Subsequently, the liberalized LDC will continue on a skill-intensive biased trend similar to that

being observed in the North.¹⁹ Relative wages would follow a similar path conditioned by changes in supply.

A related hypothesis is that trade liberalization frees up capital flows that will move from the low interest rate, capital-rich North to the high interest rate, capital-poor South. Even without bundled technology, this would lead to higher capital-output ratios. Because of complementarity between capital and skill, this would raise relative demand for skill [Robbins (1994a), Stokey (1994)]

Consistent with the SET hypothesis, Robbins (1994a; 1995a; 1996b) finds that trade liberalization is associated with large increases in machinery imports, and that the stock of imported machinery is closely associated with relative demand shifts.

Group 3. Specific Factors and Skill-Enhancing Trade ($\sim FDT \cap SET$)

Many combinations of Specific Factors models and SET (as just one variant of $\sim CC-TEK$) are possible. For example, consider the case where exports use only unskilled labor, or no labor at all. Exports may be dominated by natural resources or agriculture that may, but need not, use unskilled labor inputs. Imports consist of machinery used in these sectors and the non-tradeables sector, such as construction and information-processing machines for services and commerce. There may also be one import-competing sector which uses imported machinery. Neither FPE nor SS obtain. Domestic wages will not be determined uniquely by international goods prices. Moreover, domestic supply and exchange rate will affect relative wages.

Trade liberalization, if bundled with exchange-rate devaluation will improve the latent current account, thus permitting higher levels of machinery imports which raise capital-output ratios in the non-tradeable and import-competing sectors. Lower tariffs on imported goods may eliminate most of the skill intensive ISI sector. However, while exports may be unskilled-intensive, the imports of machinery and the bundled skill-intensive technology may raise the overall skill-intensity of demand for labor, and hence relative wages. [see Robbins (1994a; 1995b; 1996a) in

¹⁹ However, Goldin & Katz (1995) show that technological change has not always been skill-biased.

particular with regards to the Chilean case]. The result would be $dw/dX = (-, -, +)$, as observed in particular for Chile, and here for Colombia.

In this context, as Sachs (1996) argues, historical dependence on natural resource endowments may explain the absence of unskilled-labor-intensive exports before and after liberalization. The continued success of natural-resource exports would also make it difficult for these countries to lower real exchange rates enough to lower unskilled labor's wages to internationally competitive levels and induce manufactured exports intensive in unskilled labor.

Group 4. Is the South Southern?

The application of HOS where the world is divided into homogenous Northern and Southern groups of skill (or skill and capital) rich and (unskilled) labor rich countries may be inappropriate. In particular, we may be mis-classifying some LDCs as labor rich when they are skill rich.

Group 5. South of Whom? Local FPE and SS

- L95 and Davis (1996) put forth what I call models of "Local FPE." These models are related to Krueger's insight [Krueger (1979)] that factor endowments may be so divergent that global factor-price-equalization does not occur. This can be understood in terms of a hierarchy of cones of diversification *within which* products of similar factor intensities compete and FPE holds in the absence of protection. L95 presents such a framework that leads to a kinked international relative demand curve for labor. Because within cones of diversification FPE obtains, the elasticity of relative demand is infinite. Hence I call this "Local FPE." As one goes from skill-poor to skill-rich countries, though, one proceeds across cones of diversification down along an international relative demand curve.

Building on Krueger (1977), Leamer (1995), and Wood (1995), Davis (1996) posits a similar model where he argues that trade liberalization will have opposite effects on relative wages for countries within the same cone of diversification. Countries that are relatively skill-rich within their cones of diversification will experience rises in relative wages, whereas relatively skill-poor countries will experience falls in relative wages. Countries with middling skill-endowments, vis-a-vis other countries in their cone, will experience no change in relative wages. This can be understood

simply as localized Stolper-Samuelson: as in the usual SS theorem, for countries rich in skill lowering tariffs will raise relative wages, while the opposite occurs for countries rich in unskilled labor. In the absence of global FPE, this phenomenon will occur, but only in relation to 'local' competitors inside the same cone of diversification. If Colombia is relatively skilled vis-a-vis its competitors, then trade liberalization would raise its relative wages. Note that competitors and trade-partners will often be different. I will refer to this as DKLW-Cones.

