Trade Liberalization and Labor Market Adjustment in Brazil*

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Abstract

We study the impact of the 1988-1994 trade liberalization in Brazil on the wage distribution. We explore three main channels through which trade liberalization could have affected the wage distribution: increasing returns to skilled workers due to Hecksher-Ohlin adjustments to trade policy, trade induced skill-biased technological change, and changes in industry wage premiums. Our results suggest the trade reform in Brazil did partially contribute to the growing skill premium through skill-biased technological change, which was partially instigated by the increased foreign competition. We also find that sector specific returns to skill increased by more in sectors with bigger tariff reductions. However, we find little support for Hecksher-Ohlin type adjustments to trade reform. Overall, the effects of trade reforms on wage inequality seem relatively small.

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1. Introduction

Policy makers often promote trade liberalization and openness as a way to increase living standards and welfare in developing countries. For example, before the 1999 WTO ministerial meeting in Seattle the U.N. secretary general Kofi Annan and the WTO director general Michael Moore urged developed countries to "extend the benefits of free trade fully to the developing world" since free trade enhances economic development and standards of living (Wall Street Journal (1999)).[1] Brazil, like many other Latin American economies, followed these policy recommendations and underwent drastic trade liberalization episode from 1988 to 1994 in pursuit of higher living standards and productivity growth. The reforms not only reduced the average tariff level from about 60 percent in 1987 to 15 percent in 1998, but also changed the structure of protection across the industries. These drastic tariff reductions were mirrored in increased import penetration in most manufacturing sectors.

While empirical studies have documented that the Brazilian trade reforms have increased efficiency and growth (see Hay (2001), Muendler (2002)), trade liberalization might have also contributed to the growing wage inequality. Several studies have documented growing returns to educated workers in Brazil that coincide with the timing of trade liberalization (see Blom, Holm-Nielsen, and Verner (2001), Green, Arbache, and Dickerson (2001), Behrman, Birdsall, Szekely (2000)).[2] Although the causal link between growing skill premium and trade liberalization has not been established, this second development would be alarming for Brazil because it might translate into growing wage inequality in a country with extremely high levels of inequality prior

[1] Although the theoretical relationship between free trade and welfare is ambiguous, careful empirical work based on cross-country data by Frankel and Romer (1999), confirms that countries that countries with higher exposure to trade have higher living standards as measured by GNP per capita.

[2] Growing skill premium has been documented in Mexico and many other liberalizing Latin American economies (see Robbins (1996), Cragg and Epelbaum (1996), Hanson and Harrison (1999), Robertson (2000), Behrman, Birdsall, and Szekely (2000), Attanasio, Goldberg, and Pavcnik (2002)).

to trade liberalization. Growing skill premium is also puzzling because many have expected that the trade reforms would have lowered income inequality by raising the relative returns to relatively abundant factor of production in Brazilian economy, i.e. the poor, less educated, and unskilled workers.

In this paper, we investigate whether trade liberalization has affected wage inequality between skilled and unskilled workers in Brazil using data from 1987 to 1998. In particular, we combine detailed micro level worker level information from *Pesquisa Mensal de Emprego* (PME) with industry level data on tariffs, import penetration, and export exposure to analyze several channels through which trade liberalization might have affected the growing skill premium.[3]

We first analyze whether the growing skill premium could be explained by the mechanism proposed by the Hecksher-Ohlin model of international trade. We test three implications of the model. First, is the growing skill premium consistent with the pattern of tariff reductions observed in Brazil from 1987 to 1988? If tariffs declined proportionately more in sectors that use unskilled labor relatively more intensively, tariff induced changes in product prices could have contributed to the growing in skill premium by increasing the demand for the relatively skilled workers. Second, the Hecksher-Ohlin model would predict labor reallocation from industries that experienced bigger tariff reductions (and hence price reduction and output contraction) towards industries with lower exposure to trade. We explore this mechanism by relating changes in industry share of total employment to tariff changes and other measures of trade exposure. Third, the Hecksher-Ohlin mechanism would predict a decline in the share of skilled workers in industry employment as firms substitute away from skilled labor when skill premium increases after trade liberalization. Our results suggest that Hecksher-Ohlin could in

[3] Our methodology follows closely the one used in Attanasio, Goldberg, and Pavcnik (2002) for Colombia.

principle explain the growing skill premium because tariff reductions were predominantly concentrated in industries with relatively high share of unskilled workers. However, the evidence on the labor market adjustment provides little support for this claim. The structure of industry employment shares remains relatively stable over our sample period and the observed changes in industry employment shares are not in general related to tariffs.[4] Most importantly, the share of skilled workers employed in most Brazilian industries has increased concurrently with the growing skill premium, which is *not* consistent with the Hecksher-Ohlin framework, but is consistent with a positive shock to relative labor demand for skilled workers (for example, skill biased technological change).

Although we find scant evidence in support of Hecksher-Ohlin adjustments to trade reform, increased exposure to trade could have affected skill premiums by increasing the demand for skilled labor via skill biased technological change. In particular, Wood (1995) and Acemoglu (2001) argue that firms might adapt skill-biased technology in response to intensified competition from abroad. We explore this hypothesis by checking whether the demand for skilled labor increased more in sectors that experienced larger tariff reductions and larger increases in import penetration. We find that skill-biased technological change was larger in sectors that experienced larger increases in import penetration, suggesting that skill-biased technological change was partly an endogenous response to increased foreign competition.

Finally, we explore how trade reforms impacted industry wage premiums. Wage premiums represent the portion of worker wages that cannot be explained through worker or firm characteristics, but are attributed to worker industry affiliation. Most previous literature has concentrated on the effects of trade policy changes on the returns to particular worker

[4] Although the inclusion of import penetration variable is not theoretically motivated by the Hecksher-Ohlin framework, we find that sectors that experienced increases in import penetration contracted and that tariff declines led to contraction of employment in sectors with higher import penetration.

characteristics and the implications of trade policy in the long run, where labor can move across sectors.[5] However, worker industry affiliation is crucial in predicting the impact of trade reforms in short- and medium-run models of trade. These models seem particularly relevant in Latin America, where labor market rigidities obstruct labor mobility across sectors (Heckman and Pages (2000)). If workers cannot switch industry employment easily, short- and medium- run models of trade predict that workers in industries with larger tariff reductions are expected to observe a decline in their wages relative to workers with the same observable characteristics in industries with smaller tariff declines.

