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EVIDENCE ON TRADE AND WAGES IN THE DEVELOPING WORLD

by

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RÉSUMÉ

Ce document est une synthèse de neuf études approfondies portant sur l'impact des échanges sur les salaires dans les pays en développement. Il est couramment admis que la libéralisation des échanges réduit la dispersion relative des salaires dans les pays en développement, alors qu'elle l'accentue dans les pays développés. Les données sur les revenus des différentes catégories de ménages disponibles pour l'Argentine, le Chili, la Costa Rica, la Colombie, la Malaisie, le Mexique, les Philippines, le Taipei chinois et l'Uruguay montrent que : tout d'abord, contrairement au modèle de Leamer (1995), dans les pays dont les échanges sont diversifiés, tout changement dans la répartition de l'offre de travail va de pair avec un ajustement des salaires ; ensuite, la libéralisation a entraîné une hausse des salaires relatifs et de la demande de main-d'oeuvre ; et enfin, la libéralisation des échanges provoque souvent une augmentation des achats de matériel, ce qui explique en partie l'accroissement relatif de la demande qui l'accompagne.

SUMMARY

This paper synthesizes nine in-depth developing country (LDC) studies on the impact of trade upon wages. It is traditionally assumed that in LDCs trade liberalization lowers relative wage dispersion, while raising wage dispersion in DCs. Evidence from cross-sectional household data for Argentina, Chile, Costa Rica, Colombia, Malaysia, Mexico, the Philippines, Chinese Taipei and Uruguay show: first, counter to one model in Leamer (1995), for countries with diversified trade, labor supply shifts generally shift wages. Second, liberalization was accompanied by rising relative wages and labor demand. And third, trade liberalization often increases the inflow of machinery, and may partly explain positive relative demand shifts accompanying trade liberalization.

PREFACE

Trade liberalisation and globalisation are dominating the latter half of the 1990s. Throughout the world, a process has begun which is predicted to produce benefits for all nations. Doubts, however, persist. Among them is the fear that trade liberalisation will reduce national control over labour markets.

Economic theory, expressed particularly in the Hecksher-Ohlin and Stolper-Samuelson literature, links trade opening to rising wage dispersion in developed countries and to the reverse in developing economies. In the real world, however, the situation is much less clear. The impact of trade regimes on wage differentials is not linear. It may even turn out to be the opposite of what the literature suggests.

In its 1996-98 research project on "Economic Opening, Technology Diffusion, Skills and Earnings", the Development Centre aims to clarify the links between these four elements. This Technical Paper by Donald Robbins of the Harvard Institute for International Development, uses household surveys in Argentina, Chile, Colombia, Costa Rica, Malaysia, Mexico, the Philippines, Chinese Taipei and Uruguay to test the effects of trade on wage dispersion, and identifies relative labour supply as an important factor. This, in turn, impacts on the levels of imported capital stock, producing a further distortion in the outcomes predicted by traditional theories.

The Development Centre is pleased to make these findings available. They represent a further contribution to the important debate on the costs and benefits of trade liberalisation.

Jean Bonvin
President
OECD Development Centre
December 1996

INTRODUCTION

Fears are mounting that international trade is lowering unskilled workers' wages in the Developed Countries of the North ("DCs") to the low wage levels of the Developing Countries of the South ("LDCs"). Bhagwati (1994) raises the question starkly: will " . . . Free Trade, while efficient, [immiserize] the unskilled in the richer countries"? Moreover, the prospect of continued integration of countries with low unskilled-workers' wages, notably China and India - sometimes called "globalization" - suggests these fears will not die easily. These fears have arisen because the increase in wage dispersion across skill levels for the U.S. beginning in the late 1970's was accompanied by rising international trade dependence, in particular a rising share of unskill-intensive manufactured exports. Heckscher-Ohlin trade theory, the Factor Price Equalization Theorem ("FPE") and the Stolper-Samuelson theorem ("HOS") were widely interpreted as providing a firm conceptual justification for these fears. The symmetric hypothesis that trade liberalization raises the relative wages (wages of skilled to unskilled workers) in skill-rich countries (DCs) and lowers relative wages in skill-poor countries (LDCs), hereafter "HOS", is an extension of the HOS theory incorporating the empirically supported assumption that capital and skill are complimentary [Griliches (1969); Hamermesh (1993)]. Numerous studies [e.g., Borjas, Freeman and Katz (1991), Freeman and Katz (1991), Revenga (1992), Murphy and Welch (1991), Sachs and Shatz (1994), Wood (1994)] have argued that the evidence supports this "HOS" interpretation. Today few argue that trade is the only or principal cause of rising skill differentials in the U.S., but many see it as an important contributing factor, and fear "globalization" may lead to far greater deterioration in the earnings distribution. Similar to the way residual productivity change, unexplained by measurable inputs, is often labeled "technical change", our inability to fully explain rising wage dispersion by trade, labor supply shifts, educational quality changes, weakening unions or deindustrialization, and supporting evidence including within-industry occupational upgrading, has led many economists to argue that the principal cause for the rising wage dispersion is skill-biased technical change [e.g., Katz and Murphy (1992); Berman, Bound and Griliches (1994)].

Others have contested the theoretic and empirical basis for the HOS hypothesis. Bhagwati(1994) argues:

> "...it is time to remind ourselves that the original view of the FPE theory was correct: its assumptions are indeed extraordinarily demanding. It is not therefore a compelling, or adequate, guide to real-world phenomena"

He and other trade economists [e.g., Lawrence and Slaughter (1994); Lawrence and Krugman (1994); Leamer (1995)] have criticized the factor-content-of-trade studies [e.g., Borjas, Freeman, and Katz (1991); Murphy and Welch (1991); Katz-Murphy (1992); Wood (1994)]. And the recent study based on changes in the prices of traded goods [Sachs and Shatz (1994)] finds only modest evidence that trade contributed to widening U.S. wage dispersion.

Contrary to Bhagwati's dismissal of the HOS framework, Leamer (1995) or "L95", argues that the HOS framework has been unfairly maligned. That the HOS framework is far richer and more powerful than commonly understood. L95 argues, though, that many empirical studies of trade and wages have failed to adequately integrate the lessons of this theory. In addition to criticizing factor-content studies, he also argues that for "small" open economies shifts in labor supply should not affect relative wages, and rather than factor-biased technical change affecting relative wages, it is sector-biased technical change that matters. L95 finds support for Stolper-Samuelson effects in the U.S. for the 1970's, but that also by the 1980's changes in the U.S.'s product mix appear to have insulated the U.S. somewhat from low-wage competition. However, L95 finds the future less promising for the U.S.: accelerating globalization should raise relative wages in countries with large apparel and textile sectors - such as in the U.S. Another set of explanations concerning the impact of trade on relative wages in LDCs are what we have called the "Skill-Enhancing-Trade" hypothesis or "SET" [e.g., Robbins (1995a)]. "SET" hypothesizes that rising trade dependency and liberalization may accelerate inflows of physical capital and technology to LDCs that lead to widening relative wages.

Predating the current debate on trade and wages in the U.S., HOS was put forth as predicting that trade liberalization in LDCs would lower wage dispersion there. Beginning in the 1980's this was also used to argue for LDC trade liberalization on the basis that it would be painless: that trade liberalization would increase efficiency and help the distribution of earnings in LDCs. However, until recent years there has been little evidence on trade and wages in LDCs.

Studying LDCs to determine the impact of trade on relative wages also offers important advantages over studying the U.S. Classical trade theory is symmetric, so LDC experience is as potentially revealing as DC experience. LDCs offer two advantages over DCs for studying trade's impact upon wage dispersion: First, trade frequently constitutes a far higher share of GDP in LDCs than some DCs, especially the U.S.[1]. Second, major trade policy and exchange rate reforms have been frequent in LDCs. LDC studies often face greater data limitations, less perfect understanding of non-trade influences on their labor markets, and the difficulty of controlling for important non-trade changes. Thus, while examining LDCs to study the impact of trade does not constitute a panacea, it offers important opportunities.

This paper summarizes and synthesizes country studies for Argentina,

Chile, Colombia, Costa Rica, Malaysia, Mexico, the Philippines, Chinese Taipei (Taiwan) and Uruguay. In these studies household surveys were used to examine the relation between trade and relative wages. While several studies exist on Mexico, most previous findings on trade and wages for Mexico end in 1990. This work extends through 1993. We focus on whether the evidence of these country studies supports the traditional HOS prediction that trade liberalization will lower wage dispersion, and their broader implications for theory.

The remainder of the paper is organized into seven sections. Section I summarizes the broader HOS theoretic framework put forth in L95. Section II summarizes the background of the countries studied. Section III first describes the data and the disaggregated methodology, it then examines whether the evidence supports the 2-traded-good model's prediction that relative labor demand is unaffected by relative supply shifts within the range of diversified traded good production. We find that in all these countries relative supply grew very rapidly, and that for all except Chinese Taipei, supply shifts had large negative effects upon relative wages. Based on this finding we argue that to identify relative demand shifts for these countries the impact of relative supply on relative wages needs to be netted-out to identify relative demand shifts, which may be subsequently related to trade liberalization and the predicted SS effects (or HOS). We then present estimates of relative demand shifts. We find that trade liberalization or devaluation led not to falling, but *rising* relative wages - save for the second liberalization episode in Argentina where relative wages were stable. These findings go contrary to the "naive" HOS. In Section IV we discuss alternative models of trade and wages to HOS. Section V then examines evidence regarding these alternative models. We find that rising levels of imported capital stock to GDP strongly track rising relative demand, and argue this is consistent with what we refer to as the Skill-Enhancing-Trade hypothesis (“SET”). We argue that the results are consistent with SET model and have symptoms of Specific Sectors models, though without corroborating evidence of either long-run or short-run sector specificity of labor inputs. Section VI concludes.

SECTION I. THEORETICAL FRAMEWORK AND METHODOLOGICAL CONSIDERATIONS

This section summarizes the basic Hecksher-Ohlin Stolper-Samuelson (HOS) framework and the Factor Price Equalization (FPE) and Stolper-Samuelson (SS) theorems. Parts of my presentation borrow from L95 and W95. We also emphasize corollaries of these theorems, especially: that neither domestic relative supply shifts nor exchange rate changes should affect relative wages for countries satisfying the HOS conditions.

Two Traded Goods Model: HOS Framework

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. We will refer to the assumption that there are two tradable goods produced in both countries both using inputs from the two factors as assumption "A", or factor-diversified-trade ("FAT"). 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. These assumptions may be relaxed in some dimensions without necessarily invalidating the FPE and SS theorems. While identical technologies are required for FPE, this assumption may be relaxed to permit different but similar technologies across countries without invalidating the SS theorem[2]. Moreover, allowing for more than one country, inclusion of other factors and inclusion 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 production of both goods requires both factors. If this is sufficient for domestic producers' prices of these goods to be determined by the international factor supply via prices, then given technology domestic factor prices are uniquely determined. Given these conditions, for example, we may add a non-tradable 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 tradable sector need not be large for FPE and SS to be valid. Leamer (1995), hereafter L95, has recently emphasized this point[3] . This is related to the irrelevance of the size of trade flows for wage determination [e.g., Bhagwati and Kosters (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 the

wages of unskilled 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. L95 (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 elastic[4]. For example a rise in relative supply of labor endowments will increase relative production toward 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; i.e., 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 tradables, 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 (1995) for Colombia were based on a false premise.

A Simple Exposition of FPE and SS Properties

Because we wish to emphasize the relationship between trade and relative wages across workers of different skill levels, my exposition is framed in terms of goods requiring two factors: skilled and unskilled labor. My exposition follows L95 and W95. Similar expositions can be made where the two factors are capital and unskilled labor, or a composite human and physical capital factor and unskilled labor. Diagram[5] 1 (diagrams are at the end of the paper) plots the relative labor demand curve for a country in autarky and a country with diversified trade, or two traded goods. The vertical axis measures the ratio of skill to unskilled workers' wages, while the horizontal axis measures the ratio of the quantity of skilled to unskilled workers. Line DD' plots the demand curve in autarky, while line dd' plots the country with diversified trade under HO assumptions. In diversified trade for a small country the two goods' prices are exogenous. Thus, for a constant technology, where the production of each good entails skilled and unskilled labor, the two fixed prices uniquely determine the two factor prices; and for the same technology over countries, these factor prices are equal across countries (the FPE theorem). The intersection of DD' and dd' is the non-trade point. Trade shifts the demands for goods externally, and constant technology transfers this external demand to marginal demand for the two factors.

Relative Supply Shifts

In this context we see that for fixed international goods prices, diversified trade leads to constant relative factor prices. Thus, where the two factors are skilled and unskilled workers, relative wages are constant as long as the relative traded goods' prices are constant. This corresponds to the flat portion of the dd' demand curve. The point to emphasize here is that within this interval of diversified trade, shifts in relative supply will not affect relative wages. The marginal demand for labor is external, and domestic supply and non-traded goods demand does not affect factor prices. This situation stands in sharp contrast to the usual theoretical supposition in labor economics, i.e., that increases in relative supply will lower relative wages given a constant demand structure. In practical terms, this raises the question of whether in analyzing the effects of trade on wages one need net out the effect of supply upon relative wages in order to identify demand shifts that may be due to trade or other factors.

In this two traded-good model, relative factor supply shifts do not affect relative factor prices, but they do change the mix of traded goods produced. At given factor prices, a rise in the relative supply of skill must lead to a rise in the ratio of the skill-intensive traded good compared to the unskilled-intensive traded good. This is the Rybzcynski Theorem. Thus, this model predicts that for a small diversified economy with constant trade regime, facing stable international goods prices, a rise in relative labor supply will be accompanied by constant relative wages and a rising proportion of the skill-intensive traded good.

Stolper-Samuelson Effects

Exogenous changes in international goods' prices or changes in tariffs that change the relative goods prices faced by domestic producers, under fixed technology, will alter relative factor prices (Stolper-Samuelson Theorem). In terms of Diagram 1 this corresponds to a downward shift of the infinitely elastic segment of the relative labor demand curve for skill rich country. If China's entry into the global market increases the world supply of products intensive in unskilled labor, say "apparel"(A), this will lower the international price of apparel, relative to the other, skill-intensive, traded good, say "machines"(M). In each country the change of relative wages is proportional to the change in the corresponding relative prices. Define w, relative wages, as the ratio of skilled to unskilled wages and p, relative prices, as the ratio of the skill intensive to the unskilled-intensive goods. In all countries, $dw/dp > 0$, i.e., a rise in relative prices leads to a rise in the corresponding relative factor prices. China's entry depresses the apparel price, P_A, so that p rises in the skill-rich countries such as the U.S., and as a consequence w rises.

By this logic, trade liberalization in skill- rich countries (DCs) will raise relative prices, p - the price of skill-intensive versus unskill-intensive goods -

and hence raise relative wages. Trade liberalization in skill-poor countries will lower relative prices and hence lower relative wages. This is the same as the HOS theory discussed above. It is the source of DC's fear that increasing integration and China's entry into global trade will depress the wages of unskilled workers in DCs.