Table 3.1 Summary of Models of Relative Wage Determination

MODEL	RELATIVE WAGE EQUATION	PROPERTIES : dw/dX				
		Effects of Tariffs & Exchange Rate on Relative Wages via Prices, Imported Machinery & Technology			Total Effects on w from : Supply, Tariffs, Real Exchange Rate	
		τ Via p : $w_p \cdot p_\tau$	ε Via p : $w_p \cdot w_\varepsilon$	τ & ε via Imports of Machinery & Technology: $w_{km} \cdot km_\tau$; $w_{km} \cdot km_\varepsilon$ $w_\xi \cdot \xi_\tau$; $w_\xi \cdot \xi_\varepsilon$	Tariffs: w_τ [= $w_p \cdot p_\tau + w_{km} \cdot km_\tau + w_\xi \cdot \xi_\tau$]	Supply: w_s Real Exchange Rate: w_ε [= $w_p \cdot w_\varepsilon + w_{km} \cdot km_\varepsilon + w_\xi \cdot \xi_\varepsilon$]
Autarky	$w = \sigma^{-1}(d - w)$					(-)
Open Economies: 'North' vs. 'South' i.t.o. global supply	$p = p^i (1 + \tau)^m$ $m = (s_i - s_g) / s_i - s_g $, $\varepsilon \in \{-1, 0, 1\}$ $m = 1 \equiv \text{South}$; $m = -1 \equiv \text{North}$					
HOS (South)	$w = w(p)$	(+)	(0)	(0)	(+)	(0)
Specific Factors (SF or ~ FDT)	$w = w(p, s, \varepsilon)$	(+)	$\neq 0$	(0)	(+)	(-)
Sub-Case: T/NT Model	$w = w[p, s, p^{T/NT}(\varepsilon)]$ $p^{T/NT} > 0$ Skill-intensive tradeables, T , > non-tradeables, NT	(+)	(-) via $p^{T/NT}$	(0)	(+)	(-)
Skill-Enhancing Trade ("SET") (~ CC-TEK)	$w = w[p^i(1+\tau), k^m(\tau, \varepsilon), \xi(\tau, \varepsilon)]$ $km_\tau < 0$; $km_\varepsilon > 0$, $\xi_{km} > 0$	(+)	(0)	(-)	(+/-)	(0)
DLW-Cones ('North' vs. 'South' defined with respect to local cone)	$w = w(p)$ $p = p^i(1+\tau)m$ $m = (s_i - s_j) / s_i - s_j = \{-1, 0, 1\}$	(+/-) as $s_i > s_j$	(0)	(0)	(+/-) as $s_i > s_j$	(0)
Notation: $w \equiv$ relative wages $X \equiv p \equiv$ relative domestic prices of tradeables: skill-intensive/unskilled-intensive $p^i \equiv$ relative international prices of tradeables: skill-intensive/unskilled- intensive $\tau \equiv$ tariff $s \equiv$ relative supply $\varepsilon \equiv$ real exchange rate (dollars/local currency) $km \equiv$ stock of imported capital/GDP in skill-intensive sector $\xi \equiv$ technology in skill-intensive sector (1) $\sigma =$ elasticity of substitution skilled to unskilled labor $d \equiv$ relative demand shifts $s_i =$ i th country's relative supply $s_j =$ j 'th cone's relative supply $s_g =$ global relative supply						

Notes: (1) Sector-biased capital accumulation or technological change is required to raise relative wages [see Learmer(1995)].

IV. EVALUATING THE EVIDENCE FOR COLOMBIA

Validity of Basic HOS Assumptions for Colombia

Which, if any, of the HOS assumptions does Colombia satisfy? I discuss assumptions A, B and the 'Southernness' of Colombia in turn.