The effect of trade policy on industry wage premiums has two important implications for wage inequality between skilled and unskilled workers. First, since different industries employ different proportions of educated and skilled workers, changes in industry wage premiums translate to changes in the relative incomes of skilled and unskilled workers. If tariff reductions are proportionately larger in sectors employing less-skilled workers, and if these sectors observe a decline in their relative wages as a result of trade liberalization, these less-skilled workers will experience a decline in their relative incomes. This effect is distinct from the potential effect of trade liberalization on the economy-wide skill premium. Second, industry wage premiums might vary across workers with different level of skills or education. For example, the more educated workers might be more or less mobile in the labor market and might differ in the accumulated sector specific human capital. If wage premiums differ across workers with different levels of education, and trade liberalization increases the industry specific skill premiums, this could provide an additional channel through which the reforms affect the wage inequality. Our results

[5]Gaston and Trefler (1994), Feliciano (2001), Robertson (2000), Pavcnik and Goldberg (2001), and Arbache and Menezes-Filho (2000) are exceptions. Arbache and Menezes-Filho (2000) find significant evidence of rent-sharing during trade liberalization in Brazilian manufacturing from 1989 to 1995 after they instrument for the value-added with the effective tariffs.

suggest that trade reforms did not impact industry wage premiums. However, we find evidence that sector specific skill premiums have increased proportionately more in industries that experienced larger tariff reductions. This evidence is consistent with the sector-specific skill-biased technological change that is concentrated in sectors with larger tariff reductions and trade-induced productivity improvements found by Hay (2001) and Muendler (2002).

Overall, we conclude that the trade reform in Brazil did partially contribute to the growing skill premium by impacting skill-biased technological change and industry specific skill premiums. However, we find little support for Hecksher-Ohlin type adjustments to trade reform.

The paper proceeds as follows. Section 2 of the paper provides background on Brazil's trade regime, describes the labor force data, and overviews the trends in the returns to education. Section 3 explores whether labor market developments in Brazil are consistent with predictions of the Hecksher-Ohlin trade model and (trade-induced) skill biased technological change. Section 4 analyses the relationship between industry wage premiums and trade reforms. Section 5 concludes.

2. Background

2.1 Trade Policy in Brazil

Like many other Latin American countries, Brazil pursued an import substitution policy to shield domestic firms from foreign competition until the 1980s. The high level of tariffs and large number of non-tariff barriers (NTBs) severely hindered the access of foreign good to the Brazilian market and provided high levels of protection to Brazilian firms. The level of protection varied widely across industries. For example, imports from the most protected sector, clothing faced tariffs exceeding 100 percent, followed by sectors such as textiles and rubber that were subject to tariffs exceeding 80 percent in 1987. This suggests that Brazil protected

relatively unskilled, labor-intensive sectors, which conforms to a finding by Hanson and Harrison (1999) for Mexico and Goldberg and Pavcnik for Colombia (2001). In fact, the Spearman correlation between tariffs and the share of unskilled workers in an industry (measured by the share of workers with less than complete secondary education) is .4 (p-value of .08) in 1987.

From 1988 to 1994, however, Brazil underwent a significant trade liberalization that gradually reduced its tariffs and NTBs. The liberalization proceeded in several stages. In 1988 and 1989, the reforms reduced the average tariff levels from about 60 in 1987 to 39 percent in 1989. Kume (2000) and Hay (2001) argue that the initial 1988-1989 tariff reduction had no significant bearing on the exposure of domestic industries to increased foreign competition due to continuous reliance on substantial NTBs. The NTBs such as import licenses, special import programs, and administrative barriers to trade were eliminated in the second stage of the reforms that started in 1990 as the Collor government endeavored to instigate productivity improvements by domestic firms through increased foreign competition.[6] The gradual tariff reductions implemented from 1990 to 1994 lowered the average tariff from 34 percent in 1990 to 11 percent tariff in 1995. The government partially reversed these trade reforms in 1995 following the real appreciation of the *real* that lowered the competitiveness of the manufacturing sector and widened the current account deficit. Nevertheless, the average tariff climbed only slightly between 1995 and 1998.

[6] Unfortunately, the information on NTBs is not available. This might not be very problematic. First, unlike in many developed countries, tariffs were an important policy instruments in countries such as Brazil. Second, NTBs are inherently hard if not impossible to measure. The common wisdom in the field is that the agencies collecting NTB data take great care in making the data comparable across sectors in a given year, but are less concerned with consistency of the numbers across years. This makes the use of time series data on NTBs troublesome. Finally, we control for import penetration, which partially accounts for the effect of NTBs on various labor market outcomes.

This trade liberalization episode provides an excellent setting to study the relationship between wages and trade for several reasons. Table 1 reports the average tariff across 20 manufacturing industries from 1987 to 1998, the period of our study.[7] The average tariff declined from 60 percent in 1987 to 15.4 percent in 1998. Second, the reforms changed the structure of protection across industries, as different industries experienced different rates of tariff changes. Figure 1 plots tariffs in 1986 and 1998 in various industries. It shows that declines in tariffs differed across industries, and that the dispersion of tariffs was significantly reduced. The changing structure of protection is also reflected in relatively low year-to-year correlations of industry tariffs from 1987 to 1998. For example, the correlation coefficient between tariffs in 1987, a year preceding the trade reforms, and tariffs in 1989 is .81. The correlation between tariffs in 1987 and 1995, the year after the large reforms were completed, drops to .6. The intertemporal correlation of Brazilian tariffs is similar to the correlation of Colombian tariffs during the 1984-1998, but is significantly lower than the intertemporal correlation in the U.S. tariffs, where the correlation between post-Kennedy GATT Round Tariffs (1972) and post Tokyo GATT round tariffs (1988) is .98. This vast variation in Brazilian tariffs across industries in a given time period and across time provides an excellent setting to study the relationship between trade and wages.

The above shifts in Brazil's trading environment are mirrored in the increase in the import penetration (defined as imports/(output+net imports)) and export exposure (defined as

[7] Tariff data was obtained from Muendler (2002) at http://socrates.berkeley.edu/~muendler/ and are based on Kume, et. al. (2000). The original data provide the tariff levels for 53 sectors at the nivel 80 industrial classification. We have aggregated the data to nivel 50 and made some additional adjustments so that the tariff information corresponds to the level of industry aggregation in the labor force data. The reported tariffs are simple averages of more disaggregated data. When constructing our tariff series, we have also experimented with using nivel 80 import penetration as weights, which yielded similar aggregate means. The correlation between the two series was .98. We thus use the tariffs constructed as simple averages throughout the paper.

exports/output) reported in table 2.[8] The average import penetration increased from 5.7 % in 1987 to 11.6 % in 1998. The export to output ratio increased from 9.7% to 11.2% in 1998. While the import penetration has almost doubled during this period, it is worthwhile to note that the import penetration in Brazil continues to be relatively low when compared to a country such as Colombia that liberalized during the same period. Colombian manufacturing import penetration was about 21% in 1984 and significantly exceeded 30% after the 1990 tariff reductions (Pavcnik and Goldberg (2001)). This difference could potentially be attributed to a large size of Brazil relative to a country such a Colombia. Moreover, the import penetration increases in Brazil varied significantly across sectors. Figure 2 shows the evolution of industry import penetration and tariffs from 1987 to 1998. Industries with the largest surges in import penetration are clothing (industry 23), transport (industry 12), textiles (industry 22), machinery (industry 8) electronics (industry 10), and pharmaceuticals (industry 20). These are also industries that experienced large tariff declines.