Summary of Basic HOS Model & Theorems

To summarize these arguments succinctly, we express the determination of relative wages of skilled to unskilled workers, 'w' in terms of 'p', the relative price of skilled to unskilled tradable 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 tradables, p, equal relative international prices, $p^{I,}$, or p º 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 tradable goods:

(1.1) $w_i = w_i(p),\ dw_i/dp > 0.$

Stolper-Samuelson adds tariffs. Relative domestic tradables producer prices become a function of international relative prices and tariffs:

(1.2) $p = p^{I} (1 + \tau)^{m},$

where:

p = domestic relative tradables prices: skill-intensive to unskilled-intensive goods

P^{I} = international relative tradables prices: skill-intensive to unskilled-intensive goods

$m = (s_i - s_g)/|s_i - s_g|$, $\varepsilon\{-1,0,1\}$,
s_i = relative labor supply in country 'I'
s_g = relative global labor supply

Countries levy tariffs on the imports of goods in which they do not have a comparative advantage. Thus Northern, or skill-rich countries, levy tariffs on imports of unskilled-intensive goods, and vice-versa for the South. Thus: m = (-1) for the North and 1 for the South, and the Stolper-Samuelson effects of changing tariffs will be opposite for North and South:

(1.3) $dw/d\tau >$ 0 as m = 1, for the South
$<$ m = -1, for the North.

Trade liberalization should widen wage dispersion in the North and compress wage dispersion in the South. Note that given a country's relative supply endowment and ranking in the world, implicit in equations (1.1) and (1.2), relative supply and exchange rates do not affect relative wages.

(1.1a) $w_s = 0$
(1.1b) $w_{_} = 0$

The exchange rate does not affect relative (or real) wages because it leaves the relative prices of traded goods unchanged.

Letting $X = [\tau, s, \varepsilon]$ the Stolper-Samuelson predictions for relative wages are:

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

For LDCs, HOS-South predicts (1.4b). Thus, the rise in tariffs in the 1980's should have led to rising relative wages, while the fall in tariffs from 1990 onward should have led to falling relative wages. Neither relative supply shifts nor the real exchange rate should have affected this result.

SECTION II. COUNTRY BACKGROUNDS

The country cases consist of small developing countries with high trade exposure in Latin America, East and South-East Asia. For the period studied, Chile, Colombia, Costa Rica, Malaysia, Mexico, Chinese Taipei and Uruguay had rising relative supply during periods of stable trade regimes, thus affording the opportunity to see if relative wages were infinitely elastic to relative supply shifts as predicted in the two-traded-good HOS model, above. Over the periods studied, five economies, Argentina, Chile, Costa Rica, Colombia and Uruguay had major increases in trade policy openness. For these episodes SS effects (HOS) are expected. The case of the Philippines is more mixed, with modest trade liberalization for part of the period studied.

Four of the Latin American economies liberalized their trade regimes in the period studied: Chile, Costa Rica, Mexico and Uruguay. The Chilean trade liberalization experience beginning in 1975 was dramatic, and largely unaltered through the present. Average tariffs fell from over 100 per cent prior to 1975 to a uniform level of 11 per cent by 1979. They were raised slightly in the depression of 1982-3, but then lowered again. Costa Rican trade liberalization began in 1987 and continues today. Mexican tariffs were reduced by 45 per cent and import licences by more than 75 per cent Between 1985 and 1987. Mexican industries have been historically protected by both tariffs and import permits, and these quantitative import restrictions began soon after World War II. From June to December of 1985 the average coverage of import licences fell from 92.2 per cent to 47.1 per cent of the value of domestic production. Weighted tariffs fell from 22.8 per cent in 1980 to 11 per cent in 1988. The tariff reductions occurred between 1986 and 1988 tariffs fell from 24 to 11 per cent [Ten Kate(1992)]. Uruguay intensified its trade liberalization particularly after 1990. In the period studied, 1976-1989, Colombia did not undergo major trade liberalization. However, the Colombian case is an excellent exchange rate experiment. Between 1985 and 1989 Colombia devalued over 60 per cent, leading to a near doubling of exports. Argentina liberalized trade in two episodes in the 1976-1993 period studied. First, over 1976-1982 Argentina sharply lowered tariff and non-tariff barriers to trade. This episode ended in overvaluation, recession, inflation and a partial *de facto* reversal of reforms by 1983. Argentina's second liberalization episode was over 1989-1993. This episode has also been accompanied by overvaluation of the domestic currency, and this led to stagnation of exports over 1990-1994. Uruguay began a modest trade liberalization in the 1970s. During the 1980s the trade policy was stable, but in the beginning of the 1990s a major increase in the trade policy openness was introduced. The Philippines is a heterodox case of modest, faltering trade reform in the late seventies and early eighties, then sharp trade reform in 1991. However, for the Philippines wage data was unavailable after 1989.

The generally high trade exposure of these countries - in the sense that international trade constituted a large share of GDP - is seen in the figure

below. This figure plots exports plus imports over GDP (sometimes referred to as "openness", though this appellation is controversial). By this measure, openness was in excess of 50 per cent Chile, Costa Rica, Malaysia, Philippines and Chinese Taipei by 1992, and openness grew in five of the seven countries. Chinese Taipei and Malaysia were by far the most open. In Malaysia openness grew from .75 to 1.5, while in Chinese Taipei openness averaged about 1. In most of these countries, the share of exports to GDP and imports to GDP fluctuated sharply over the periods studied - even in countries without changes in trade liberalization - and tended to grow. In Argentina openness grew with the first phase of trade liberalization, but declined afterward. In 1993 openness was at the same level as in 1976, at about 12 per cent. In Chile, openness rose from about twenty to fifty-five per cent over the 1970-1990 period. This trend was interrupted over 1980-83 due to an overvalued currency, the international debt crisis and insolvency of Chilean banks, but afterwards openness grew rapidly through 1990. In Colombia, openness hovered roughly between twenty and twenty-five per cent thorough 1984. Then a major devaluation led to a dramatic expansion of exports - nearly doubling their share of GDP - that peaked in 1990. The plot of openness for Colombia understates this export boom, as imports fell over this period. In Costa Rica openness has been high but variable. It began in the early seventies around 55 per cent, rose through 1976 then fell though 1980, jumped upwards in the severe 1981 recession as domestic demand collapsed, then fell until 1987. Beginning in 1987, coincident with trade liberalization, openness rose again to 71 per cent in 1993. Malaysia shows a continual process of rising openness, from a high initial value of openness near 70 per cent in 1970, rising briskly to nearly 100 per cent in 1983, then rocketing to 150 per cent by 1992. Openness in the Philippines was 28 per cent in 1970, shifted upwards to about 40 per cent after 1973, and then after 1986 rose rapidly to 55 per cent in 1992. Chinese Taipei is the only country where openness fell slightly overall, though still remaining at 0 .9 in 1993. In Uruguay openness stayed fairly constant over the period 1985-1995, at about 35 per cent.

The only country where openness did not grow after trade liberalization (or devaluation in the case of Colombia) is Argentina during its second liberalization episode, after 1990. This is due to the overvaluation of the domestic currency and consequent stagnation of exports. In constant dollars, the level of Argentine exports remained the same in 1993 as in 1990. In all countries trade flows changed significantly, and we will examine relationship between this variation and wage structure later.

With the exception of Chinese Taipei, these countries are plentiful in land. Most of these countries are not mineral rich, except for Chile, and Colombia after 1991 (large petroleum deposits were discovered). All countries, save perhaps Argentina, are endowed with large supplies of unskilled labor, in particular when compared to DCs. Excluding processed primary products, of which the Latin American countries are large exporters, manufactured exports are largest in Chinese Taipei and Malaysia (after 1980).

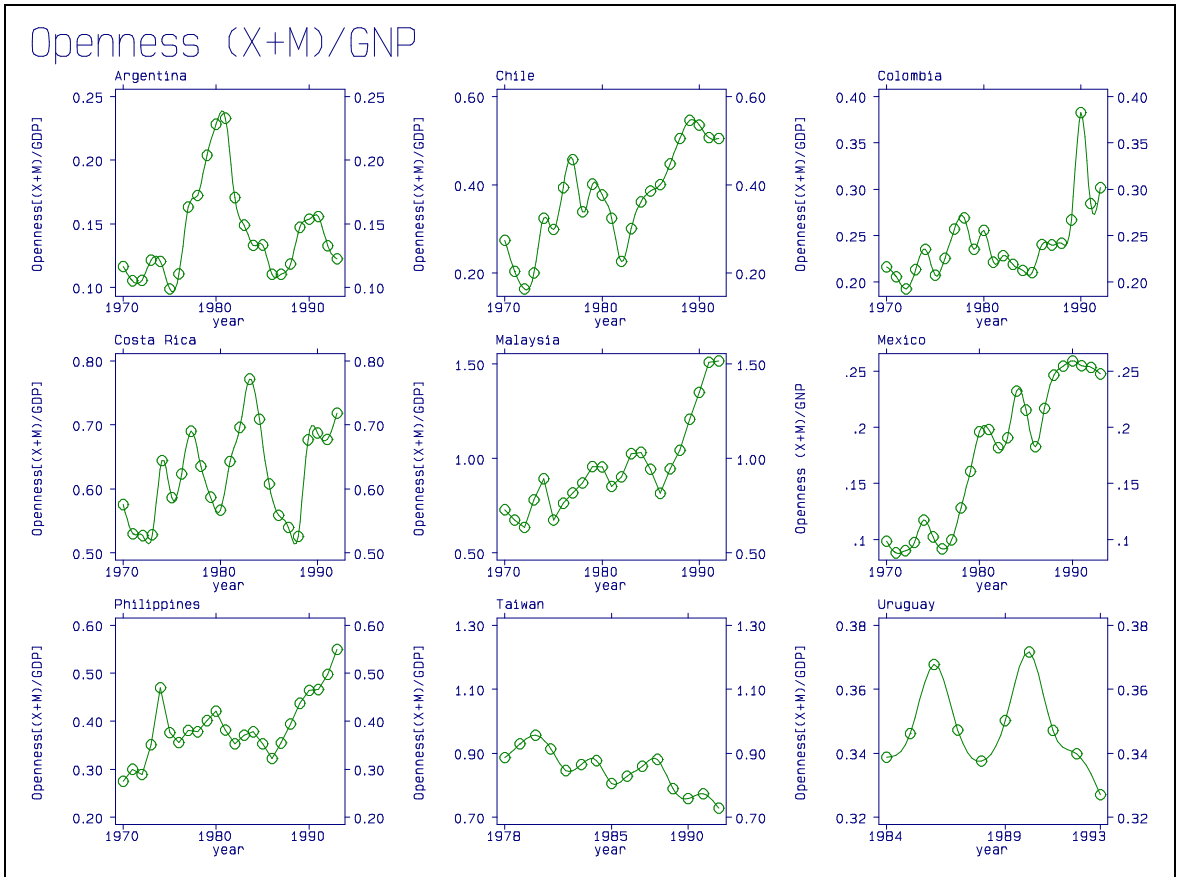


Figure 1.Openness (Exports+Imports)/GDP

Next we summarize and discuss the empirical results.

SECTION III. DATA, AND BASIC RESULTS ON THE RELEVANCE OF SUPPLY AND THE NEUTRALITY OF DEMAND

In this section, we first briefly summarize the data employed. Next we examine evidence to determine whether, as these are all for the most part open economies, we can ignore the impact of relative supply shifts upon relative wages. We find that for Argentina, Chile, Colombia, Costa Rica, Malaysia and Uruguay, that relative supply shifts appear to have large impacts on relative wages. For Chinese Taipei, the evidence is consistent with relative supply shifting the product mix without affecting relative wages.

Data

Household survey data is used for each of these countries. 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 entities[6]. For Costa Rica, Malaysia, Philippines, and Chinese Taipei the data are national in coverage. For Argentina, Chile, Colombia and Uruguay, the coverage is for their metropolitan areas - Greater Buenos Aires, Santiago Bogotá and Montevideo. Annual sample sizes varied from 12,000 for Chile, to 100,000 for the Philippines. For six countries we have largely uninterrupted series of annual household surveys: in Argentina over 1974-1993; in Chile over 1957-1992; in Colombia over 1976-1989; in Costa Rica over 1976-1993; in Chinese Taipei over 1978-1992, and in Uruguay over 1985-1995. In Malaysia we used surveys for 1973,1984,1985, and 1989, while for the Philippines we have surveys for 1976, 1978, 1982, 1986 and 1988. We focus on hourly wages for salaried employees, but examine various groupings of individuals for employment and supply measures.

Relative Wage and Supply Shifts

Methodology and Results

Overview - In the first part of this section we first employ a disaggregated approach to measuring relative wage and relative supply changes that are fully comparable through time. In the second part, we use these measures to test whether demand shifts were factor neutral - i.e. that there were no skill-biased demand shifts.

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), we 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, 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 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.[7]

This method of aggregation described 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.[8]

Is Relative Demand Infinitely Elastic?

Using this disaggregated methodology to construct relative wage and relative quantity measures that are comparable through time, we first examine whether relative demand is infinitely elastic for these countries. According to the two-good small open-economy model presented above (see Diagram 1), by FPE a country with diversified trade faces an infinitely elastic relative demand curve, and relative supply affects the product mix but not relative wages. This should hold true for small open economies producing more than one tradable. And this would be true even for countries with protective tariffs, as long as those tariffs and international goods prices were stable. These conditions hold for Chile (1960-1970), Colombia (1976-1985), Costa Rica (1976-1985) and Uruguay (1985-1990) in their pre-trade liberalization phases and for Malaysia and Chinese Taipei. If Model 1 is correct, then if relative supply changes we expect stable relative wages, or $dw/ds = 0$, where w º relative wages and s º relative supply (and a rising relative share of skill-intensive goods, following the Rybzcynski Theorem). If demand is elastic, we expect outward shifts of relative supply to trace-out a downward-sloping relative demand curve, or $dw/ds < 0$.

The graphs below plot relative supplies for each country based on the

technique described above. In all cases we find that the relative supply of skill rose very rapidly. The usual reasoning would lead us to believe that such relative supply growth would engender corresponding declines in relative wages, unless demand shifts intervened.