FDT? - Assumptions 'A' require that the country have Factor-Diversified-Trade, consisting of a mix of import-competing and export industries that use a mix of unskilled and skilled labor. While a thorough examination of this is beyond the scope of this paper, a cursory look at manufactured exports suggests that they satisfy the formal FDT conditions. Total manufactured exports range from 5 to 10 percent of GDP over 1970-1993 [World Tables, World Bank]. Manufactured exports, excluding agriculturally based and natural-resource based products, as a percent of total exports rose steadily from 30.7 percent in the 1965-1973 period to 49.1 percent in the 1985-88 period [Londero and Teitel (1996)]. In turn, the share of domestic production of these non-agricultural, non-resource-based manufactured exports rose from 4.3 percent in 1965-1973 to 7.3 percent in 1985-88 [Londero and Teitel (1996)]. These figures are a lower bound to which we should add factor-diversified import-competing goods.²⁰ These numbers are of comparable magnitude to the import of U.S. manufactures from LDCs which many claim qualify the U.S. as FDT and are the purported source of trade's impact on U.S. wages in recent years. Manufactured imports to GDP from LDCs were 2 percent of GDP in 1990, up considerably over prior years. Thus, if as many argue the U.S. satisfies the FDT conditions, Colombia surely satisfies FDT.

To test whether the Specific Factors model held because of short-run labor immobility, I also examined inter-industry wage dispersion. The figure below plots the weighted standard deviations of average and estimated interindustry wage differentials [from Robbins and Menendez (1996a)]. We are interested in the estimated wage differentials controlling for worker characteristics, since averages reflect changes in the composition of workers within industries. We see that the estimated standard deviation in wage differentials

²⁰ Data is not readily available for these goods, however.

fell from 1980 through 1989. This occurred despite shifts in the composition of workers across industries, as evidenced by the changes in the standard deviation of average wages. Thus, because I find no increase in the variance of estimated inter-industry wage differentials associated with changes in trade policy, I conclude that labor was mobile across industries in this period.

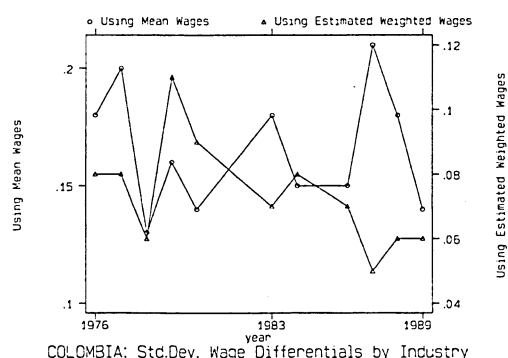


Figure 4.1

Southern? - Colombia's wages are low compared to Mexico's, and to Malaysian wages in the early 1970's. Thus, it seems safe to classify Colombia as rich in unskilled labor, or 'Southern'. I calculated indices of the dollar costs of wages by educational level from household surveys for Colombia, Mexico, Malaysia and Taiwan that control carefully to hold constant worker characteristics through time [see Robbins and Menendez (1996c) for details]. The comparisons are presented in Table 5 below. We see that Colombia's wages were only 20 to 30 percent below Mexico's in 1987, following the sharp Mexican devaluation of 1985. Colombian wages were two third's of Malaysian wages in the early 1970's, and then fell to one third by 1989. While Taiwanese wages have risen in recent years, imports from Taiwan to the U.S. have been considered part of the low-wage competition affecting U.S. wages. Compared to Taiwan, Colombia's wages were one half or equal to Taiwan's for primary and secondary educated workers, respectively in 1978, and fell to between one sixth and one quarter of Taiwanese wages by 1989.