2.2 Labor Force Data

We combine the trade exposure measures with labor market data *Pesquisa Mensal de Emprego* (PME) from *Instituto Brasileiro de Geografia e Estatística* (IBGE), the Brazilian Statistical Bureau from 1987 to 1998. The data set covers the 6 largest metropolitan areas in Brazil: São Paulo, Rio de Janeiro, Porto Alegre, Belo Horizonte, Recife, and Salvador. These metropolitan areas account for about 31.9 million people of the economic active age out of a total of 79 million. Moreover, in 1997, the states of the 6 surveyed metropolitan areas produced

[8] Data on import penetration and export to output ratio was obtained from Muendler (2002) at http://socrates.berkeley.edu/~muendler/. We made adjustments similar to those for tariffs explained in previous footnote so that the trade exposure information corresponds to the level of industry aggregation in the labor force data. We use industry level trade exposure measures that are weighted by the import penetration of the less disaggregated nivel 80 industry data. However, the correlation between the weighted import penetration series and the import penetration series based on simple averages is .99. Similarly, the correlation between the weighted export to output series and the export to output series based on simple averages is .99.

72 percent of the Brazilian GNP.[9] Our findings are thus representative of the large and modern parts of the Brazilian labor market, but do not necessarily carry over to the rural economy. Because we focus on manufacturing industries, this might not be very problematic.

The data used in this paper consists of people affiliated with any of the 20 manufacturing industries. We include workers or self employed working full-time (defined as working more than 25 hours per week) between ages 15 and 65. We use the data to create several variables that capture worker demographic characteristics such as wage, age, education, geographical location, informal sector of employment, self-employment, and industry affiliation. Our wage measure is hourly wage based on monthly wage divided by 4 times the reported number of hours worked per week. We deflate the hourly wage with the monthly national price index, IPCA. All wages are thus expressed in 1997 September *reals*. The main indicator for education is completed years of schooling, which is computed using an algorithm based on three survey questions on education.[10] Based on completed years of schooling, we classify workers into those with no complete education, complete elementary education, complete lower secondary education, complete secondary education, and complete tertiary education.[11] We also distinguish whether a worker has formal or informal employment on the basis of "*carteira assinada*", a signed workcard. A signed workcard entitles a worker to several rights and benefits regulated by the labor market legislations, which enables us to classify whether or not a person works for a formal establishment that complies with labor market regulation. The variable informal is an indicator that is one if the worker is employed in the informal sector of the economy.

[9] Source: IBGE accounts of gross regional products in current market prices. Brazilian GNP was R$ 864,112 mil and the six states (São Paulo, Rio de Janeiro, Rio Grande do Sul, Minais Gerais, Pernambuco, and Bahia) together accounted for R$ 618,728 mil.

[10] The algorithm follows the standard conversion used elsewhere (see Lam and Schonie (1993) and Barros and Ramos (1996)).

[11] Elementary education in Brazil consists of four years of schooling. Secondary education, ensino medio, is comprised of two parts, 4-8 years of schooling and 9-11 years of schooling. Tertiary education runs from 12 to 15/17 years of schooling.

2.3 The Returns to Education in Brazil

Prior to exploring whether trade liberalization has contributed to the growing skill premium during our sample period, we summarize the trends in the returns to education during the 1980s and 1990s. Using the same data as this paper (but focusing on workers in all sectors of the economy rather than just manufacturing), Blom, Holm-Nielsen, and Verner (2001) investigate the returns to education for Brazil from 1981 to 1998. Their main findings are summarized in Figure 3, which reports the growth in the returns to education relative to1982 for workers with complete elementary education, complete lower secondary education, complete secondary education, and tertiary education. These estimates are based on the coefficients from earnings regression that controls for age, age squared, gender, whether a person is self employed, and whether the person works in the formal sector. Several interesting finding emerge. First, workers with complete elementary and lower secondary education have experienced a 26% and 35% decline in their return to education relative to 1982, respectively. Second, the returns to complete secondary education have not changed substantially relative to 1982. However, since the returns to elementary and lower secondary education have actually declined during the same period, this translates into a growing return to secondary education relative to the less educated workers. Third, the returns to tertiary education have increased by 24 percent relative to 1982. Given that the returns to elementary and lower secondary education have actually declined, this translates into an even bigger increase in premium associated with complete university degree relative to the return earned by relatively uneducated workers. The above findings are also confirmed for a sample of urban and rural workers by Green, Arbache, and Dickerson (2001) using data from a nationally representative labor survey (PNAD).

Given that Brazil underwent drastic trade liberalization from 1987 to 1998, trade liberalization, could in principle account for part of the observed increase in the premium to skilled workers. We explore various channels through which trade could have contributed to the growing returns to skill in the subsequent sections.

3. The Economy-Wide Skill Premium and Trade Reforms

In this section we explore whether the rise in the economy-wide skill premium in Brazil is due to Hecksher-Ohlin adjustments to trade reform or skill biased technological change. We first check whether the Brazilian experience supports three implications of the Hecksher-Ohlin model. We then exploit whether the evidence is consistent with skill biased technological change that was potentially induced by trade reforms.

The Heckscher-Ohlin model and Stolper-Samuelson theorem relate trade liberalization to changes in the economy-wide skill premium in the long run, when labor and other factors of production are mobile across sectors. Let us consider the predictions of the model in a simplified world that has two sectors, two factors of production (skilled and unskilled labor), and consists of a developed and a developing country. The developing country is assumed to be relatively unskilled labor abundant. When the developing country reduces trade barriers on the imported product, the Stolper-Samuelson theorem predicts that the decline in the price in the import-competing sector will hurt the factor of production used relatively intensively in the production of the imported good (skilled labor) and benefit the factor of production used intensively in the export sector (unskilled labor). According to this Hecksher-Ohlin framework, trade liberalization will then reduce the skill premium in the developing country. This prediction of the model seems to contradict the evidence from developing countries such as Brazil that have experienced an increase in skill premium following trade liberalizations.

Despite this seemingly conflicting evidence, we check whether the labor market adjustments in Brazil are in line with predictions of the Hecksher-Ohlin theory. We first investigate if the growing skill premium is consistent with the predictions of the Stolper-Samuelson theorem. The increase in the skill premium surrounding Brazilian trade liberalization is exactly what the Stolper-Samuelson theorem would predict if the largest tariff reductions (and thus the largest reductions in the price of goods) occurred in sectors that employed a higher share of unskilled workers.[12] Figure 4 relates industry declines in tariffs between 1987 and 1998 to the share of unskilled workers in industry employment (a tariff decline is a positive number in the graph). The figure suggests that industries with higher shares of unskilled workers experienced larger declines in tariffs. This positive correlation between tariff declines and unskilled labor intensity of the industry is also confirmed in a regression of annual declines in tariffs on the share of unskilled workers in 1987. The coefficient on the share of unskilled workers is 3.97 (T-statistic=1.88). These results suggest that tariff cuts in Brazil, like in Mexico and Colombia (see Hanson and Harrison (1998) and Attanasio, Goldberg, and Pavcnik (2002)) were concentrated in unskilled labor intensive industries. As a result, the Hecksher-Ohlin adjustment to trade reform could in principle account for the growing skill premium in Brazil. However, this is not necessarily the case.