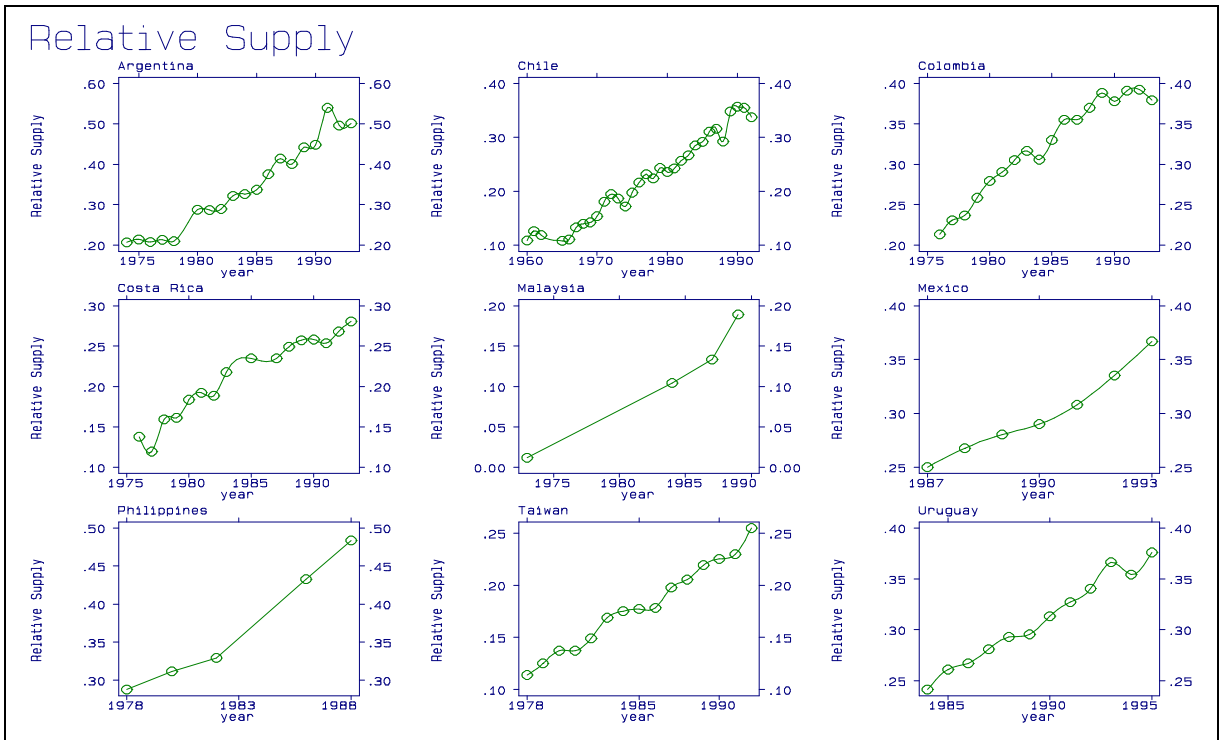


Figure 2. Relative labor Supply

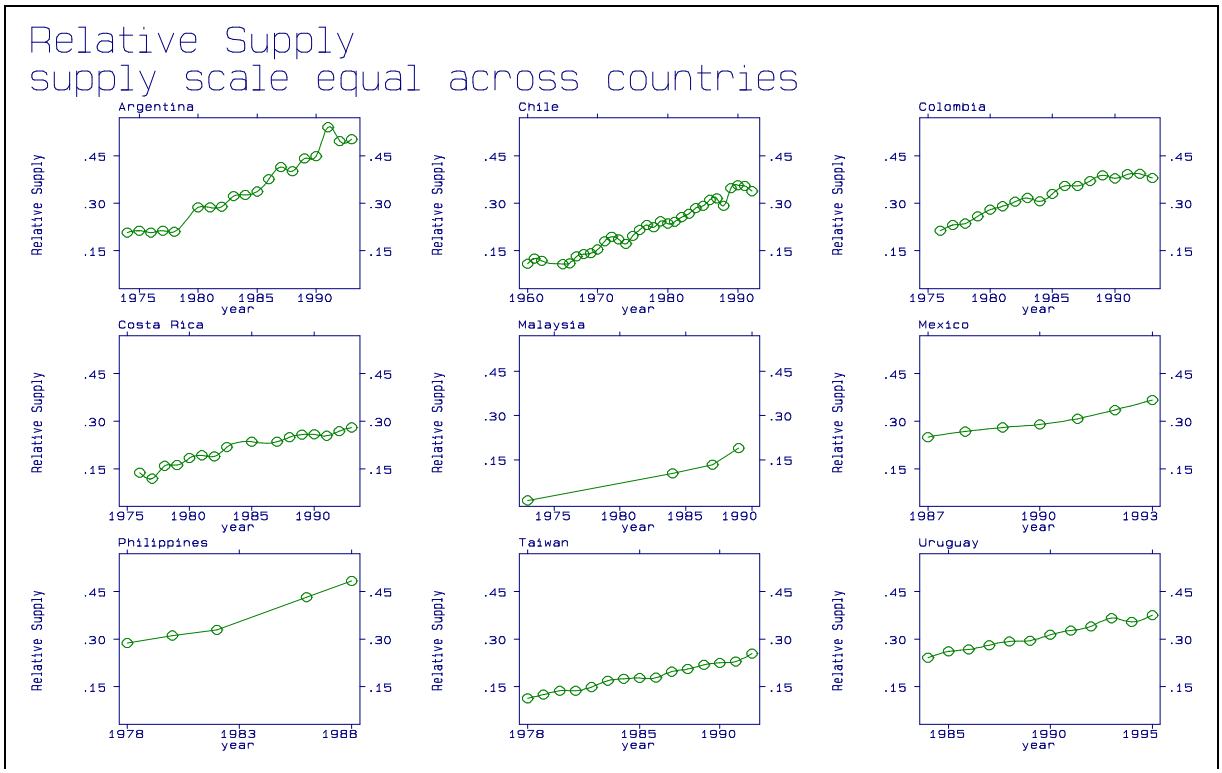


Figure 3. Relative labor Supply, equal scale across countries.

Table 1. **Relative Supply Growth**
(Percentage Increase in Ratio of University over Primary Complete Equivalents)

Argentina 1976-90	Chile 1976-90	Colombia 1976-89	Costa Rica 1976-90	Malaysia 1973-89
115.8%	65.0%	82.3%	87.4%	1508.1%
Mexico 1987-1993	Philippines 1978-88	Chinese Taipei 1978-90	Uruguay 1984-90	
46.8%	68.1%	110%	29.9%	

The figure below plots relative wages and relative supply together for the seven countries. Focusing on Chile, Costa Rica, Colombia and Uruguay prior to trade liberalization (1960-1975; 1976-1985; 1976-1985, and 1985-1990, respectively) and Malaysia, we see that the very large increases in relative supply are closely associated with very large falls in relative wages. For example, in Colombia relative supply grew nearly three times over 1976-1985 and during this time relative wages fell by almost two-thirds. This accords with estimates (discussed below) of elasticities of substitution between 1 and 1.5 for these (below) and other countries (e.g., Hamermesh (1993)).

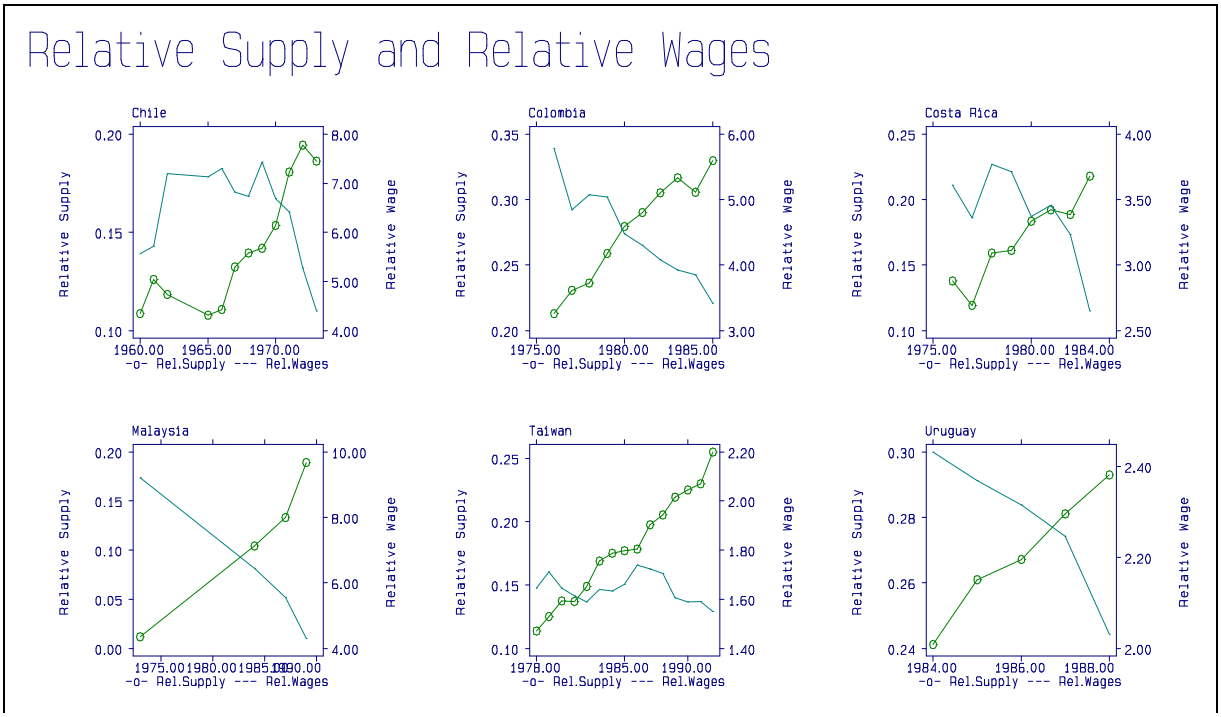


Figure 4. Relative Supply and Relative Wages

For Chinese Taipei relative wages were relatively stable in the face of a more than doubling of relative supply. Relative supply rose from .12 to .25 over 1978-1993, while relative wages fluctuated modestly around a mean of about 1.7. These findings are consistent with Model 1 and an infinitely elastic relative demand curve. Further, as discussed below, between-sector employment shifts in Chinese Taipei were toward more skilled sectors, as predicted by the Rybzcynski Theorem. We should note, however, that these facts are also consistent with upward relative demand shifts that proceed at the same rate as relative supply shifts.

We also regressed log relative wages onto log relative supply and the log of the terms of trade to control for possible common shifts in the terms of trade. We continue to find evidence that shifts in domestic relative labor supply have large, negative, effects upon relative wages.[9]

The country-level findings for Chile, Colombia, Costa-Rica, Malaysia, Mexico and Uruguay are not consistent with the prediction from the basic HOS model of a flat relative demand curve.

In sum, it appears that for most of these countries the large increases in relative supply exert strong downward pressure on relative wages. Thus, it appears necessary to net out the effects of relative supply shifts on wages to identify relative demand shifts. In this context, in examining relative wages and supply, with rising relative supply, if relative wages also rise this would suggest upward relative demand shifts.

Stolper-Samuelson Effects and HOS

Stolper-Samuelson effects should be visible in Argentina (1976-1982; 1989-1993), Chile (1975-1993), Colombia (1985-1989), Costa Rica (1987-1993) and Uruguay (1991-1995). According to the usual prediction for LDCs, such SS effects would lead to lower relative wages - once we net out the effects of relative supply shifts - for these LDCs. Turning again to Figure 3, For Chile, Costa Rica, and Colombia - hereafter the three C's - trade liberalization does not appear to generate falls in relative wages. The combination of SS effects and rising relative demand should have produced very large falls in relative wages. In fact relative wages rise in these cases and for Argentina's first trade liberalization episode (1978-1982).

Testing Demand Neutrality: The Inner Product Test

The inner product test asks whether supply changes alone are sufficient to explain changes in relative wage structure across various time periods. If demand is neutral, relative wage changes will move in the opposite direction from relative supply shifts. Therefore the inner product between the vectors of changes in relative wage and quantity vectors would be negative or zero.[10] [11] Thus, we test the pure supply hypothesis across the interval t to t+m by

calculating:

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

Our approach differs in three 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, we examine alternative measurements of supply. KM92 assumes full employment, and uses 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, we test the robustness of the inner-product results using various supply measures, including total labor 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. Third, we calculate a normalized inner-product. We normalize the inner-product by the length of the vector of supply changes. 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, and those based on the annual data are reported.]

In Chile, Colombia, Costa Rica and Uruguay, their periods of trade liberalization (and devaluation) were associated with positive or zero inner products, suggesting that supply shifts alone could not explain relative wage outcomes. In the open Asian economies and the Philippines, inner products were negative throughout, suggesting that relative supply shifts could explain relative wage outcomes. In Argentina, inner products were strongly positive from 1976 through 1989 and then strongly negative after 1989. The 1976-1989 period largely corresponds to the period of higher trade openness for Argentina, though other factors were also changing. In the next section we continue the exploration of the nature of relative demand shifts in a time-series framework.

Time Series Analysis of Relative Wages, Supply and Demand

We are ultimately interested in measuring relative labor demand shifts and determining whether they were due to trade liberalization or changes in trade openness. Here we aggregate up from the disaggregated measures to estimate the time series of relative demand shifts. To do this we examine the time series of relative wages and a constructed time series of relative supply, and net out relative supply shifts from relative wage changes to get estimates of the time series of relative demand shifts. These findings of rising relative demand after 1985 are consistent with the results from the disaggregated analysis above: both suggest that relative demand became skill-biased in the second half of the 1980's. In this framework we also test whether changes in minimum wages or the skill composition of unemployed workers were

responsible for relative wage shifts.

The approach employed builds upon Freeman (1976,1979,1980) and follows KM92. For a simple CES production function we may write relative wages shifts as a function of relative demand and supply shifts, and the elasticity of substitution between more and less skilled workers:

$$(3.2) \quad \log(W_{1,t}/W_{2,t}) = (1/s)\,[d_t - \log(s_{1,t}/s_{2,t})\,],$$

or

$$(3.2') \quad w_t = (1/s)\,[d_t - s_t]$$

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 s 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. We incorporate a more complete supply measure and employ a different estimation strategy reflecting that both the elasticity of substitution and demand shifts are unobserved. We proceed in three stages. First we construct the time series of relative wages and supply. Second, we estimate equation (1'), above, approximating demand by a linear trend to obtain bounds on the elasticity of substitution, and test the impact upon relative wages of some other time-varying variables. Third, we calculate the time series of relative demand assuming differing elasticities of substitution.

Stage One: Forming the Time-series of Relative Wages and Relative Supply

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 demographic weights from the disaggregated relative wage matrix presented earlier in Section II. In order to create a composite index of relative skill (cognitive to physical skill), we use the Linear Skills Synthesis hypothesis of Welch (1969). Welch suggested that while our 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: for example, physical strength ("brawn") and agility and cognitive ability ("brain"). Individuals would be assigned weighted averages of these two dimensions, and range from mostly "brawn" to mostly "brain." We do this by proxying the two dimensions by those with primary-incomplete 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, we 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.[12]

These measures of relative supply rise steadily throughout the 1976-1993 period. They are robust to different definitions of supply. Though rising much more slowly than the ratio of university to primary-complete graduates, these measures rise quickly. We focus on the relative supply measure that includes employees, self-employed, and unpaid family workers. In Costa Rica, for example, this measure grows at an average 4.3 per cent annual rate, and more than doubles from .12 to .28 between 1976 and 1993. Broader measures of supply adding unemployed and discouraged workers, and even the total potential labor force, follow similar paths.