Table 5. Comparison of Labor Costs Between Colombia and Selected Countries
(at current exchange rates in U.S. dollars)

	<i>Colombian Wages in Current U.S. Dollars</i>		<i>Colombian Wage as Ratio of Other Countries' Wages</i>				
			Mexico	Malaysia		Taiwan	
<i>Educational Level</i>	1976	1989	1987:1987	1973-1976	1989:1989	1978:1978	1989:1989
<i>Primary Complete</i>	.29	.47	.68	.67	.34	.56	.16
<i>Secondary Complete</i>	.68	.76	.80	.54	.34	1.12	.25

Notes: Indices for wages by educational level were constructed as weighted averages across sex and experience cells using fixed-demographic weightings (see Robbins and Menendez(1996c))

Immobility of Physical Capital

Examination of machinery imports shows that physical capital movements were important for Colombia over the period studied. Machinery imports over 1970-1990 averaged 4 percent of GDP, peaking at 7 percent in 1990. The stock of imported machinery to GDP to have averaged 15 percent, rising from 12 to a peak of 22²¹. I will discuss the constancy of technology below.

In sum - Colombia appears to technically satisfy HOS assumptions 'A', or FDT, and to qualify as a low-wage country. It appears that it does not satisfy some of the HOS assumptions 'B', or CC-TEK of immobility of physical capital. Later I will argue that it also does not satisfy the assumption of constancy of technology.

²¹ This is a relatively conservative estimate assuming initial imported capital stock to be zero in 1960 and depreciating imported machinery at 20 percent per year.

Alternative Models of Colombia

Specific Factors - Despite the lack of supporting evidence, assume that Colombia did not satisfy FDT. Is the T/NT hypothesis supported? The answer appears to be 'no'. According to the T/NT Specific Factors model, real depreciation raises the relative price of tradeables to non-tradeables, and this lowers wages. This argument requires that non-tradeables are less skill-intensive than tradeables this would raise relative wages. However, for Bogotá, Colombia, the non-tradeable sector, which constitutes three quarters of total employment, is more skill-intensive than the tradeables sector. I calculated skill densities by sectors from the household surveys. Non-tradeable skill densities, or relative employment (hours worked by university educated/ hours worked by other educational groups) grew from .26 to .7 in the non-tradeables sector over 1976-1989, compared to .17 to .47 for the tradeables sector.

Changing Technology or Capital Mobility - Assuming that assumptions A, or FDT, hold, what evidence do we have in support of theories violating the CC-TEK assumptions? In particular, is there evidence supporting the SET hypothesis? SET posits that rising machinery imports raise relative wages. To test this proposition I first regressed the log (relative wages) onto log (relative supply) and log (imported capital stock to GDP), where the capital stock variable was instrumented using the real exchange rate and tariffs as instruments. The results are supportive of the SET hypothesis. The coefficient on log (imported capital stock/gdp) is .5 and significant at the 5 percent level, while as before the coefficient on log(supply) is highly significant and negative.

Adopting a heterodox empirical approach to examining the causes of shifts in relative demand, I regressed the time series of imputed relative demand discussed in Section II.3 equation II.2. onto factors that may have shifted demand. I.e. I estimated an equation of the form:

$$(3.1) \quad d_t = f(\log(x), \log(m), \log(ics), \log(GDP))$$

where "x" are measures of export flows divided by GDP, "m" are measures of import flows divided by GDP, and "ics" is the imported capital stock divided by GDP.²² The results were not sensitive to different depreciation rates (here I report using a 20 percent rate) and were robust across various

²² Trade flows for exports and imports were taken from the World Bank's World Tables, while imported capital stock was constructed from the COMTRADE data base.

specifications. Nonetheless, caution is warranted given the small sample size and potential simultaneity bias. The estimated coefficients on log (imported capital stock) and log (GDP) for various specifications of trade flows [log (exports/GDP) and log (imports/GDP)] are reported below. Findings are summarized in Table 6 below. The estimated parameters on the imported capital stock variable averaged about .6 (ranging from .39 to .66), with t-statistics averaging about 5 (ranging from 2.6 to 6). Even regarding these estimates as partial correlations, they provide additional support for the SET hypothesis.²³

Table 6. Correlates of Implied Demand: Regressing Relative Demand Onto Imported Capital Stock and Output and Various Combinations of Trade Flows (estimated using Cochrane-Orcutt)