We thus test whether labor market adjustment in Brazil is consistent with other implications of Hecksher-Ohlin adjustments to trade reform. In particular, the model predicts that sectors that experience tariff induced declines in relative prices should experience a contraction in employment, while industries with increased tariff induced relative prices should expand. As a result, labor should migrate from the sectors with the largest tariff reductions to the

[12] Throughout the paper, we classify workers with complete secondary or tertiary degree as skilled. All other workers are classified as unskilled.

sectors with the smaller tariff reductions. Table 3 reports the industry shares in manufacturing employment in 1987, 1992, and in 1998. If trade policy changes would move resources across industries, we would expect low year-to-year correlation of industry shares in total manufacturing employment. The correlation between the 1987 and the 1992 industry share is .99. The correlation between the 1987 and the 1998 industry share is .96. This descriptive evidence suggests no significant labor reallocation across sectors during trade liberalization.

We next investigate more formally whether labor reallocates from the sectors with the largest tariff reductions to the sectors with the smaller tariff reductions. In column 1 of table 4 we report the results of regressing industry employment shares on industry tariffs, industry fixed effects, and time indicators. The tariff coefficient is extremely small (0.00005) and statistically insignificant, which corroborates that trade liberalization did not lead to a significant reallocation or resources across sectors. In columns 2 and 3 we also include lagged import penetration and lagged export to output ratio as regressors. Although the inclusion of these variables is not theoretically motivated by the Hecksher-Ohlin model, industry imports and exports might capture the combined effect of all trade related channels, other than tariffs, on industry employment shares. We focus on the additional trade exposure measures because large tariff reductions might overstate the exposure of Brazilian economy to import competition due to the large size of the country and might not fully capture the effects of reduction in NTBs that occurred during this period.

Three noteworthy results emerge. First, the inclusion of additional trade exposure measures does not affect the coefficient on tariffs. Second, there is no relationship between export to output ratio and the industry share of manufacturing employment.[13] This finding is

[13] We have also estimated these regressions without tariffs as a regressor. This yields similar findings on the export to output ratio and import penetration variables.

consistent with predictions by Carneiro and Arbache (2002), who use CGE simulations to explore the effects of export growth on Brazilian labor market. Third, the results suggest the contraction of employment in industries that experience an increase in the import penetration. The coefficient on the import penetration in column 2 suggests that a .01 increase in import penetration in a given industry reduces the industry's share in manufacturing employment by .00137. Since the import penetration increased on average by .076 from 1987 to 1998, an industry experiencing an average increase in import penetration would contract its employment share by .01 over the entire period. Finally, trade policy changes could potentially impact industries with greater exposure to international competition more. In column 3, we check whether trade policy has differential impact on industry employment share in industries with higher import penetration by including the interaction of import penetration and tariffs. The results suggest that a tariff decline has a larger negative impact (in absolute terms) on industry employment in industries with higher import penetration. A 10 percentage point tariff decline in an industry (evaluated at the mean import penetration .08) is associated with a .002 decline in the industry's share in manufacturing employment.[14]

In sum, the employment patterns over 1984-1998 are not fully consistent with an explanation that would attribute the rise in the returns to skilled workers to changes in trade policy, operating through Stolper-Samuelson effects. The high year-to-year correlations of industry employment shares before and after trade liberalization suggest that the structure of employment patterns across industries remain relatively stable over the 11 years surrounding the trade liberalization episode. Moreover, we find no general association between employment contractions and tariff reductions. However, tariff reductions are associated with declines in the industry share of manufacturing employment in industries with high import penetration. Also,

[14] In our data, a tariff level of 10 indicates a 10% advalorem tariff (i.e. .1).

an increase in the industry import penetration is associated with a contraction of industry employment. Although the association between import penetration and industry employment shares is not theoretically motivated by the Hecksher-Ohlin framework, this evidence suggests that increased foreign competition might have partially affected the structure of employment across Brazilian industries.

However, if Stolper-Samuelson effects were the main mechanism leading to the rise in the returns to skilled workers, the share of skilled labor in industry employment should decline as firms substitute away from skilled workers when skill premium increases. As a final check of evidence in support of Hecksher-Ohlin adjustments, we thus compare the share of skilled workers in each industry (measured by the share of workers with complete high school or university degree) before and after trade liberalization. The share of skilled workers in industry employment in 1987, 1992, and 1998 is reported in table 5. The left panel of the table shows that 2 out of 20 manufacturing industries experienced a substantial increase in the share of skilled workers. The right panel focuses only on the share of workers with complete university degree and suggests that 5 out of 20 industries experienced an increase in the employment share of university educated workers. Overall, table 5 provides strong evidence against Hecksher-Ohlin adjustments to trade reform. Firms do not substitute away from skilled labor given the higher relative price of hiring skilled workers. As a result, increased economy-wide skill premium cannot be attributed to Hecksher-Ohlin adjustments to trade. The evidence is however consistent with skill biased technological change.

Although we find scant evidence in support of Hecksher-Ohlin adjustments to trade reform, increased exposure to trade could have affected skill premiums by increasing the demand for skilled labor via skill-biased technological change. In particular, Wood (1995) and

Acemoglu (2001) argue that firms might adapt skill-biased technology in response to intensified competition from abroad. In addition, lower trade barriers might make the importation of foreign technology and capital equipment cheaper. Recent studies by Eaton and Kortum (1996, 1997) model how the benefits of innovation spread from one country to another through diffusion of technology or through the exchange of goods. They find that the impact of diffusion of technology on productivity depends on the proximity of a country to the technology source, tariff levels, and the flexibility of the domestic labor force. Lower prices of foreign machinery and technology thus provide an additional incentive for the firms to adapt new technology.

To investigate whether trade reforms were associated with the increase in the return to skilled workers via skill biased technological change, we regress in table 6 the share of skilled workers in each industry against industry tariffs, industry fixed effects, and time indicators. The results indicate that the share of skilled workers in each industry is not related to protection. In columns 2 and 3 we also explore the relationship between increased demand for skilled labor and import penetration and export to output ratio. First, there is no relationship between export to output ratio and the share of skilled workers. Second, the results suggest that an increase in import penetration in an industry is associated with an increase in the share of skilled labor in total industry employment. The coefficient on import penetration in column 2 implies that a .01 increase in industry import penetration is associated with a .0046 increase in the share of skilled workers in this industry. This suggests that an industry with the average increase in import penetration from 1987 to 1998 (.076), experiences a .035 increase in the share of skilled workers.[15] We also explore whether increased import penetration has stronger impact on skill biased technological change in industries with lower tariffs by interacting import penetration with tariffs in column 3, but do not find any evidence in favor of this claim.