Stage Two - Estimates of the Relative Wage Equation

Estimates of equation (1') assuming a linear trend for demand yielded implied elasticities of substitution between 1 and 1.5 for most countries. Here we also tested whether minimum wages, the unemployment rate or the skill composition of the unemployed altered the results. Where the information was available, neither minimum wages[13] nor the unemployment rate were statistically "significant" (as traditionally understood) or altered the results when included as controls. Similarly, broader supply measures including unemployed workers, or even the entire potential labor force had little effect on the estimates.

Stage Three - Imputing Relative Demand Shifts

To impute demand we solve (1') for d_t and calculate d_t assuming a range of elasticities of substitution around the estimated values from Stage Two. Thus,

$$(3.3)\quad d_t = \sigma \cdot w_t + s_t,$$

and the imputed demand series using elasticity equal to 1.5 (the same qualitative results hold for a wide range of elasticities) in the figure below:

For those countries undergoing trade liberalization or devaluation - Chile, Colombia, Costa Rica and Uruguay - imputed relative demand shifts were not negative as predicted by HOS. Instead relative demand shifted upwards in each of these cases. Argentina's trade reform was very different, because trade reform there has not led to greater openness or export success, largely due to its overvalued exchange rate.

In the open economies, estimated relative demand also rises. As discussed above, for Chinese Taipei, it could be argued that this is not a demand shift: relative wages were fixed internationally, and the increase in relative supply led to between-sector shifts toward more skilled products.

Malaysia cannot be interpreted in this way since their relative wages fell rapidly for university to primary graduates.

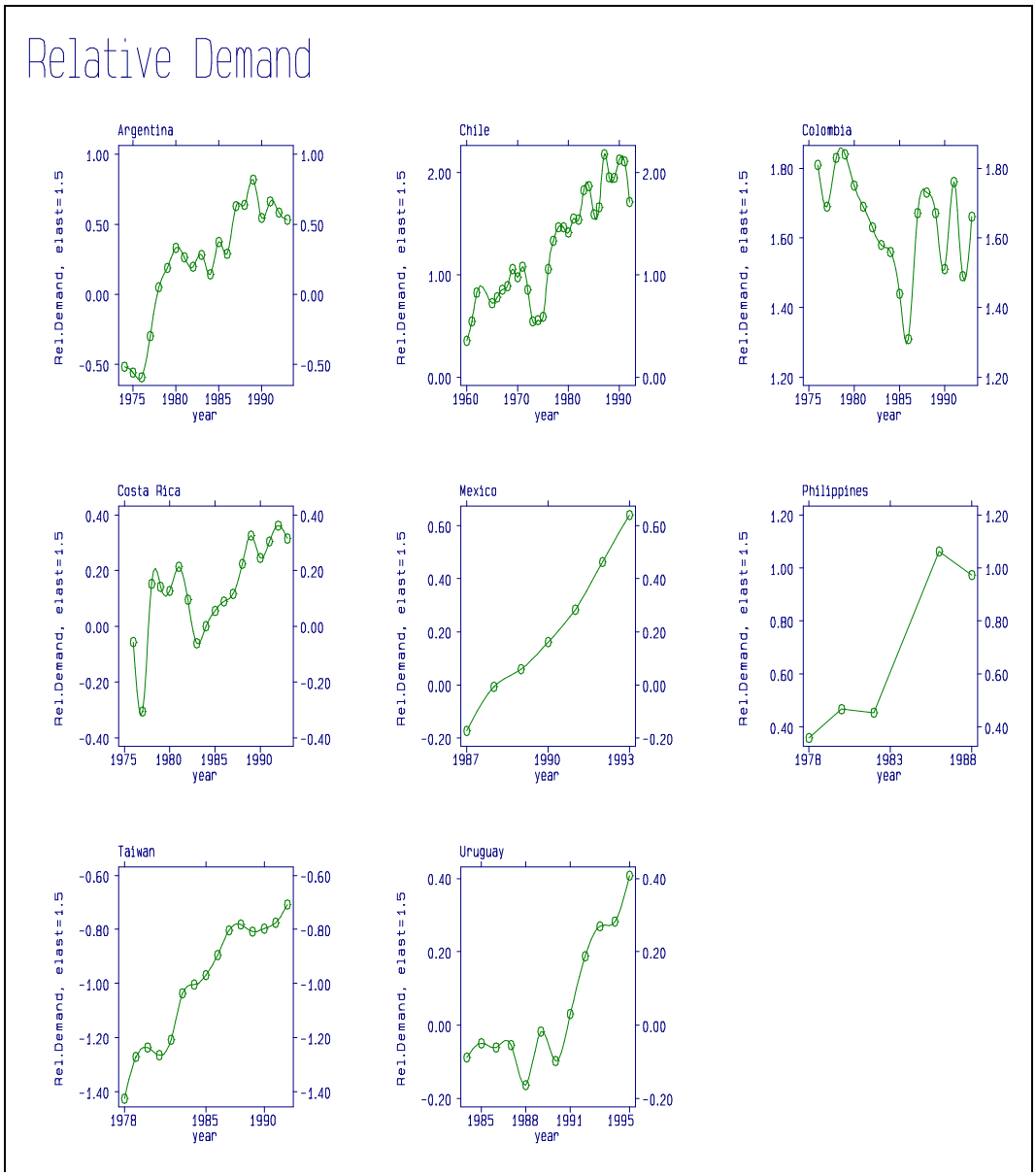


Figure 6. Relative Demand

Non-trade factors that could influence outcomes include changes in unobserved schooling quality, labor laws, asymmetric composition of skill affecting our relative supply measure, and minimum wages. We were able to control to differing degrees for these factors.

Unions were not important in Malaysia, the Philippines, or Chinese Taipei. The decline of the union movement and labor laws in Chile preceded the rise in relative wages, and subsequently rose gradually - counter to the wage pattern observed. Unions declined in Argentina over this period and may have been an important factor in raising relative wages there. Data on union density is unavailable in Argentina, as in most of these countries.

The studies of Argentina, Chile, Colombia, Costa Rica and Uruguay found that minimum wages did not affect relative wages. Minimum wage and labor laws in the Asian countries studied are weak and unlikely to have affected relative wages, though explicit controls were not possible. In all countries, several supply measures were examined to see if skill-intensity of supply was sensitive to supply definition, but results were robust across all definitions of supply. In Malaysia, there was a major effort to increase the economic standing of the native Bumi-Putra population over the local Chinese who are widely regarded as successful. This involved preferential affirmative-action-like job creation in state employment, greater access to land, and support for farming. This could be an important part of the falling measured relative demand between the university and primary groups, though direct tests of this were not possible.

Tests for educational quality shifts that might explain relative wages were performed for Argentina, Chile, Colombia, Costa Rica and Uruguay. In these five cases no evidence was found in support of unmeasured educational quality shifts as causing relative wage shifts.

Table 2. Correlation Between Relative Wages and Relative Wages by Cohorts

Argentina	Chile	Colombia	Costa Rica	Malaysia	Mexico	Philippines	Chinese Taipei	Uruguay
0.89	0.75[1]	0.80	0.66	0.94	[*]	-0.51	0.51	0.85

Note: Calculated for Males. Correlation is computed between the relative wage (university to primary) and the relative wage (university to primary) that corresponds to one cohort through time, to control for quality. Cohorts and relative wages begin in the earliest year available.

*: For ***Mexico*** relative wages are 2.24 and 2.82 for 1987 and 1992 respectively, and the relative wages that corresponds to the 1987 cohort are 3.04 for 1987 and 3.66 for 1992.

1: 1970-1985. The correlation for Chile is lower if we follow the 1970 cohort of labor force entrants becomes negative after 1985 because the aging 1970 labor-force entrant cohorts' wages fall relative to younger workers.

To the extent it was possible to control for these other non-demand-related factors, there is little evidence of their importance for these countries in this period. The most important cases warranting caution are Argentina, because of the decline in its union movement that also accompanied de-industrialization, and Malaysia where policies to support the Bumi-Putra population may explain the fall in wage differentials between university and primary graduates.

Conclusion

In this section we saw that estimated time series relative demand shifts rose after trade liberalization for all countries save in Argentina's most recent trade reform. The available evidence does not generally suggest that non-demand-based factors cause the observed wage patterns, with the important reservations of Argentina and Malaysia.

SECTION IV. ALTERNATIVE THEORIES OF TRADE AND WAGES

We now turn to alternative theories of trade and wages. The three main dimensions of relative wage behavior we wish to discuss are summarized by the dw/dX vector ($\equiv w_{\tau}, w_{s}, w_{\varepsilon}$):

We 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, we begin by examining the cases: ~ A, ~B, and (~A∩~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 skilled and unskilled labor. The fifth alternative is a theory where global FPE fails [D.Davis (1996); L95; Krueger (1977)].

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 tradable products each using both factors. This is also called "Specific Factors Models"(or "SF"), where at least one tradable 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-tradable 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 tradable 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.[14]

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-tradables versus tradables, and if non-tradables are more intensive in unskilled labor, then this would raise relative wages. We 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-tradable sector that may include manufactures. Manufactures are effectively non-tradables 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 (unskill-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-tradables 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 per cent of employment in Greater Santiago over 1957-1965 and over 1985-1990, or roughly 4-5 per cent of national employment [Robbins (1994a)].

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

Feenstra and Hanson (1995) 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. It is often argued that 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.

Technical Change

In aggregate growth accounting and firm studies, after controlling for observed factor input changes it is common to attribute the residual unexplained output growth to technical change. In the same spirit, the apparent inability of supply, trade, or educational quality changes to explain the rise in U.S. relative wages in the 1980's has been increasingly attributed to skill-biased technical change [e.g., Katz and Murphy (1992); Berman, Bound and Griliches (1994)]. L95 argues that in an open economy this reasoning is flawed.

In a closed economy skill-biased technical change would shift the relative demand curve outward and, given supply, raise relative wages. The effect of technical change on relative factor prices in an open economy can be seen using the Lerner-Pearce framework, in Diagram 3, below. There the vertical axis represents the skilled labor inputs, L1, and the horizontal axis the unskilled labor inputs, L2. Unit value isoquants summarize the technology at given international goods prices. Zero profit conditions require that W1*L1 + W2*L2 = 1 lies tangent to both unit-value isoquants, determining unique relative factor prices, w º W1/W2. L95 appears to argue that, because skill-biased technical change will shift both unit value isoquants left by similar amounts, this would cause a parallel shift of the line, W1*L1 + W2*L2 = 1, that would leave relative factor prices largely unchanged. Instead, sector-biased technical change that shifted the unit value isoquant of only one product would pivot this line and change relative wages. In particular, if there were technical progress for the skill-intensive good, this would raise relative wages.

Alternative understandings of factor-biased technical change serve to underscore L95's argument that skill-biased technical change may be incapable of explaining rising relative wages for open economies. The above discussion of 'factor-biased' technical change is strictly true where this leads to an equal absolute reduction in the amount of the factor used per unit of output. This would imply different percentage reductions in the amount of those inputs across products. However, if "factor-biased change" were understood to reduce the amount of one input required by the same percentage for each good, then this would pivot the zero-profit condition line and alter relative wages. Note, however, that skill-biased change, whereby the percent of unskilled labor required to produce goods A and M both fell by 30 per cent, would actually lower relative wages. Thus, contrary to the closed economy model, in the open economy model sector neutral skill-biased technical change of this sort would raise relative wages.

Thus, if technological change is global and is sector-biased toward skill-intensive sectors, it can raise relative wages. However, what is the transmission mechanism of changes in technology to developing countries? 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. We call this Skill-Enhancing-Trade ("SET"). Recent evidence finds technology transfer occurs via trade. As we 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.[15] Relative wages would follow a similar path conditioned by supply 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 complimentarity between capital and skill, this would raise relative demand for skill [Robbins (1994a, 1995a, 1996a), Stokey (1994)].

Consistent with the SET hypothesis, Robbins (1994a, 1995a, 1996a) 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 (~FDT ∩ SET)

Many combinations of Specific Factors models and SET (as just one variant of ~CC-TEK) are possible. For example, consider the cases where exports use one kind of labor, 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-tradables 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 the 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-tradable 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-intensivity of demand for labor, and hence relative wages [see Robbins (1994a, 1995a), in 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, W95 and Davis (1996) put forth what we 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 leading to a kinked international relative demand curve for labor. Because within cones of diversification, FPE obtains, the elasticity of relative demand is infinite. Hence we refer to this as "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.

N Goods and "Localized" Factor Price Equalization ("LFPE")

L95 presents an extended version of HOS for n traded goods. Here each open country produces either one or two traded goods. This translates into an extrapolated relative labor demand curve like the dd' curve in Diagram 1 consisting of n negatively sloped segments connected by n-1 flat segments, as in Diagram 2, below. Each flat segment of the demand curve corresponds to the country trading two goods whose factor-intensities bound the line segment on the x-axis. As skill intensity rises countries will shift from diversified trade to trade in the more skill-intensive good, and then to trade in that good and a more skill-intensive good, and so on. For example, as skill intensity rises within or across countries, the mix of goods would shift from software to computers to machines to apparel to footwear, alternating between one "locally" specialized to two "locally" diversified goods to one "locally" specialized good.

This model has several important implications. First, factor price equalization is not absolute but "local". It is local in the sense that there is FPE only among countries trading the same diversified basket of competing goods, with proximate factor requirements. Shifting out of such "cones of diversification" can lead to different relative factor prices. Second, this model suggests both a positive explanation of trade patterns and factor prices, and normative prescriptions to insulate oneself from the depressing effects (upon unskilled workers' wages) of "globalization" (the increasing integration of high-skilled economies with low-skill countries, and the entry of China and India into world trade). By shifting outputs to more capital and/or skill intensive products, countries can insulate themselves from competition with low (unskilled) wage products countries. Investments in human and/or physical capital can aid this shift into local specialization or high (unskilled)-wage cones of diversification. Here the wages of unskilled workers are held up by the high productivity of skilled workers and capital at the cost of relatively low returns to skill and capital.

The third implication of this model is that relative supply shifts will more easily translate into relative wage changes. "Small" increases in relative supply can shift the product mix right and downward along the serrated demand curve in Diagram 2. W95 emphasizes this demand curve, and, citing Dornbush, Fischer and Samuelson (1980) notes that as the number of goods approaches infinity the demand curve becomes perfectly smooth and downward sloped. From a methodological viewpoint, in this state of the world relative supply shifts would imply relative factor price changes. Unlike HOS, to identify trade-related relative wage changes it would be appropriate to first control for the effects of relative supply shifts upon relative wages.

“DLW Cones” or Local Stolper Samuelson Effects

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. We will refer to this as DKLW-Cones.