Independent Variables (ln logs)	Dependant Variable: Imputed Relative Demand for Skill										
	1	2(*)	3	4(a)	5	6(a)	7©	8(a,c)	9(b)	10(b)	11(*)
GDP	1.06 (4.2)	2.9 (1.9)	1.11 (3.8)	3.5 (2.9)	1.0 (4.2)	2.96 (2.2)	1.1 (4.3)	1.5 (2.7)	.34 (3.1)	.25 (4.8)	.24 (1.5)
Imported-Capital-Stock	.61 (5.6)	.66 (5.7)	.63 (5.1)	.39 (2.6)	.52 (4.2)	.56 (4.6)	.61 (6.0)	.59 (5.7)	.59 (4.1)	.51 (4.8)	.51 (3.6)
F-Statistic	40.9	32.7	34.7	38.7	35.7	32.07	79.2	54.2	33.1	61.96	42.7

N = 18. Adjusted R-squares between .89 and .93

* includes a time-trend.

a: These equations included a linear trend variable, and varying combinations of current and lagged trade flows/GDP.

b: These equations include domestic capital stock (total fixed capital - imported capital stock).

c: These equations include primary exports as a share of GDP.

Notes: the ICS variable here was constructed assuming 20 percent annual depreciation and zero initial value in 1960; alternative depreciation rates did not substantively change results.

Similar results were obtained in other specifications and when controlling for inflation, terms-of-trade or primary exports.

The SET hypothesis also posits that machinery imports accelerate with devaluation, and sometimes trade liberalization. Regressing log (machinery-imports to GDP) onto the log (real exchange rate), log(€)[dollars to pesos] or onto log(€) and tariffs, yields negative, significant

²³I include log(GDP) principally as a control in studying the effects of trade-related variables upon relative demand, however some brief remarks are worth mentioning. For Latin America, it is frequently assumed that higher growth leads to higher income inequality in Latin America. Recently Psacharopoulos, Morley and Fiszbein(1993), "PMF93", argue that growth is equalizing in Latin America, while Fields and Newton(1994), "FN94", for Brazil, Venezuela and Costa Rica find that growth did not improve income distribution. Here I find that estimated coefficients on log(GDP) are consistently positive. They range from 3.5 to .24, while t-statistics range from 1.9 to 4. Estimated coefficients on log(GDP) drop to about .3 when I control for the stock of domestic capital. These results do not support PMF93, but are consistent with FN94: i.e. growth does not seem to compress wage dispersion between the university equivalents and primary-complete equivalents.

coefficient of the real exchange rate variable corresponding to an elasticity of (-.35). I.e. real devaluation is associated with rising machinery imports to GDP.

Changes in the density of employment by occupation, particularly when counter to wage changes, indicative of biased technological change [e.g. KM92]. Using the same KM92 methodology, I decompose employment shifts into between and within-industry (see Table 7 below).

"Overall" employment shifts are measured using average manning ratios within industries and occupations, and calculating the projected employment changes from shifts in both industry and occupational employments. Between-industry changes are measured by projecting changes in the composition of employment from shifts in the employment pattern across industries. "Within" changes are then calculated as the difference between "overall" and "between" changes.²⁴

The between-sector change in demand for group k measured relative to base year employment of group k in efficiency units, E_k is:

$$\Delta X_{kd} = \Delta D_k / E_k = \sum_j (E_{jk} / E_k) (\Delta E_j / E_j) = \sum_j \alpha_{jk} \Delta E_j / E_k,$$

for the jth sector. Here E_j is the labor input in the jth sector in efficiency units, $\alpha_{jk} (=E_{jk}/E_k)$ is group k's share of total employment in efficiency units in the jth sector in the base year, which I normalize into an index of relative demand shifts using employment measures so total employment in efficiency units sums to one in each year. This formula is used to calculate the three groups of demand shifts: the overall demand shifts, by letting "j" vary over both industries and occupations; between-industry demand shifts, by letting "j" vary only over industries; and within-industry shifts as the difference between overall and between shifts.