In summary, our results in this section suggest that the increase in the skill premium cannot be attributed to Stolper-Samuelson effects. However, our evidence is consistent with skill-biased technological change, which was concentrated in sectors that experienced larger increase in import penetration. These results suggest that skilled-biased technological change could have been partially induced by changes in foreign competition, so that trade liberalization may have had an indirect effect on the rise of the skill premium. Our results are similar to the finding by Attanasio, Goldberg, and Pavcnik (2002) for Colombia. They also find little support for Hecksher-Ohlin adjustments to trade reform, but strong evidence that is consistent with skill biased technological change. Moreover, the evidence from these two studies is also consistent with the evidence on pervasive skill biased technological change in a large set of developing countries by Berman and Machin (2000).

4. Effects of Trade Reforms on Industry Wage Premiums

4.1 Theoretical Background and Methodology

Since Hecksher-Ohlin model is a long run model of trade that assumes that labor is perfectly mobile across sectors, Hecksher-Ohlin type adjustments to trade reforms can only affect the economy-wide skill premiums and not industry specific wage premiums. Yet, this assumption on labor mobility might not hold, especially in the short- and medium-run, and in developing countries like Brazil, where labor markets are characterized by significant labor rigidities. Industry wage premia might thus also play an important role in labor market adjustment to trade liberalization. In particular, as we argued in the introduction of the paper, tariff induced changes in industry specific wage premiums could contribute to growing inequality between unskilled and skilled workers if tariff declines are larger in industries that employ larger share of unskilled workers or if tariff reductions increase industry specific returns

to skilled workers. As a result, we next investigate whether trade reform impacted industry wage premiums.

The theory link between trade policy and industry wages is ambiguous. In a short run model of trade and Ricaro-Viner model, where labor is immobile across sectors, sectors that experienced relatively large tariff cuts observe a decline in their wages relative to the economy-wide average, while sectors with proportionately smaller trade barrier reductions benefit in relative terms. The above trade models assume perfectly competitive product and factor markets. Introducing imperfect competition opens up additional channels through which trade policy may impact wages. For example, in the presence of unionization, it is possible that unions extract the rents associated with protection in the form of employment guarantees rather than wages (see Grossman (1984)). Moreover, liberalization induced productivity changes may further impact industry wages. A large literature explores the effects of trade reform on firm productivity. While in theory the effects of liberalization on productivity are ambiguous (see Rodrik (1991) and Roberts and Tybout (1991, 1996) for a discussion), most empirical work to date has established a positive link between liberalization and productivity (Harrison for Cote d' Ivoire (1994), Krishna and Mitra for India (1998), Kim for Korea (2000), Pavcnik for Chile (2001), Fernandes for Colombia (2001)). Hay (2001) and Muendler (2002) estimate that the 1988-1995 trade reforms had a significant impact on plant level productivity in Brazil. As tariffs declined, firms had to become more productive in order to remain competitive. To the extent that productivity enhancements are passed through onto industry wages, we would expect wages to increase in the industries with the highest productivity gains. If these occur in the industries with the highest trade barrier reductions, industry wages would be positively correlated with

trade liberalization. Thus, theory yields ambiguous predictions about the effect of trade liberalization on industry wage premia.

To empirically investigate the effect of trade exposure to wage premia, we employ the two-stage estimation framework familiar from the labor literature on industry wages. The estimation has two stages. In the first stage we regress the log of worker i's wages ($\ln(w_{ijt})$) on a vector of worker i's characteristics (H_{ijt}) such as education, age, age squared, gender, geographic location, an indicator for weather the person is self-employed, an indicator for whether the person works in the informal sector, and a set of industry indicators (I_{ijt}) reflecting worker i's industry affiliation:

$$\ln(w_{ijt}) = H_{ijt}\beta_{Ht} + I_{ijt} * wp_{jt} + \varepsilon_{ijt} \qquad (1)$$

The coefficient on the industry dummy, the wage premium, captures the part of the variation in wages that cannot be explained by worker characteristics, but can be explained by the workers' industry affiliation. Following Krueger and Summers (1988) we express the estimated wage premiums as deviations from the employment-weighted average wage premium.[16] This normalized wage premium can be interpreted as the proportional difference in wages for a worker in a given industry relative to an average worker in all industries with the same observable characteristics. The normalized wage differentials and their exact standard errors are calculated using the Haisken-DeNew and Schmidt (1997) two-step restricted least squares procedure provided to us by John P. Haisken-DeNew and Christoph M. Schmidt.[17] The first stage regressions are estimated separately for each year in our sample as the subscript t in equation (1) indicates. In the second stage, we pool the industry wage premiums wp_{jt} over time and regress them on trade related industry characteristics.

[16] The sum of the employment weighted normalized wage premiums is zero.
[17] Haisken DeNew and Schmidt (1997) adjust the variance covariance matrix of the normalized industry indicators to yield an exact standard error for the normalized coefficients.

$$wp_{jt} = T_{jt}\beta_T + D_{jt}\beta_D + u_{jt} \quad (2)$$

The primary variable we include in T_{jt}, the vector of trade related industry characteristics, is tariffs. In addition, to address potential concerns about omitted variable bias, we also experiment with other controls in $T_{jt,}$ such as lagged import penetration, lagged export to output share, and interactions of the above variables with exchange rates. The vector D_{jt} consists of a set of industry and time indicators, which we include in our more complete specifications.[18]

Since the dependent variable in the second stage is estimated, we estimate (2) with weighted least squares (WLS), using the inverse of the variance of the wage premium estimates from the first stage as weights. This procedure puts more weight on industries with smaller variance in industry premiums. We also account for general forms of heteroskedasticity and serial correlation in the error term in (2) by computing robust (Huber-White) standard errors clustered by industry.

4.2 Results

Prior to discussing our regression results, let us provide some information on the wage premiums. First, most of our estimates of industry wage premiums are highly statistically significant, which confirms that industry affiliation plays an important role in determining worker wages. Second, our results suggest that the structure of Brazilian industry wages does not change substantially between 1987 and 1998. The year-to-year correlation in industry wage premiums are very high, with the correlation coefficient usually exceeding .9. This finding is surprising given the results from previous studies on Mexico and Colombia during trade liberalization episodes (see Robertson (2000), Goldberg and Pavcnik (2001)). Those studies

[18] We consider the use of individual wage data and worker characteristics in the first stage a plus. As Gaston and Trefler (1994) point out, by conditioning our industry wage premium estimates on individual characteristics in the first stage, the relationship between tariffs and wages in the second stage cannot be driven by observable differences in worker composition across industries.

found low year-to-year correlations of industry wages, which suggested that the trade reforms changed the structure of industry wages. The magnitude of the correlation in Brazil is in line with the evidence on wage premiums in the U.S., where wage premiums are very stable across years (year-to-year correlations are always estimated to be above 0.9).[19] The resemblance of Brazil to the U.S. could be attributed to the fact that despite the large tariff reductions, most Brazilian industries continue to face relatively low import penetration rates, which is also the case for the U.S..