Chart 1. **Summary of Models of Relative Wage Determination**

		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		
MODEL	RELATIVE WAGE EQUATION	*τ Via p*: $w_p \times p_\tau$	*ε Via p*: $w_p \times w_\varepsilon$	*τ & ε via Imports of Machinery & Technology*: $w_{km\times} km_{t\tau}$; $w_{km\times} km_\varepsilon$ $w_\xi \cdot \xi_t$; $w_\xi \xi_\varepsilon$	*Tariffs*: w_τ [$= w_p \cdot p_\tau + w_{km\times} km_\tau + w_\xi \cdot \xi_\tau$]	*Supply*: w_s	*Real Exchange Rate:* w_ε [$= w_p \cdot w_\varepsilon + w_{km\times} km_\varepsilon + w_\xi \cdot \xi_\varepsilon$]
Autarky	$w = \sigma^{-1}(d - w)$					(-)	
Open Economies: 'North' vs. 'South' i.t.o. global supply	$p = p^i (1 + \tau)^m$ $m = (s_i - s_a)/\lvert s_i - s_a \rvert$, $\in \{-1,0,1\}$ $m = 1$ ⇒ South; $m = -1$ ⇒ North						
HOS (South)	$w = w(p)$	(+)	(0)	(0)	(+)	(0)	(0)
Specific Factors (SF or ~	$w = w(p, s, \varepsilon)$	(+)	≠ 0	(0)	(+)	(-)	?
Sub-Case: T/NT Model	$w = w[p, s, p^{T/NT}(\varepsilon)]$ $p^{T/NT}_{\varepsilon_-} > 0$ Skill-intensivity tradables, T , > non-tradables, NT	(+)	(-) via $p^{T/NT}$	(0)	(+)	(-)	(-)
Skill-Enhancing Trade("SET") (~CC-TEK)	$w = w[p^i \cdot (1+\tau), k^m(\tau,\varepsilon), \xi(\tau, \varepsilon)]$ $km_\tau < 0$; $km_{\varepsilon_-} > 0$, $\xi_{km} > 0$	(+)	(0)	(-)	(+/-)	(0)	(-)
DLW-Cones ('North' vs. 'South' defined with respect to local cone)	$w = w(p)$ $p = p^i(1+\tau)m$ $m = (s_i - s_j)/\lvert s_i - s_j \rvert = \{-1,0,1\}$	(+/-) as $s_i \gtrless s_j$	(0)	(0)	(+/-) as $s_i \gtrless s_j$	(0)	(0)

Notation:

X ≡ w≡ relative wages; p ≡ relative domestic prices of tradables: skill-intensive/unskilled-intensive; p^i ≡ relative international prices of tradables: 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 = ith 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)].

SECTION V. EVALUATING THE EVIDENCE FOR ALTERNATIVE THEORIES

In this section we first examine cross-country wage and supply data for agreement with HOS, or for the DLW-Cones or localized SS. We find the evidence supports neither of these. In Part 2 we discuss whether the evidence supports Specific Factors models. While not conclusive, we argue that it is unlikely that sector specificity of factors can explain the results for most of the countries examined here. In part three we summarize decompositions of employment shifts into between-sector and within-sector shifts. HOS implies that we would expect negative between-sector shifts. The contrary is observed, along with strong within-sector employment shifts along with rising relative wages that are suggestive of the SET model. In Part 4 we explore the SET hypothesis by examining the relationship between relative demand shifts and machinery imports as a ratio of GDP. The evidence is consistent with the SET hypothesis of occupational upgrading.

Part 1. DLW Cones or Local SS

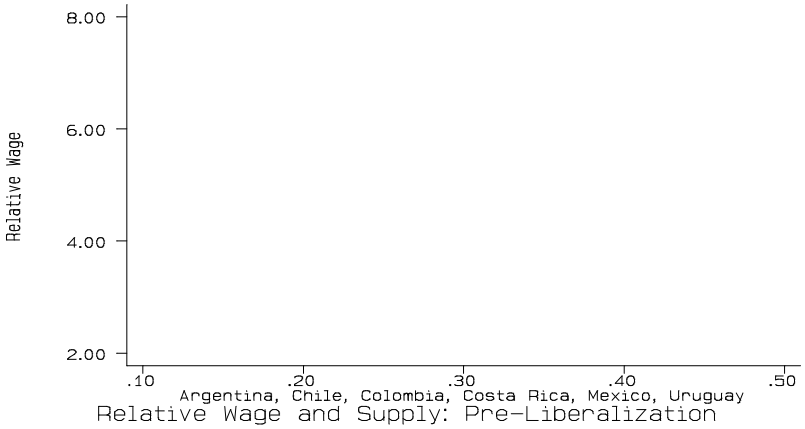
While the country level data is consistent with the n-traded-goods model of L95 of Davis (1996), the cross-country data is not. Those models would predict that the cross-country wage and supply data would lie on the serrated demand curve, with relative wages falling as relative supply increases. However, when we examine the wage and supply data across countries we find neither support for HOS nor for the downward sloping cross-country demand curve of the n-traded-goods model. The first group of figures below plot relative wages for our sample before trade liberalization and afterwards, both for all countries and for Latin America alone. By HOS we would expect the variance of relative wages to fall, though not necessarily the variance of relative supplies (in very long-run HOS this should be the case). Thus, we expect after trade liberalization to see a flat international demand curve. Relative wages will have converged to, or toward, international levels (this level may have shifted as a result of trade liberalization), while relative supplies vary across countries. No evidence of such wage convergence is observed.

We also expect convergence of the dollar-denominated value of wages for workers with the same levels of human capital after trade liberalization. To examine this we have constructed constant human capital wage costs by country through time. The next group of figures plot the current dollar costs of workers with primary-complete and university-complete educations (controlling for the distribution of sex and age within these educational groups). Again, we see no convergence in real wages after trade liberalization.

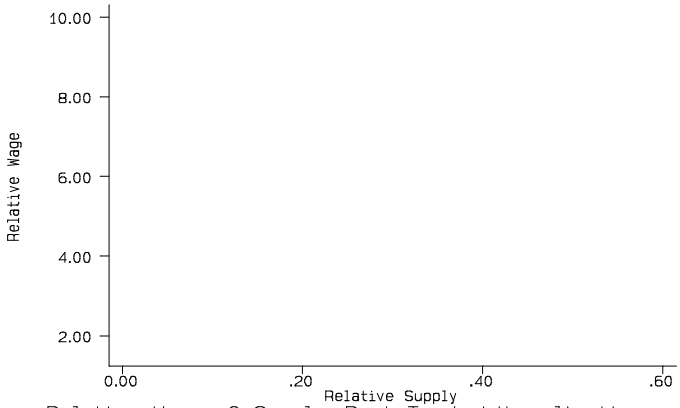
These findings go counter both to the simple HOS model and the n-traded-goods models of L95 and probably to Davis (1996). It is possible that we are looking across local 'cones of diversification,' in which case this would not fairly test Davis (1996). However, this seems unlikely given the results for

similar Latin American countries.

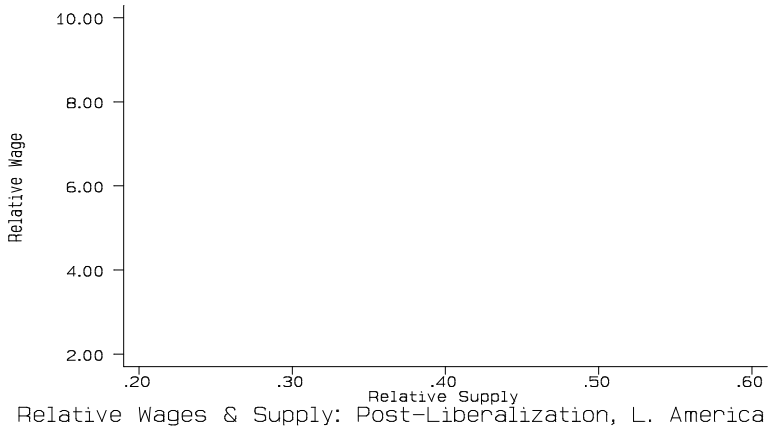
Relative Supply and Wages



Relative Wage and Supply: Pre-Liberalization

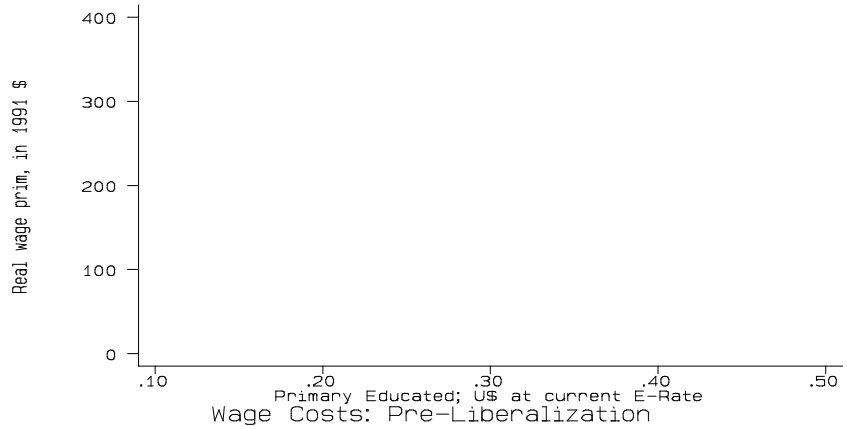


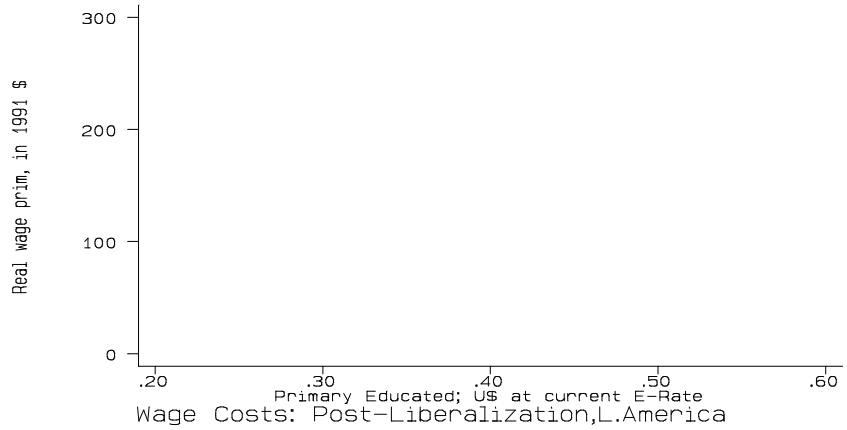
Relative Wages & Supply: Post-Trade Liberalization

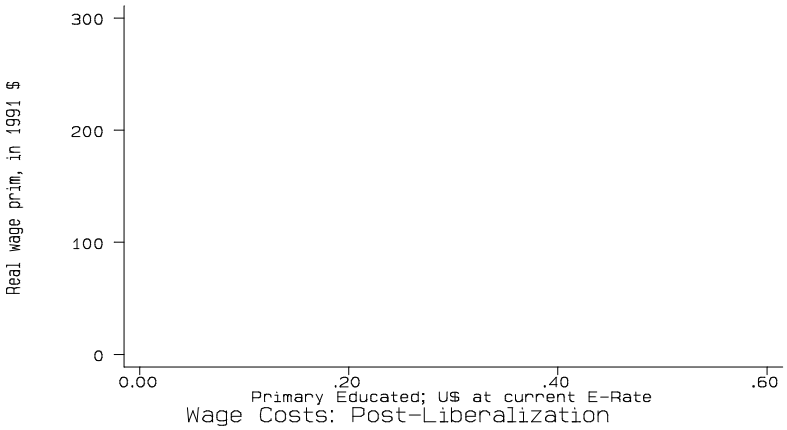


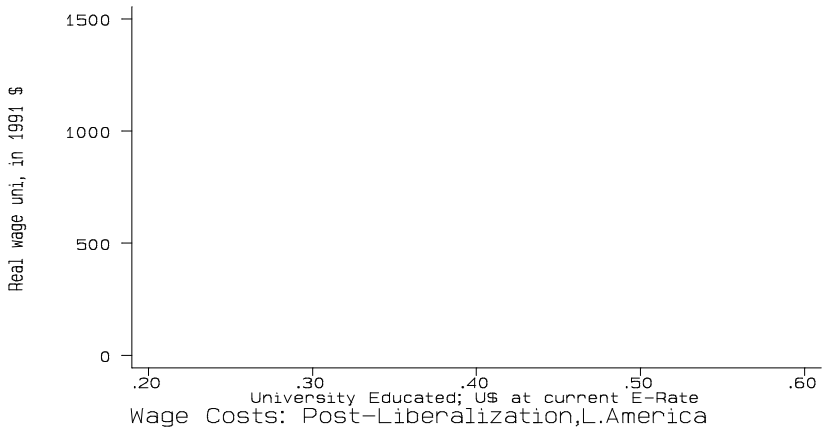
Relative Wages & Supply: Post-Liberalization, L. America

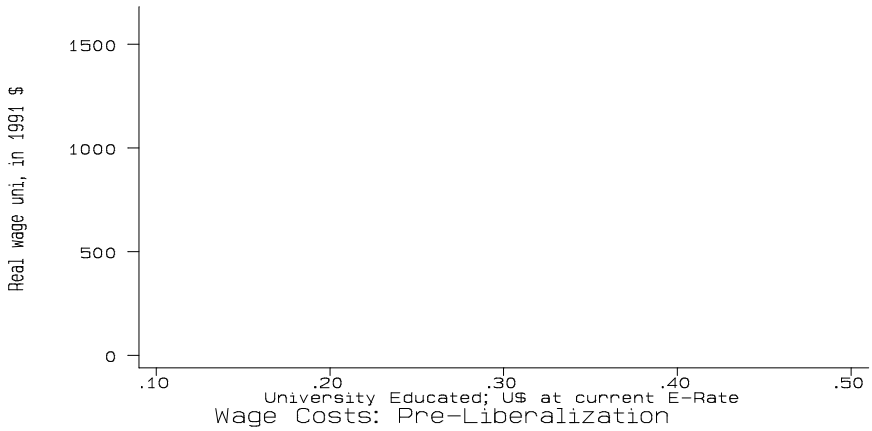
International Wage Comparisons In Dollars at Current Exchange Rates: Primary & University Educated