After 1987, within-industry shifts were large and positive for university educated workers. In Table 7 below we see in the second panel that within-industry shifts were very large and positive for males in 1985-88, moderate and positive in 1988-91, and again very large in 1991-94, with values of .43, .12, and .43, respectively. The pattern for women was similar, with values of .33, .06 and .28,

²⁴ More formally, the between-sector change in demand for group k measured relative to base year employment of group k in efficiency units, E_k is:

$\Delta X_{kd} = \Delta D_k / E_k = \sum_j (E_{jk} / E_k) (\Delta E_j / E_j) = \sum_j \alpha_{jk} \Delta E_j / E_k,$
for the jth sector. Here E_j is the labor input in the jth sector in efficiency units, $\alpha_{jk} (=E_{jk}/E_k)$ is group k's share of total employment in efficiency units in the jth sector in the base year, which I normalize into an index of relative demand shifts using employment measures so total employment in efficiency units sums to one in each year. This formulae is used to calculate the three groups of demand shifts: the overall demand shifts (by letting "j" vary over both industries and occupations) and between demand shifts (letting "j" vary only over industries) and then calculating the within-industry shift as the residual.

respectively. Because these increases in within-sector densities of high-skill-occupations occurred despite rising relative wages, they imply strong skill-biased shifts in technology.

It is also important to note that HOS-South predicts that between-industry shifts will be positive after trade liberalization. We see that precisely the opposite is the case. Between shifts for males were strongly negative after trade liberalization for males and females, with values of (-.4) and (-.27) respectively over 1991-1994.

Table 7. Decomposition of Employment Changes, Bogota

(Data pertains to employed workers, self employed, proprietors and unpaid family workers)

		BETWEEN CHANGES					
		76-79	79-82	82-85	85-88	88-91	91-94
GENDER	EDUCATION						
Males	Primary	-0.022	0.099	0.041	-0.128	-0.049	-0.070
	Secondary	0.059	0.058	0.007	-0.015	0.047	-0.049
	University	-0.310	0.389	0.216	-0.604	-0.206	-0.396
Females	Primary	0.105	-0.110	-0.109	0.191	0.064	0.179
	Secondary	0.112	-0.158	-0.049	0.230	0.074	0.133
	University	-0.208	0.182	0.117	-0.409	-0.120	-0.272
		WITHIN CHANGES					
		76-79	79-82	82-85	85-88	88-91	91-94
GENDER	SCHOOL						
Males	Primary	-0.054	-0.098	-0.074	0.150	0.063	0.030
	Secondary	-0.035	-0.083	-0.019	0.025	-0.047	0.059
	University	0.321	-0.331	-0.111	<u>0.437</u>	<u>0.122</u>	<u>0.443</u>
Females	Primary	-0.123	0.164	0.066	-0.185	-0.009	-0.198
	Secondary	-0.090	0.128	0.028	-0.174	-0.062	-0.135
	University	0.232	-0.204	-0.029	<u>0.331</u>	<u>0.057</u>	<u>0.284</u>

These findings are strongly supportive of the SET hypothesis, particularly operating via the real-exchange rate. However, SET does not explain the impact of relative supply upon relative wages. These considerations bring us back to the validity of the FDT assumptions. Specific Factors

models appear necessary to explain the impact of relative supply on wages. Thus, despite the absence of direct evidence, some approximation to Specific Factors may be operative - perhaps via the product differentiation discussed earlier.

In Table 8 below I summarize these results and the different models. The findings are not consistent with any one theory. HOS-S is rejected fully. The SET hypothesis is consistent with the tariff and exchange rate effects. However, alone, it cannot explain the impact of supply. Supply impacts appear to require some form of SF or non-FDT explanation, though the direct evidence supported the FDT assumptions. Some degree of endogenous product diversification or differentiation could perhaps account for this.

Table 8. Comparing Findings and Predictions.