We next relate wage premiums to tariffs in the regression framework described in section 4.1. All regressions include year and industry indicators. Note that it is crucial to control for unobserved industry-specific and year-specific variables that could influence wages concurrently with tariffs. For example, a country experiencing a recession or macroeconomic instability could temporarily increase its tariffs and might observe a decline in wages as people are willing to work for less given the increased probability of being laid-off. Without controlling for year effects, one would falsely conclude that higher tariffs lead to lower wages. Similarly, specifications that do not control for unobserved worker and industry attributes that affect protection and wages could induce spurious correlation between tariffs and wages. Such characteristics could involve the ability to lobby the government for trade protection, or government's targeting of industries with specific characteristics. If these characteristics are time invariant, industry fixed effects will capture their effects.

All columns of table 7 suggest no relationship between tariffs and industry wage premiums. While industry wage premiums are an important component of worker earnings, they do not seem associated with trade policy. Given that Brazil's tariff changes might overstate the extent of trade liberalization (due to its size and NTBs), we next explore whether wage premiums

[19] See Krueger and Summers (1988) and Gaston and Trefler (1994).

are affected by the alternative trade exposure measures. We first estimate a specification in which, in addition to tariffs, we include industry measures of lagged import penetration and lagged export to output ratio.[20] The results presented in column 2 suggest that high export to output ratio is associated with higher industry wages. This result is intuitive since higher industry exports likely increase the demand for workers in that particular industry. However, we find no statistically significant effect of lagged import penetration on wage premiums. In column 3 we add the interaction of tariffs with import penetration to the specification in column 2. The insignificant interaction coefficient suggests that import penetration does not impact wage premiums differentially in industries with lower tariffs. Finally, exchange rate fluctuation might also affect wages. Although year effects capture the exchange rate fluctuation over time, one would expect that the effect of exchange rates might vary depending on trade exposure of the sector. We thus interact the exchange rate with lagged trade flows. As our results in column 4 indicate, however, the inclusion of exchange rates does not affect any of our previous findings.

Overall, there is little evidence that Brazilian trade liberalization affected the industry wage structure and thus wage inequality between skilled and unskilled workers via this channel. This finding is consistent with the evidence from Mexico by Feliciano (2001), who finds no relationship between industry wages and tariffs, but is inconsistent with the evidence from Colombia by Goldberg and Pavcnik (2001), who find that tariff reductions are associated with declines in industry wages.

4.3 Industry Wage Premiums for Skilled Workers

[20] Because trade flows are likely endogenous (they depend on factor costs), we include the first lags of import and export measures in the estimation rather than their current values. Of course, to the extent that these variables are serially correlated, this approach might yield biased results, especially in industry fixed effects specifications with relatively small number of observations. Nevertheless, the inclusion of these lagged variables does not change our conclusions about the relationship between tariffs and industry wages.

Although we find no relationship between trade exposure and industry wage premiums, trade policy could still account for part of the increase in the return to skilled workers if tariff reductions are associated with increases in sector specific skill premiums. Industry wage premiums could differ across workers with differing degrees of education. For example, the more educated workers might be more or less mobile in the labor market. Or, workers with different amounts of education might differ in the accumulation of their sector specific skills. To investigate this possibility, we compute skill specific industry wage premiums by employing a modified version of equation (1) that allows industry wage premiums to differ for skilled and unskilled workers:

$$\ln(w_{ijt}) = H_{ijt}\beta_H + I_{ijt} * wp_{jt} + I_{ijt} * S_{ijt} * wp_{Sjt} + \varepsilon_{ijt}$$

The variable S_{it} is an indicator for whether worker i in industry j is skilled (i.e. has complete secondary or university degree). The coefficients wp_{jtS} represent the incremental wage premium skilled workers earn in industry j *in addition* to the base wage premium in industry j wp_{jt}, which is received by unskilled and skilled workers. By relating these industry specific returns to skill to trade policy measures in the second stage of the estimation along the lines discussed in section 4.1, we investigate the differential impact of trade policy on industry wages of skilled and unskilled workers, respectively.

Our results suggest that sector specific skill premiums are in fact important. Most of the industry-skilled worker interactions are individually and jointly statistically significant. As a result, we next investigate whether changes in sector-specific skill premiums are associated with changes in trade policy. We regress the sector-specific skill premiums in each year against

tariffs, sector fixed effects, and time indicators.[21] The regression reported in column 1 of table 8 implies that industry tariff declines are associated with the increase in industry specific skill-premium. The magnitude of the coefficient suggests that a 10 percentage point decline in tariff in a given industry is associated with a 2.3% increase in the skill premium to skilled workers employed in that industry.

This result might at first seem surprising. Short run or medium run models of trade with restricted labor mobility predict a decline in wages in industries that experience a tariff induced decline in product prices. This argument implicitly assumes that trade policy does not affect labor productivity. In section 3 we have found some evidence that suggests that skill biased technological change was stronger in industries that experienced larger exposure to foreign competition. This would translate into higher relative wages of skilled workers in these sectors and could increase their sector specific skill premium if the productivity increases outweigh the negative effect of tariff reductions on product prices. Moreover, our results are also consistent with the studies that find productivity improvements after Brazilian trade liberalization in sectors that experienced biggest tariff cuts (see Hay (2001), Muendler (2002)). These studies do not differentiate between skill biased and Hicks neutral productivity improvements. If these productivity improvements outweigh the decline in prices dues to tariff reductions and enhance the earnings of relatively skilled workers more than the earnings of unskilled workers, they could partially account for the increase in industry specific wages of skilled workers.

We perform several specification checks. To begin with, in columns 2-4 we consider whether other trade exposure measures are also related to sector-specific skill premiums. Two findings emerge. First, the relationship between tariffs and sector specific skill premiums is

[21] In unreported regressions, we also investigated whether there is a relationship between trade exposure and sector-specific base wage premiums using the same set of specification as in table 7. We reach the same conclusions as in table 7. That is, we find no relationship between base wage premium, tariffs, and import penetration.

robust to the inclusion of other trade exposure measures. While the magnitude of the coefficient somewhat declines, the estimates are still within the confidence interval of the coefficient in column 1. Second, we find no relationship between sector specific skill premium and import penetration and export to output ratio. Moreover, given that the structure of protection has changed in Brazil during our sample period, one could object that unobserved time-varying shocks, which may simultaneously affect tariff changes and sector specific skill premium, drive our results. We thus also account for the potential endogeneity of trade policy *changes* by instrumenting for changes in trade policy with presample tariffs and presample tariffs interacted with the exchange rate.