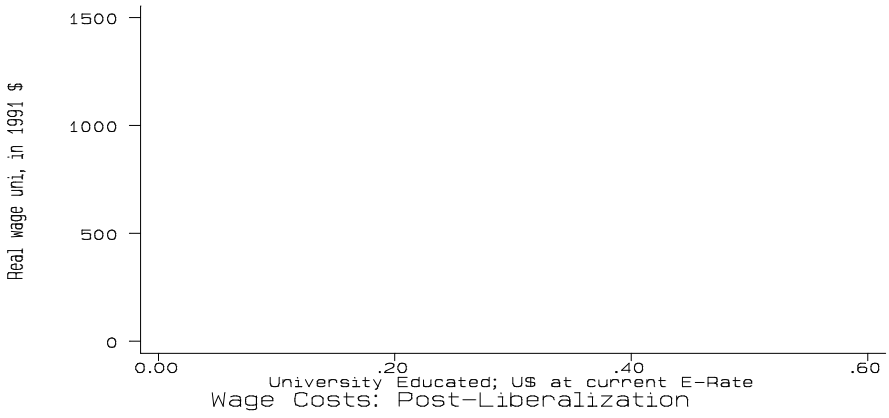







Real wage uni, in 1991 $
1500
1000
500
0
.20
.30
.40
.50
.60
University Educated; U$ at current E-Rate
Wage Costs: Post-Liberalization,L.America


Real wage uni, in 1991 $
1500
1000
500
0
.10
.20
.30
.40
.50
University Educated; U$ at current E-Rate
Wage Costs: Pre-Liberalization


Real wage uni, in 1991 $
1500
1000
500
0
0.00
.20
.40
.60
University Educated; U$ at current E-Rate
Wage Costs: Post-Liberalization

Part 2. Violation of the FDT Assumptions - Specific Factors Models -

The assumption of production of diversified tradables may be incorrect. However, this seems unlikely, since most of these countries appear to both produce and import consumer durables and export a diversified mix of products. Malaysia, for example, exported light manufactures, processed agricultural and natural-resource products, and competed in textiles and apparel. Perhaps what we have termed "local specialization" is more prevalent than we might suppose. One way of thinking about this is in terms of monopolistic competition, where similar products compete only indirectly. And, it is also possible that natural resource-related exports contain so little labor of one or both types that FPE for both skilled and unskilled wages does not occur (though perhaps it does for the less skilled factor). Again, though possible, the fact that most of these countries appear to have competed in textiles, clothing, footwear, processed natural-resource goods, and sometimes light manufactures argues against this specialization of tradables interpretation. Perhaps the degree of openness determines the degree to which labor demand is external. While the findings for Chinese Taipei might suggest this, the results for Malaysia, with high and rising exports plus imports to GDP, appear inconsistent with this hypothesis. Finally, it is possible that for some open-economy trade models, despite diversified trade, the marginal demand for both skilled and unskilled labor is determined in the domestic market - i.e., that the theory presented is incomplete in some respect.

Our analysis of export data shows that the export of non-resource and non-agricultural based manufactured exports is high and rising in the liberalizing countries studied. For example, in Argentina such non-resource-based exports were 18 per cent of total exports in 1975 and 1993, though falling somewhat in the interim. For Costa Rica these exports were 20 per cent of total exports in 1976, rising to 24 per cent in 1989 and then falling to 21 per cent in 1992. For Colombia the figures are 9 per cent in 1975 and 17 per cent in 1993.

Similarly, if FDT was violated because of the short-run immobility of labor we would expect a rise in the variance of interindustry wage differentials. However, we find no rise in the variance of estimated inter-industry wage differentials controlling for worker characteristics after trade liberalization.

Part 3. Decomposition of Employment Shifts

In this section we probe further into the causes of relative demand shifts. According to HOS, trade liberalization would lead to between-sector unskilled-intensive labor demand shifts that cause relative wages to fall. We first examine the stability of the distribution of employment across time, expecting that if HOS is true, trade liberalization will lead to large sectoral employment shifts. However, we find a high degree of stability in Chile, Costa Rica, Colombia, Mexico and Uruguay. We then summarize the decomposition of employment

shifts into between and within-industry shifts. We find skill-intensive between-industry shifts for the liberalizing countries in the group, in contrast to HOS predictions. We also find positive between-industry shifts for Chinese Taipei, Malaysia, and Argentina, though the interpretations here are less obvious. To examine the correlates of relative demand shifts, in the second part we regress the time series of relative demand, from Section IV above, onto trade flows, output, and capital stock measures. Though subject to criticisms of simultaneity and limited by small sample size, clear patterns emerge suggesting that growth of output and of imported capital stock both raise the relative demand for skill.

Sectoral Employment Shifts

Trade liberalization in LDCs is expected to induce sectoral employment shifts favoring less skilled workers. In the table below the stability of the distribution of employment across industries is examined. The distribution of employment is relatively stable in most of these countries. Malaysia experienced important employment shifts between 1973 and 1984, thereafter remaining stable. In Chinese Taipei the sectoral distribution of employment changed continuously and rapidly over the 1978-1993 period. Finally, in Argentina employment structure changed enormously and continually over the 1976-1993 period.

Table 3. **Correlations of the Distribution of Employment by Industry Over Time**

Argentina	Chile	Colombia	Costa Rica	Malaysia
1974	1960	1976	1976	1973
19800.88	19800.92	19800.99	19800.83	19840.86
19860.72	19850.94	19860.99	19870.91	19870.86
19930.56	19910.93	19890.97	19930.89	19890.86

Mexico		Philippines		Chinese Taipei		Uruguay	
1987		1978		1978		1984	
1989	0.99	1982	0.99	1982	0.97	1987	0.98
1991	0.99	1988	0.96	1988	0.87	1991	0.97
1993	0.95	1993	0.89	1992	0.75	1995	0.93

Note: Correlations between years are computed using the employment distribution over the industries.

The relative stability of employment is somewhat surprising in the cases of Chile, Colombia and Costa Rica. Employment structure was extremely stable over the entire period in Colombia and Chile. And, while employment structure shifted in Costa Rica between 1976 and 1980, it remained stable afterwards,

including after trade liberalization. Next we take a more careful look at the structure of employment shifts across sectors for given skill intensities and changing skill intensities within industries.

Decomposition of Demand Shifts

According to HOS, trade should lead to output and employment shifts "between" sectors from skill-intensive to unskilled-intensive sectors, or unskilled-intensive between-industry shifts. HOS also predicts that these between-industry shifts will induce lower relative wages. In response to lower wages, within industries and firms, there will be a second order increase in skill intensity, or "within-industry" skill-intensive shifts. In this section we disaggregate employment shifts into between and within-industry changes. For males, we find that between shifts were negative through 1985, but became positive overall for the period 1987-1993, contrary to HOS predictions. Within shifts were positive over 1980-1985, but mostly negative between 1987 and 1993, perhaps induced by rising relative wages. The results for females are less clear.

To decompose employment shifts into overall, between-industry and within-industry shifts, we employed the methodology advanced in KM92. That methodology is a generalization of the standard fixed-coefficients index. The difference from Freeman's approach is that first, employment is measured in constant-valued efficiency units instead aggregating across experience and subdivisions of schooling levels using counts of workers or hours worked [see KM92, Freeman (1975,1979,1980)]. Then data on employment distributions within activities by occupations is used to estimate within-industry employment and demand shifts. "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.[16]

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:

$$(5.1)\ \Delta X_{kd} = \Delta D_k/E_k = \Sigma_j\ (E_{jk}/E_k)\ (\Delta E_j/E_j) \qquad = \Sigma_j \alpha_{jk} \Delta E_j/E_k,$$

for the jth sector. Here E_j is the labor input in the jth sector in efficiency units, α_{jk} $(=E_{jk}/E_j)$ is group k's share of total employment in efficiency units in the jth sector in the base year, which we 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.

It is useful to examine the results for Chile. The decomposition of employment shifts for Chile reveal skill-intensive between-industry shifts, going counter to HOS predictions; however, the strongest employment shifts occurred within industries. The between-industry shifts do not appear consistent with HOS predictions, rising after trade liberalization along with relative wages. The positive within-industry shifts suggest capital deepening and/or technological progress.

For the other countries the results are as follows: In Colombia between-industry shifts were positive following devaluation and the export boom. Between-industry shifts were also positive in both of Argentina's liberalization episodes, in Malaysia, the Philippines and Chinese Taipei. In addition to Chile, within-industry shifts were positive for Colombia and Argentina while weak or negative in Costa Rica, Colombia, Malaysia, the Philippines and Chinese Taipei.

For the opening economies studied, the positive between-sector shifts with rising wages as tariffs fall give little support to the simple HOS predictions. For the already open economies the trend toward more skill-intensive products is consistent with other explanations, such as the Feenstra-Hanson outsourcing argument. With product cycles and outsourcing, DCs might shed 'mature', highly mechanized and possibly relatively lower-skill production processes to lower-wage LDCs, where such processes were relatively skill-intensive compared to existing LDC industries. It could be due to common shifts in production accompanying development. It could also partly reflect development strategies of upgrading the sophistication of products - or some combination of these explanations.

Part 4. Skill-enhancing Trade (SET)

The Correlates of Relative Demand Shifts

The rapid, positive within-industry shifts for several countries are suggestive of technological change that is consistent with the SET theory. Earlier we found that the estimated time series of relative demand shifts rose after trade liberalization. In this section we examine the correlates of these demand shifts to shed more light upon the causes of these demand shifts, in particular in relation to trade variables. Techniques are limited by the small sample size. At a minimum, though, we may treat these results as partial correlations. Important patterns supporting SET emerge. [Also see my work on Chile and Colombia for more detailed analyses that strongly support SET].

We model relative demand shifts here as potentially affected by GDP, trade flows as percents of GDP, and a measure of the stock of machinery imported relative to GDP. Ex ante, there is no particular reason or evidence why relative demand should follow a trend. For example, while most U.S. economists now believe that the rising relative demand after 1980 was due to skill-biased technological change, Katz and Goldin have shown that technical

change is not always skill biased. Ex ante we would expect balanced economic growth to lead to skill-neutral labor demand. HOS is a theory of unbalanced growth of between-sector product and employment shifts to more labor-intensive sectors. Trade liberalization in LDCs is expected to induce unbalanced growth in the form of higher imports and higher exports to GDP. And, by HOS, both higher export and import ratios to GDP would lower relative demand. The Skill-Enhancing (SET) hypothesis suggests an additional channel by which trade liberalization could induce rising relative demand - by raising the imported capital/GDP ratio, tending to raise the overall capital/GDP ratio and serving to accelerate the transfer of, what in recent years appears to be skill-biased, technology. To control for the SET effect we included estimates of the stock of imported machinery divided by GDP (ICS).

More explicitly, we employ the time series of imputed relative demand, discussed above in Section IV. Recall that relative demand was estimated above as:

$$(5.2)\quad d_t = \sigma \cdot w_t + s_t,$$

where rough bounds on s were obtained by regressing relative wages onto a trend and the constructed relative supply. We then estimate equations of the form:

$$(5.3)\quad d_t = f(x, m, ics, GDP)$$

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. 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. The results were not sensitive to different depreciation rates (here we report using a 20 per cent rate). Various specifications were estimated.

The table below reports representative findings for regressions of relative demand onto these correlates. Despite the small sample size, and hence the indicative result, some strong patterns do emerge. The principal finding was that the key explanatory variables appeared to be log(GDP) and the log of the stock of imported capital over GDP. Estimated coefficients for both variables were positive, statistically "significant" and stable across specifications.

Table 4. **The Correlates of Relative Demand - Argentina, Chile, Colombia, Costa Rica, Malaysia and the Philippines (estimated using Cochrane-Orcutt)**

Dependent Variable: Implied Relative Demand (University/Primary equivalents) All variables in logs. T-statistics in brackets					
	GNP	Imported Capital Stock	R^2 (adjusted)	F-statistic	Number of observations
All Countries					
maximum	0.471 (3.16)	0.591 (2.58)	0.75	19.9	
minimum	0.387 (2.5)	0.575 (2.44)	0.51	12.2	66
All Countries Except Argentina					
max.values	0.463	0.684 (3.83)	0.75	33.2	47
min.values	(3.44)	0.575 (2.44)	0.73	19.8	
	0.442				
	(3.11)				

Notes:
For Chinese Taipei, data for imported machinery was unavailable.
All equations include country dummies. These ranges encompass results from a wide variation of specifications controlling for the following variables: net fixed capital, exports/gnp ratio, imports/gnp ratio and openness measured as (Exports+Imports)/GNP.

We included 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 (Fields and Newton, 1994, "FN94"). 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 we find that estimated coefficients on log (GDP) are consistently positive.

While these results may be most cautiously viewed as partial correlations, we are inclined to interpret them as largely causal. Theory and evidence would suggest agnostic priors on the time-paths of the explanatory variables, as well as relative demand shifts. While the nominal values of exports, imports, GDP and the imported capital stock (ICS) would generally follow a common upward trend, or be cointegrated over the longer run, there is no ex ante reason why their values divided by GDP should follow a trend. For this reason we are inclined to give a causal interpretation to regression results of relative demand onto these variables, rather than to interpret coefficients as biased due to non-stationarity, and we viewed first-differencing or detrending as inappropriate.[17] Furthermore, Harris and Rish (1991) argue that for short samples such techniques are inappropriate. Our estimates were robust to the inclusion of a time-trend.

We interpret these findings as consistent with the SET hypothesis, while offering mixed results regarding direct factor content of trade effects along HOS. The SET hypothesis is supported by the positive, statistically "significant" and stable estimated coefficients on Imported Capital Stock. The HOS hypothesis is weakly supported by a tendency toward negative estimates on import to GDP ratios. However, the tendency for export to GDP ratios to be positive goes counter to the "naive" HOS. GDP growth appears to raise relative demand, and hence wage dispersion, but it does not affect most other coefficients, in particular those on the ICS variable.

Interpretation

The evidence of Section III and this section does not support the naive HOS model. Relative wages are positive function of tariffs in the South, and relative supply has first-order negative effects upon relative wages. Evidence from Colombia (Robbins (1996a,c)) shows that real devaluation can also affect relative wages. Thus, none of the basic HOS predictions are borne-out.

In this section cross-country wage and supply data supported neither HOS nor the DLW-Cones, or localized SS . While not conclusive, it is unlikely that sector specificity of factors can explain the results for most of the countries examined here. While HOS implies that we would expect negative between-sector shifts, the contrary is observed, along with strong within-sector employment shifts along with rising relative wages that are suggestive of the SET model. The examination of the relationship between relative demand shifts and machinery imports as a ratio of GDP reveals evidence that is consistent with the SET hypothesis.

While the results are consistent with the SET hypothesis, that hypothesis does not explain why domestic supply shifts affect relative wages when FDT conditions appear to be satisfied. Thus, we are inclined to believe that some forces, such as endogenous product diversification or endogenous monopsonsy insulate the domestic product and labor markets to some degree. Future research should focus on deepening our understanding of machinery and technical flows, and on endogenous responses to international competitive pressures that may - even in the starkest of liberalizations - significantly insulate domestic labor markets from global or even local FPE. Further study of potential “local” FPE and SS are also merited, despite failure to find support for these in the current study.