FINDINGS & MODELS	PROPERTIES : dw/dX					
	Effects of Tariffs & Exchange Rate on Relative Wages via Prices, Imported Machinery & Technology			Total Effects on w from : Supply, Tariffs, Real Exchange Rate		
	τ Via p : $w_p \cdot p_\tau$	ε Via p : $w_p \cdot w_\varepsilon$	τ & ε via Imports of Machinery & Technology: $w_{km} \cdot km_\tau$; $w_{km} \cdot km_\varepsilon$ $w_\xi \cdot \xi_\tau$; $w_\xi \cdot \xi_\varepsilon$	Tariffs: w_τ [$= w_p \cdot p_\tau + w_{km} \cdot km_\tau + w_\xi \cdot \xi_\tau$]	Supply: w_s	Real Exchange Rate: w_ε [$= w_p \cdot w_\varepsilon + w_{km} \cdot km_\varepsilon + w_\xi \cdot \xi_\varepsilon$]
FINDINGS	(?)	(?)	(-)	(-)	(-)	(-)
Autarky					(-)	
Open Economies:						
North' vs. 'South' i.t.o. <u>global</u> supply						
HOS (South)	(+)	(0)	(0)	(+)	(0)	(0)
Specific Factors (SF or ~ FDT)	(+)	$\neq 0$	(0)	(+)	(-)	(?)
T/NT Model	(+)	(-) via $p^{T/NT}$	(0)	(+)	(-)	(-)
Skill-Enhancing Trade("SET") (~CC-TEK)	(+)	(0)	(-)	(+/-)	(0)	(-)
DLW-Cones (North' vs. 'South' :with respect to <u>local</u> cone)	(+/-) as $s_i > s_j$	(0)	(0)		(+/-) as $s_i > s_j$	
Notation: w = relative wages X = p = relative domestic prices of tradeables: skill-intensive/unskilled-intensive p^i = relative international prices of tradeables: skill-intensive/unskilled-intensive τ = tariff s = relative supply ε = real exchange rate (dollars/local currency)						
km = stock of imported capital/GDP in skill-intensive sector ξ = technology in skill-intensive sector (1) σ = elasticity of substitution skilled to unskilled labor d = relative demand shifts s_i = i th country's relative supply s_j = j 'th cone's relative supply s_g = global relative supply						

Notes: (1) Sector-biased capital accumulation or technological change is required to raise relative wages [see Learner(1995)].

V. CONCLUSION

I set out looking for evidence of Stolper-Samuelson in the tropics. While Colombia appeared to be a ripe case due to its apparent satisfaction of basic HOS assumptions and due to the large variation in tariffs in recent years, I came up empty-handed in this pursuit. Instead I found a basket laden with results contrary to HOS. Tariff reductions were associated with rising wage dispersion; increases in domestic relative supply did not merely lead to Rybczinski sectoral shifts to more skilled sectors, they had uncompromisingly large, negative effects on relative wages; and, real devaluation, rather than leaving relative wages unaffected, contributed to raising relative wages. Evidence of general or localized Specific Factors was contradicted by the apparent absence of disequilibrium in the labor market accompanying trade liberalization or real devaluation. Liberalization and devaluation were associated with rising imports of machinery. If sector-biased toward skill-intensive sectors, these imports could explain the rising relative wages. However, alone they do not fully explain the findings. For relative supply to affect relative wages requires something more. That something may be a variant of Specific Factors emerging out of product differentiation and diversification, which may be endogenous to international competition. Further research will be required to answer this question. This paper makes significant progress in isolating the factors which may be behind non-traditional wage outcomes associated with trade liberalization in Colombia and elsewhere. I have employed some tentative methods to test the Factor-Diversified-Trade assumptions that are central to the HOS framework. Defenders of the HOS framework are nimble in responding to apparently contrary facts, saying that the problem lies not with the theory but in its application, without offering adequately clear criteria for judging these conditions. Clear debate founders somewhere between short-run factor stickiness and the threshold minimum size of the FDT tradeables sector. Clarity could be resurrected and intellectual progress advanced if future research were directed toward providing solid answers to these at once conceptual and methodological questions.

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