Our choice of instruments is guided by the institutional details of Brazilian trade liberalization. Kume (2000) suggests that at the macroeconomic level Brazil changed trade policy in response to exchange rate fluctuations. Moreover, as we discuss in section 2.1 of the paper some sectors experienced larger tariff reductions than others. This is due to the fact that tariffs were widely dispersed across sectors prior to trade reforms and that Brazil was committed to economy-wide liberalization. As a result, trade reform led to proportionately larger tariff reductions in sectors with historically higher tariff levels. Figure 5 relates the industry decline in tariffs between 1987 and 1998 to the pre-reform levels of protection in 1986 (a year prior to our sample) and illustrates a strong positive correlation between tariff declines and the 1986 tariff level. Moreover, the regression of the 1998-1987 tariff decline on 1986 tariffs yields the coefficient on 1986 tariffs of .8 (t-statistic 16.77) and R^2 of .94. This discussion suggests that the 1986 industry tariff levels, and their interaction with exchange rates, are highly correlated with the industry tariff reductions and may provide good instruments for the tariff changes. We estimate the relationship between sector specific skill premiums and tariffs in first differences

using 2SLS. The results are reported in table 9. The 2SLS coefficient on tariff changes is -.0014. Because coffee prices likely affect the exchange rate, we have also experimented with the interaction of coffee prices rather than exchange rates with presample tariffs as an instrument. This yielded the tariff coefficient of -.002 (column 2 of table 9). Thus we continue to find that even after accounting for endogeneity of trade policy changes, tariff reductions are associated with the increases in sector specific skill premiums.

In sum, our evidence suggests that sector specific skill premiums have increased proportionately more in industries that experienced larger tariff reductions. These sector specific wage increases are potentially associated with skill biased productivity improvements in sectors that face more foreign competition. They provide an additional channel through which trade liberalization might have affected the growing skill premium.

5. Conclusions

This paper explores three channels through which trade liberalization might have contributed to the growing return to educated workers in Brazil during the 1980s and 1990s: the increase in skill premium due to Hecksher-Ohlin response to trade reforms, the increase in skill premium due to skill-biased technological change that was potentially associated with trade liberalization, and changes in industry wage premiums.

We do not find much evidence that Hecksher-Ohlin type mechanisms have contributed to the growing skill premium. While our results suggest that an increase in the industry's import penetration is associated with contraction in the industry's share of total manufacturing employment, we find no general relationship between tariff declines and contractions in employment. Moreover, the structure of employment within manufacturing sector has not

changed significantly during the trade reforms. Most importantly, the share of skilled labor in industry employment has increased in most industries despite the growing skill premium.

Our results suggest that skill-biased technological change might have been the primary source in increasing skill premium as the share of skilled workers increased in most industries. Part of the adoption of skill-biased technology might have been associated with the firm's response to intensified foreign competition. We find that the demand for skilled workers increased by more in industries that experienced a larger increase in import penetration. Finally, our evidence suggests that sector specific skill premiums were inversely related to tariff reductions (potentially because productivity gains associated with trade reform in these sectors were passed on to skilled workers as higher wages).

Overall, the magnitude of the effect of trade reforms on various labor market outcomes does not seem very large. This, combined with the fact that wage inequality has actually not risen much in Brazil despite the rise in skill premium (see Blom, Holm-Nielsen, and Verner (2001) and Green, Arbache, and Dickerson (2001)), seems to suggest that trade liberalization had only a small impact on wage inequality.[22] Our conclusion that trade liberalization played a relatively minor role is in line with other studies focusing on Brazil (see Green, Arbache, and Dickerson (2001) and Carneiro and Arbache (2002)). This could potentially be due to the fact that, despite large tariff reductions, import penetration in Brazil continues to be relatively low due to the large size of Brazilian economy. However, the results of the overall modest effects of trade on wage inequality have also been found by Attanasio, Goldberg, and Pavcnik (2002) for Colombia, and these findings differ significantly from the experience in Mexico (see Cragg and

[22]Both of these studies find that various wage inequality measures such as standard deviation of log wages and Gini coefficient have not changed much before and after the trade reform. Green, Arbache, and Dickerson (2001) argue that the wage inequality has not risen dramatically despite the growing skill premium because college educated workers continue to represent a relatively small share of Brazilian population.

Epelbaum (1996) Feenstra and Hanson (1997), Robertson (2000a)). Exploring these similarities and differences in labor market adjustments to trade reforms in various Latin American countries will likely provide a fruitful ground for future research.

References

Acemoglu, D. (2001). “Technical Change, Inequality, and the Labor Market”, manuscript.

Annan, K. (1999). "Help the Third World Help Itself", *Wall Street Journal* (29 November).

Arbache, J.S. and N. Menezes-Filho (2000). "Rent-Sharing in Brazil: Using Trade Liberalization as a Natural Experiment", Universidade de Brasilia mimeo.

Attanasio, O., Goldberg P., and N. Pavcnik (2002). “Trade Reforms and Income Inequality in Colombia,” mimeo.

Barros, R. and L. Ramos (1996). "Temporal Evolution of the Relationship between Wages and Education of Brazilian Men," In Birdsall, N. and R.H. Sabot ed. *Opportunity Foregone: Education in Brazil*, IADB, Washington, DC.

Berman, E. and S. Machin (2002). “Skill-Biased Technology Transfers: Evidence of Factor-Biased Technological Change in Developing Countries, Boston University mimeo.

Behrman, J., Birdsall N. and M. Szekely (2000). "Economic Reform and Wage Differentials in Latin America," IADB Working Paper.

Blom, A., Holm-Nielsen L., and D. Verner (2001). "Education, earnings, and inequality in Brazil 1982-1998: Implications for Education Policy, World Bank mimeo.

Carneiro, F.G. and J.S. Arbache (2002). "The Impacts of Trade on Brazilian Labor Market: A CGE Model Approach," University of Brasilia mimeo.

Cragg, M.I. and M. Epelbaum (1996). “Why has wage dispersion grown in Mexico? Is it the incidence of reforms or the growing demand for skills?”, *Journal of Development Economics,* Vol. 51, pp. 99-116.

Eaton, J., and S. Kortum (1996). "Trade in Ideas: Productivity and Patenting in the OECD," *Journal of International Economics* 40, 251-278.

_____(1997). "Technology and Bilateral Trade," *NBER Working Paper* 6253.

Feliciano, Z. (2001). “Workers and Trade Liberalization: The impact of trade reforms in Mexico on wages and employment”, *Industrial and Labor Relations Review*, Vol. 55, No. 1, forthcoming.

Feenstra, R. and G. Hanson (1997). "Foreign direct investment and relative wages: Evidence from Mexico's maquiladoras," *Journal of International Economics* 42, pp. 371-393.

Fernandes, A.M. (2001). “Trade Policy, Trade Volumes and Plant-Level Productivity in Colombian Manufacturing Industries ”, Yale University, manuscript.

Frankel, J.. and Romer D. (1999). "Does Trade Cause Growth?", American Economic Review 89, pp. 279-399.

Gaston, N. and Trefler D. (1994). “Protection, trade, and wages: Evidence from U.S. manufacturing,” *Industrial and Labor Relations Review* 47, pp. 575-93.

Goldberg, P. and Pavcnik N. (2001). "Trade, Wages, and the Political Economy of Trade Protection: Evidence from the Colombian Trade Reforms, mimeo.