SECTION VI. CONCLUSION

Instead of trade liberalization compressing relative wages in LDCs, liberalization may sometimes widen wage dispersion. This is likely related, indirectly, to a higher degree of insulation from FPE of the domestic labor market than expected from HOS based models. The source of this insulation remains unclear. It does not appear to be due to violation of basic HOS conditions. While the high natural resource content of Latin exports might contribute to this partial insulation in the absence of FPE, FPE appears both technically valid and empirically supported by the absence of significant rises in interindustry wage differentials with trade liberalization. The evidence is consistent with the Skill-Enhancing Trade (SET) hypothesis, where trade liberalization permits or encourages the acceleration of the ratio of the imported physical capital stock to GDP in a sector-biased pattern. The attendant capital-skill complimentarities and bundled technology would then raise the relative demand for skilled workers. This explanation is also compatible with trade patterns following comparative advantage in unskilled-intensive products and a greater degree of indirect skill inputs for exports required for marketing and distribution.

NOTES

1. In the U.S. the export/GDP ratio including goods and non-factor services doubled over the 24 years from 1965-1989, rising from 6 to 12 per cent. For Chile this ratio nearly tripled, rising from 14 to 38 per cent over the same period. [World Development Report, 1991]

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

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

4. 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.

5. We refer to data plots as figures and to sketches of hypothetical relationships as diagrams.

6. For Costa Rica a change in survey designed occurred in 1986. That has been corrected for in this work.

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

   $mw_{i,t}$ ≡ mean (or median) wage for I-th cell and,
   $n_{i,t}$ ≡ distribution of quantities (hours or counts) for the I-th cell.

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

   N ≡ $\Sigma_{t=1}^{T} n_t/T$, where Tº 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:

$$w_u \equiv \Sigma_{i \in u} w_i \times [N_{i,u}/N_u], \{\text{or } w'N_i/N_u\}$$
$$\text{where } N_u \equiv \Sigma_{i \in u} N_i.$$

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

8. 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) $\theta_{i,t} = w_t' I_{k,t}/[I_{k,t}'I_{k,t}]$
(ii) $= \Sigma_{i \in k} w_t / n_{k,t}$, 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) $w_K \equiv \Sigma_{i \in k} w_i \times [N_{i,k}/N_k]$, {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).

9. The estimated coefficient on log relative supply is -.29 (t-statistic 5.8), while the coefficient on the log terms of trade is -.28 significant at the 15% level; adjusted r-squared = .65, F-statistic = 28. Similar estimates were found using Cochrane-Orcutt.

10. 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) $dW'_t(dX_t - D_z dZ_t) \leq 0.$

Using this framework, we 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.

11. 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.

12. For example, on this basis in Costa Rica workers with secondary educations were allocated eighty-two per cent to primary education equivalents, and eighteen per cent to university equivalents; workers with special education were allocated eighty-eight per cent to primary education equivalents, and twelve per cent to university equivalents.

13. For Chile there is one minimum wage. Costa Rica has industry minimum wages. Our minimum wage variable was the ratio of the highest to lowest industry minimum wages.

14. 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 United States 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 reseacrh needs to address these questions.

15. However,Goldin and & Katz(1995) show that technological change has

not always been skill-biased.

16. 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:

(5) $\Delta X_{kd} = \Delta D_K/E_K = \Sigma\ (E_{jk}/E_k)\ (\Delta E_j/E_j) \qquad = \Sigma_j \alpha_{jk} \Delta E_j/E_k,$

for the jth sector. Here E_j is the labor input in the jth sector in efficiency units, α_{jk} $(=E_{jk}/E_j)$ is group k's share of total employment in efficiency units in the jth sector in the base year, which we 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.

17 Such techniques would be similar to using the detrended values of weight and food intake to study the effect of food intake on weight; with subjects who tended to gain weight gradually, it is not clear whether regressions of the innovations around trend variables would correctly test the hypothesis that weight increases with food intake.

APPENDIX

Table 5. **Comparison of Labor Costs**
(at current exchange rates in U.S. dollars)

Country & Completed Educational Level	*Wages in Current U.S. Dollars*		*Wage as Ratio of Other Countries' Wages*						
			Mexico	Argentina		Malaysia		Chinese Taipei	
Argentina	1976	1989	1987:1987	1976:1976	1989:1989	1973:1973	1989:1989	1978:1978	1989:1989
Primary	3.64	2.24	2.22	N/A	N/A	4	2.07	1.41	0.7
Secondary	2.34	4.05	2.74	N/A	N/A	2.8	2.30	2.47	1.23
Chile	1976	1989	1987:1987	1976:1976	1989:1989	1973:1973	1989:1989	1978:1978	1989:1989
Primary	.46	.51	0.41	0.2	0.23	1.03	0.6	0.57	0.16
Secondary	1.06	1.02	0.61	0.3	0.25	1.08	0.57	1.15	0.25
Costa Rica	1978	1989	1987:1987	1976:1976	1989:1989	1973:1973	1989:1989	1978:1978	1989:1989
Primary	.85	.83	0.99	0.23	0.37	1.23	0.76	0.51	0.26
Secondary	1.66	1.34	1.19	0.29	0.24	0.83	0.76	0.89	0.41
Colombia	1976	1989	1987:1987	1976:1976	1989:1989	1973:1973	1989:1989	1978:1978	1989:1989
Primary	.42	.48	0.68	0.08	0.21	0.67	0.34	0.56	0.16
Secondary	.98	.78	0.8	0.12	0.19	0.54	0.34	1.12	0.25
Mexico	1987	1989	1987:1987	1976:1976	1989:1989	1973:1973	1989:1989	1978:1978	1989:1989
Primary	.96	1.13	N/A	0.26	0.5	1.39	1.04	0.57	0.35
Secondary	1.39	1.56	N/A	0.24	0.39	0.7	0.89	0.74	0.47
Uruguay	1984	1989	1987:1987	1976:1976	1989:1989	1973:1973	1989:1989	1978:1978	1989:1989
Primary	1.3	1.85	1.35	0.36	0.83	1.08	1.83	0.78	0.49
Secondary	2.08	2.92	1.5	0.36	0.72	1.05	1.85	1.11	0.81

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(1996__)

Diagram 1. Relative Demand for Labor, Two Traded Goods

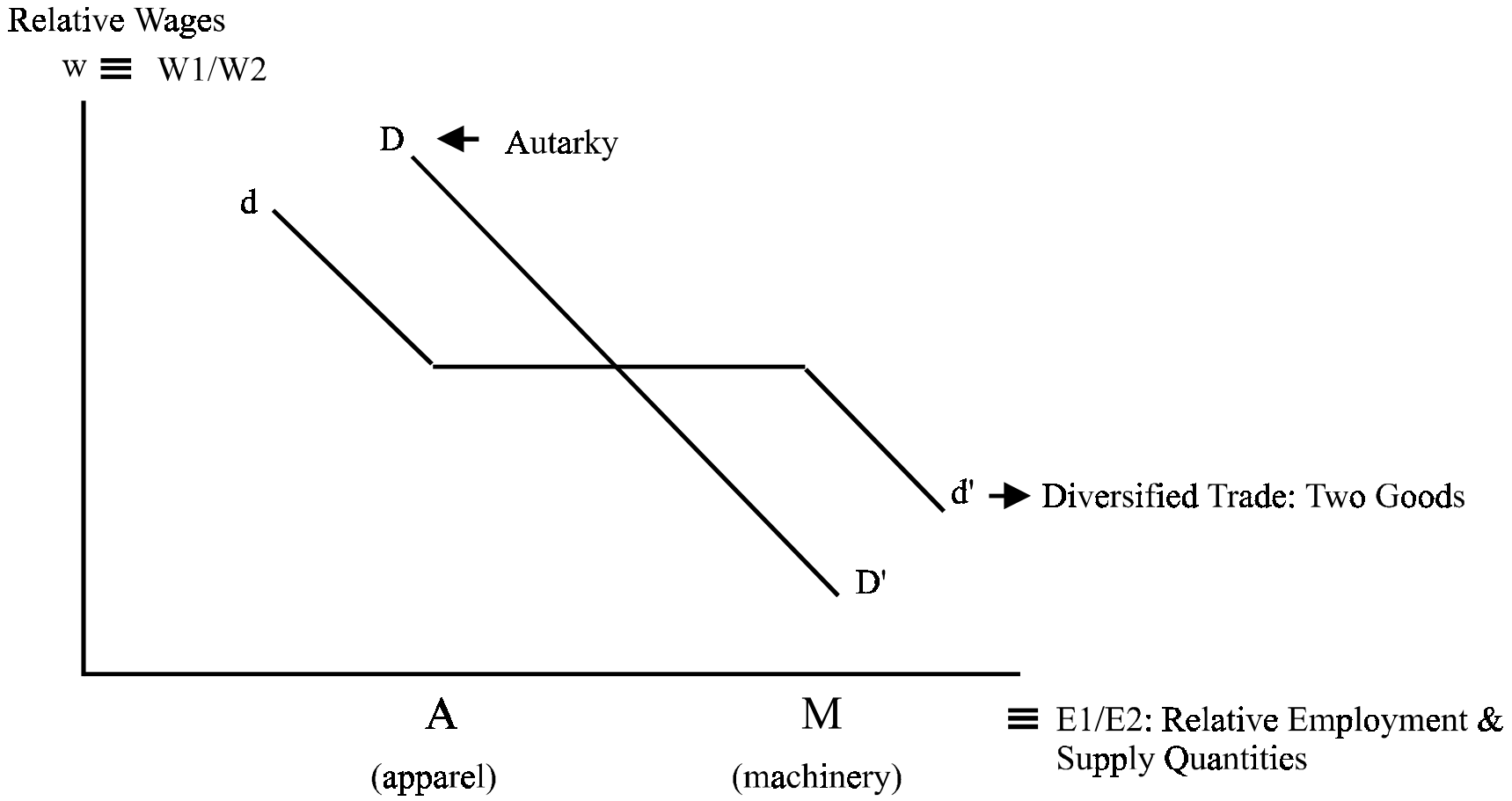


Diagram 2. Relative demand for Labor, N Traded Goods

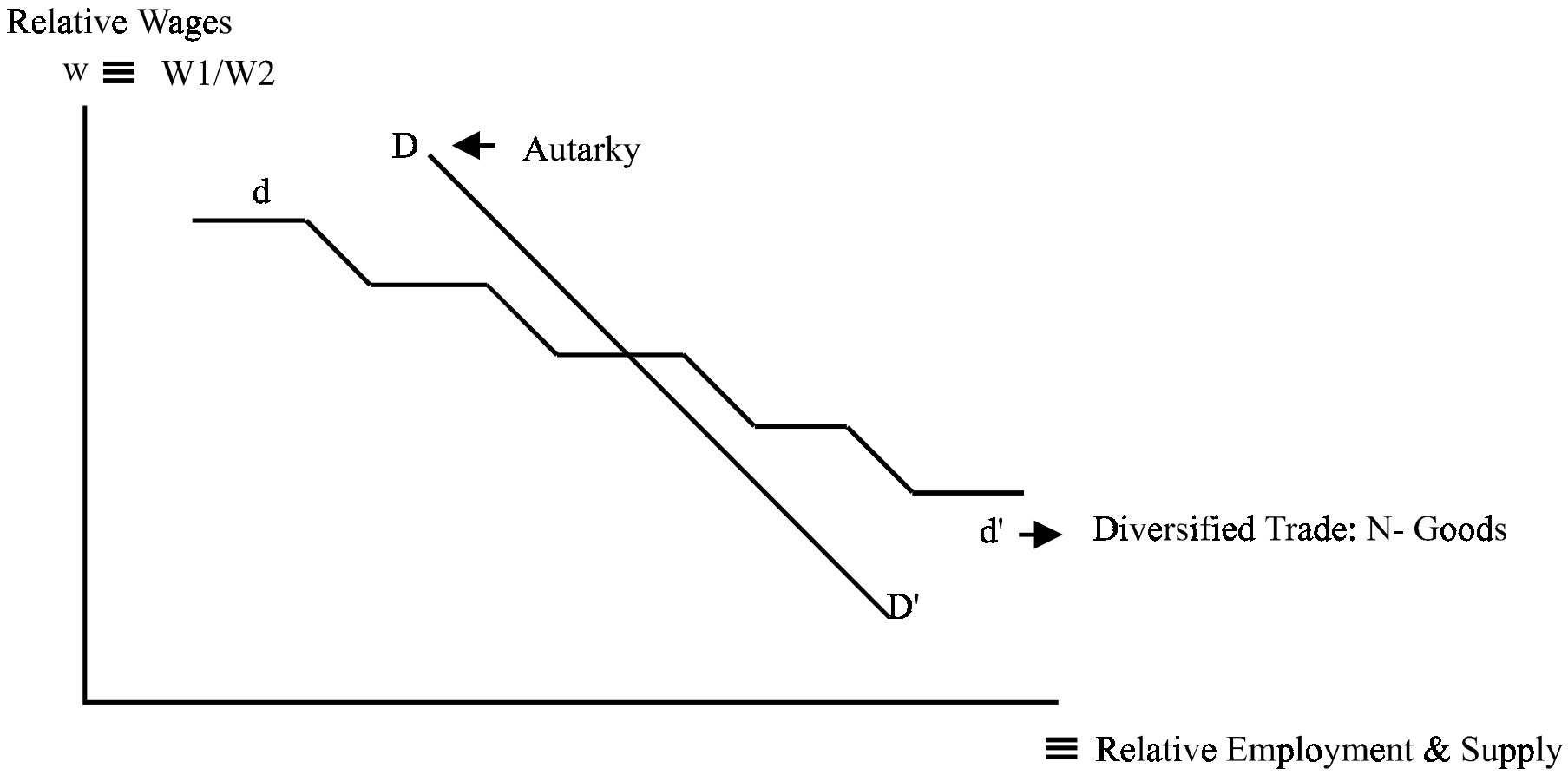


Diagram 3. Lerner-Pearce Diagram and Technical Change: Factor & Sector Biased
(Factor Bias - Case 1: Equal Amounts of Unskilled Labor Saved)

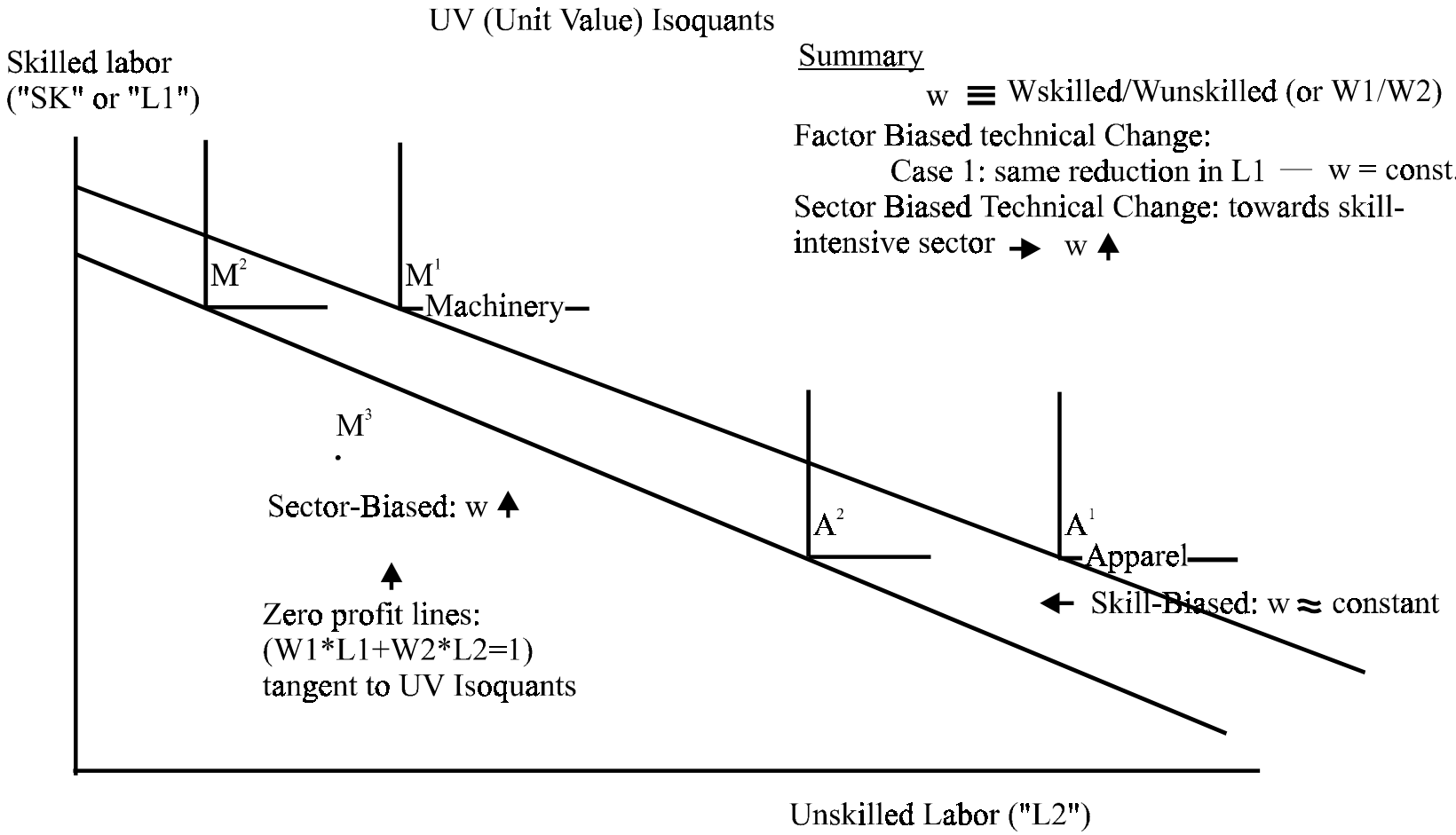
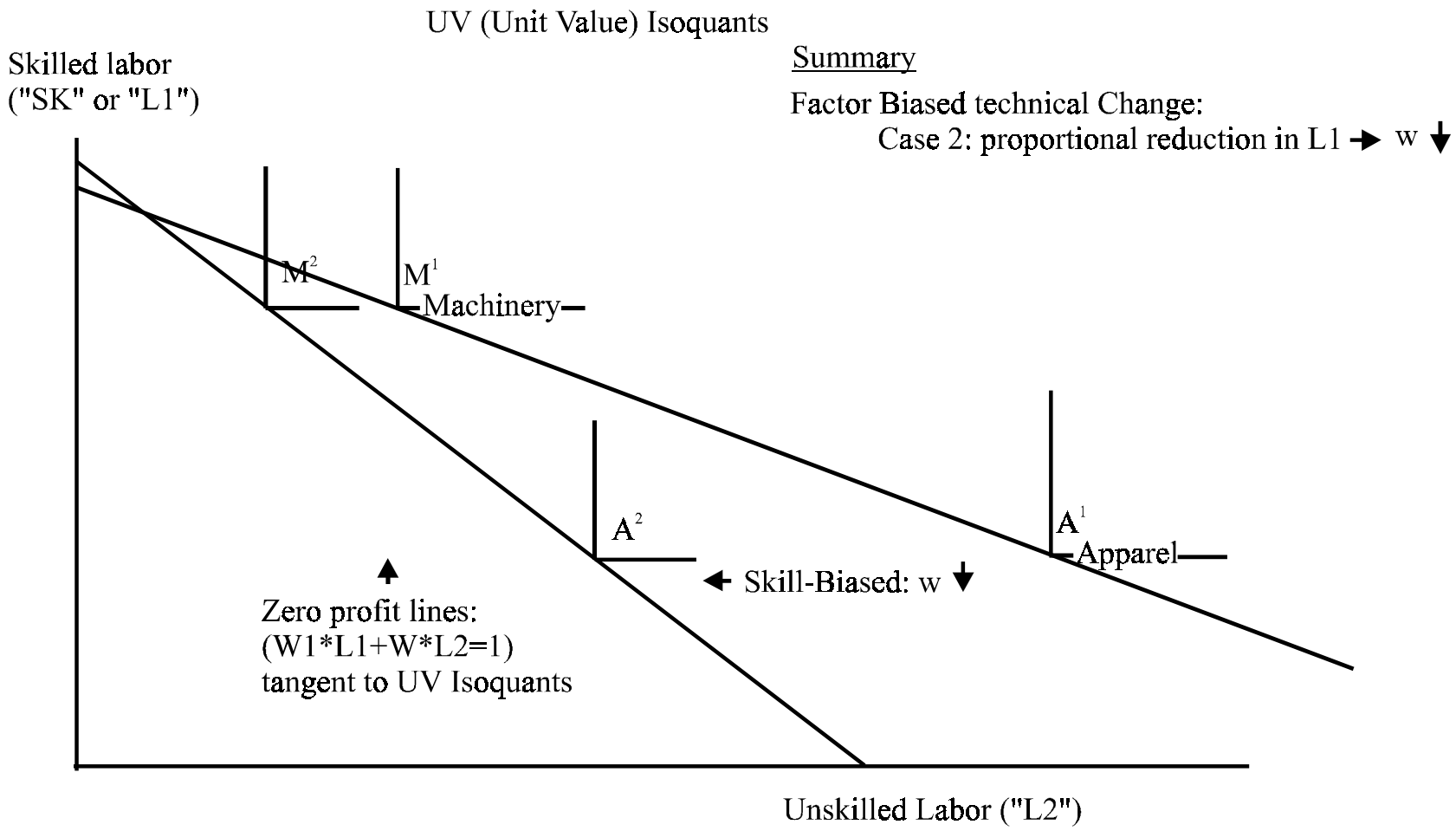
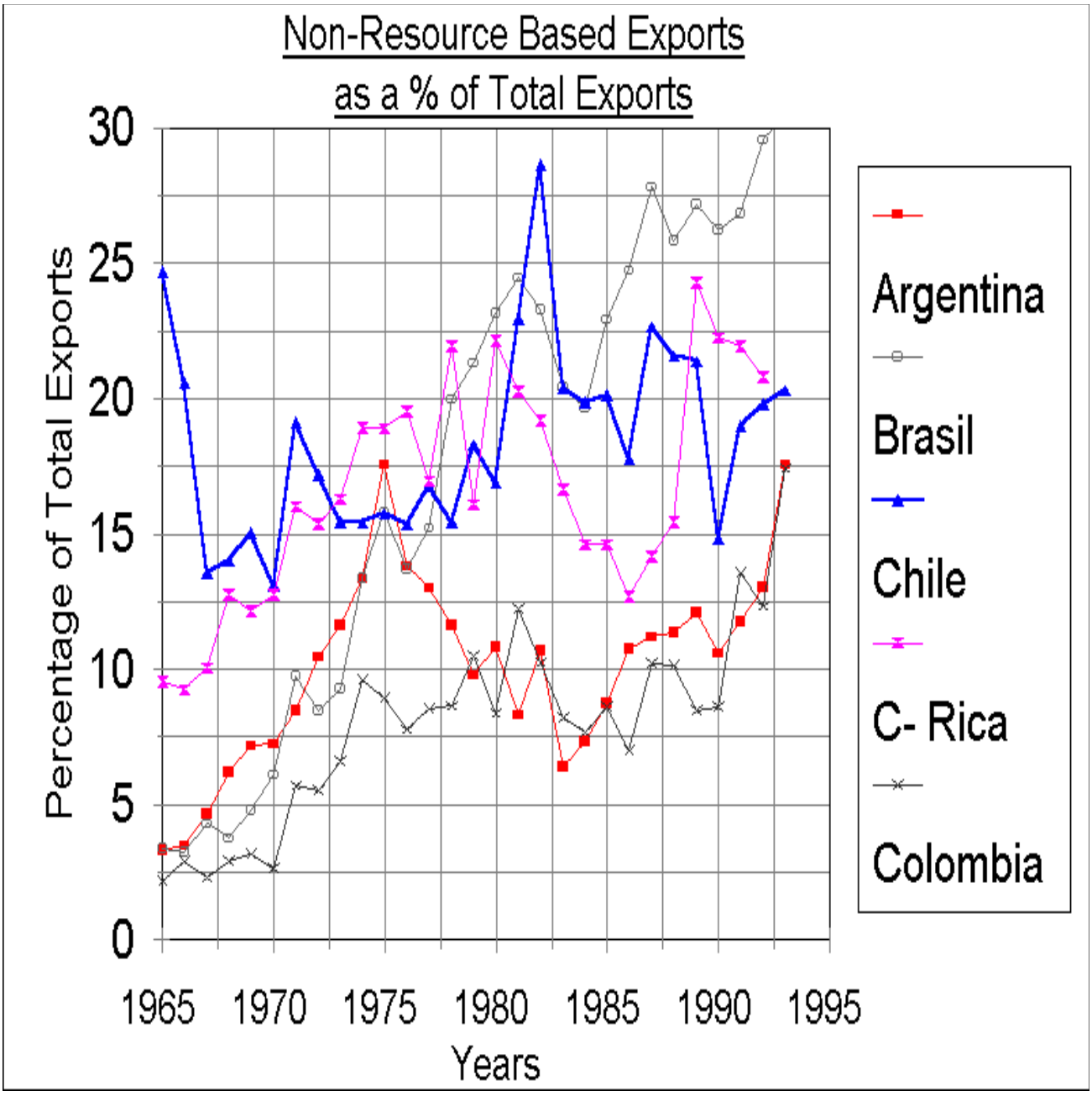
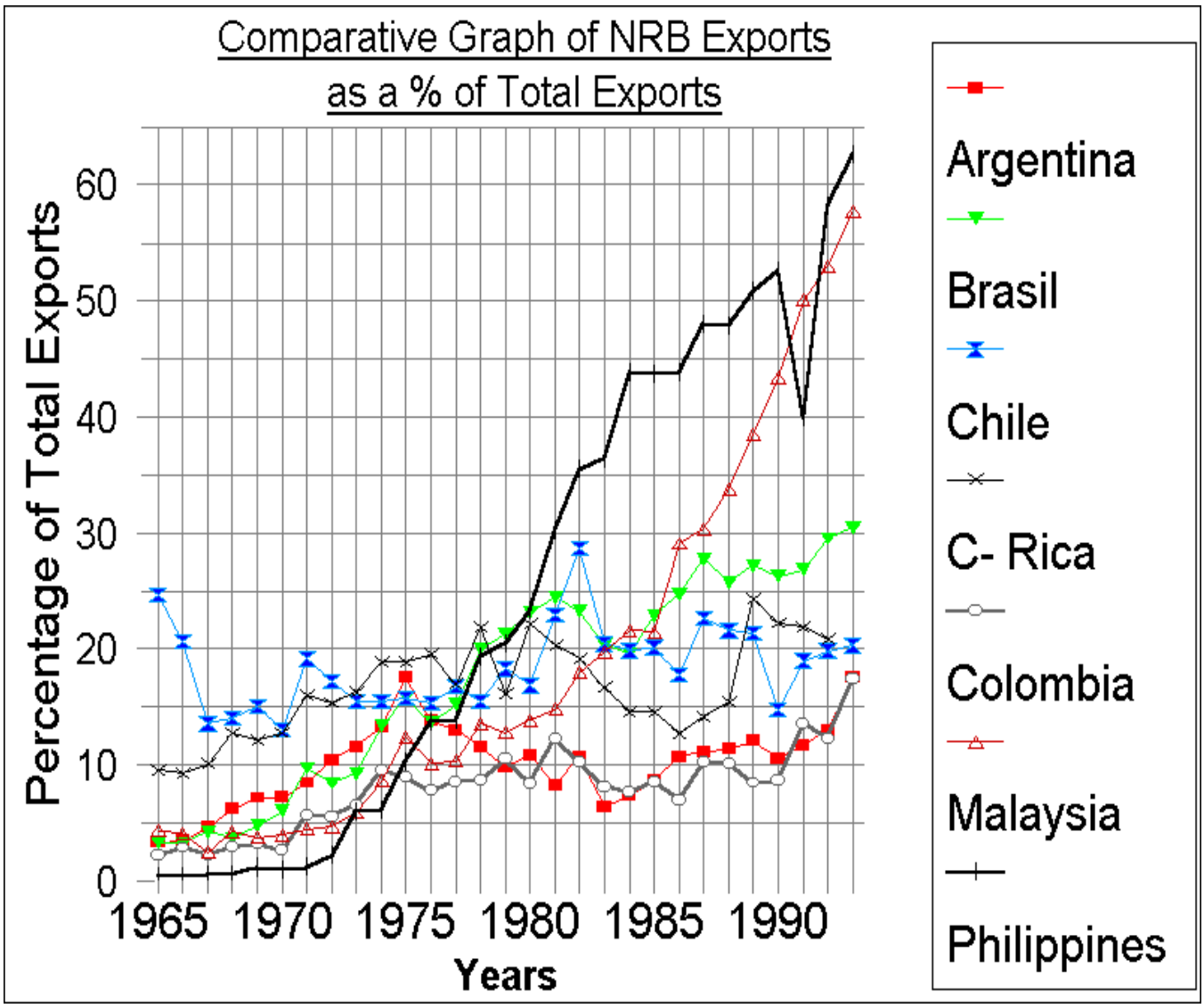


Diagram 4. Lerner-Pearce Diagram and "Proportional" Factor- Biased Technical Change




Non-Resource Based Exports
as a % of Total Exports
Percentage of Total Exports
0
5
10
15
20
25
30
1965
1970
1975
1980
1985
1990
1995
Years
Argentina
Brasil
Chile
C- Rica
Colombia


Comparative Graph of NRB Exports
as a % of Total Exports
Percentage of Total Exports
0
10
20
30
40
50
60
1965
1970
1975
1980
1985
1990
Years
Argentina
Brasil
Chile
C- Rica
Colombia
Malaysia
Philippines

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