Green, F., Dickerson, A. and Arbache, J.S. (2001). "A picture of wage inequality and the allocation of labor through a period of trade liberalization: The case of Brazil," *World Development*, 29: 1923-1939.

Haisken-DeNew, J.P. and C.M. Schmidt (1997): "Inter-Industry and Inter-Region Wage Differentials: Mechanics and Interpretation", *Review of Economics and Statistics*, Vol. 79, No. 3, pp. 516-521.

Hanson, G., and Harrison A. (1999). “Who gains from trade reform? Some remaining puzzles,” *Journal of Development Economics* 59, 125-154.

Harrison, A. (1994). “Productivity, Imperfect Competition and Trade Reform: Theory and Evidence”, *Journal of International Economics,* Vol. 36 (1-2), pp. 53-73.

Hay, D.A. (2001). "The Post-1990 Brazilian Trade Liberalization and the Performance of Large Manufacturing Firms: Productivity, Market Share, and Profits," *Economic Journal* 111: 620-641.

Heckman J. and Pages C. (2000). “The Cost of Job Security Regulation: Evidence from Latin American Labor Market,” *NBER Working Paper* 7773.

Kim, E. (2000). “Trade Liberalization and Productivity Growth in Korean Manufacturing Industries: Price Protection, Market Power and Scale Efficiency”, *Journal of Development Economics,* Vol. 62(1), pp. 55-83.

Krishna, P. and D. Mitra (1998). “Trade Liberalization, Market Discipline and Productivity Growth; New Evidence from India”, *Journal of Development Economics,* Vol. 56(2), pp. 447-462.

Krueger, A.B. and L.H. Summers (1988). “Efficiency Wages and the Inter-Industry Wage Structure”, *Econometrica,* Vol. 56, pp. 259-293.

Kume, H. (2000) “*A politica brasileira de importação no period 1987 descrição e avaliação.*”

Kume, H, Piani, G. And C.F. Souza (2000). "Instrumentos de Politica Comercial no Periodo 1987-1998," mimeo.

Lam, D. And R. Schoeni (1993). "The Effects of Family Background on Earnings and Returns to Schooling: Evidence from Brazil," *Journal of Political Economy* 101(4): 710-740.

Muendler, M. A. (2002). "Trade, Technology, and Productivity: A Study of Brazilian Manufacturers, 1986-1998", University of California, Berkeley mimeo.

Pavcnik. N. (2000). "Trade Liberalization, Exit and Productivity Improvements: Evidence from Chilean Plants", *Review of Economic Studies* 69, pp. 245-276.

Revenga, A. (1992). "Exporting Jobs? The Impact of Import Competition on Employment and Wages in U.S. Manufacturing", *Quarterly Journal of Economics,* 107(1), pp. 255-284.

Revenga, A. (1997). "Employment and wage effects of trade liberalization: The case of Mexican manufacturing," *Journal of Labor Economics* 15, pp. S20-43.

Robbins, Donald J. (1996). "Evidence on Trade and Wages in the Developing World," OECD Technical Paper No. 119.

Robbins, Donald and Mari Minowa. "Do returns to Schooling Vary Across Industries?", in Birdsall, N. and Sabot, R.H. (1996) ed."Opportunity Foregone; Education in Brazil", Inter-American Development Bank, Washington, DC.

Roberts, Mark J. and James R. Tybout (eds.) (1996). *Industrial Evolution in Developing Countries*. Oxford: Oxford University Press.

Robertson, Raymond (2000). "Inter-industry Wage Differentials Across Time, Borders, and Trade Regimes: Evidence from the US and Mexico", Macalester College mimeo.

_____(2000a). "Trade Liberalization and Wage Inequality: Lessons from Mexico," *World Economy*.

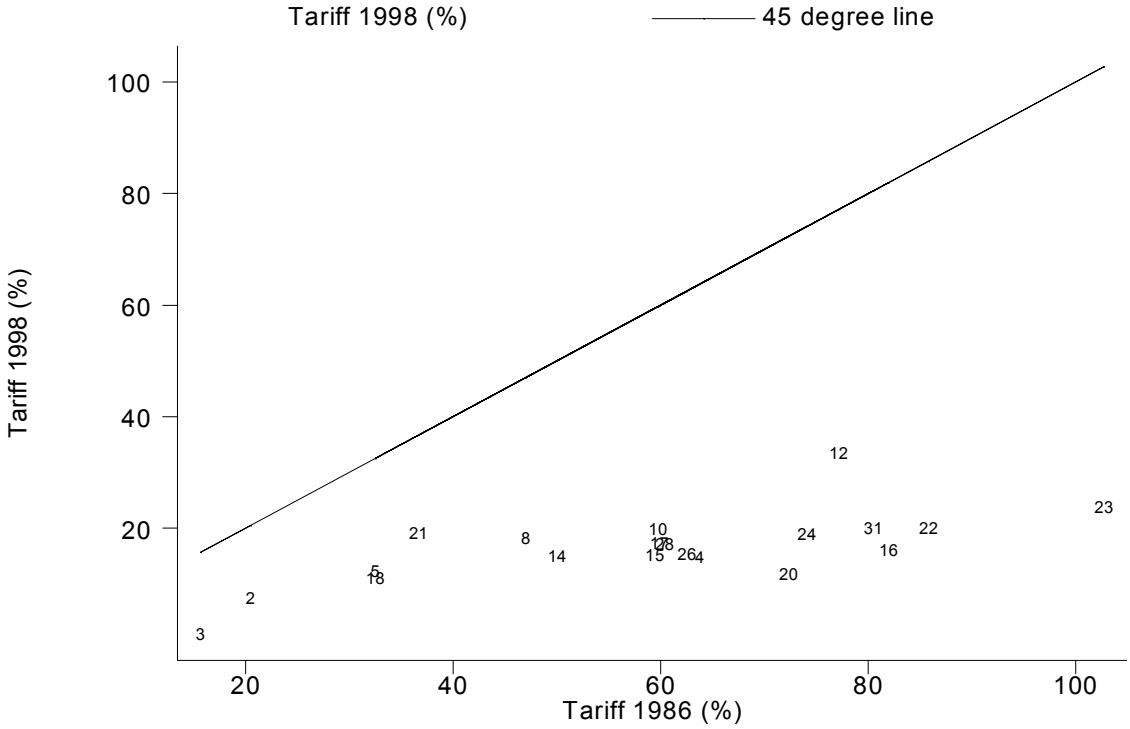
Rodrik, D. (1991). "Closing the Productivity Gap: Does Trade Liberalization Really Help? ", in: Helleiner, G. (ed.) *Trade Policy, Industrialization and Development*, Clarendon Press, Oxford.

Wood, A. (1995). "How Trade Hurt Unskilled Workers", *Journal of Economic Perspectives,* 9(3), pp. 57-80.

Wood, A. (1999). "Openness and Wage Inequality in Developing Countries: The Latin American Challenge to East Asian Conventional Wisdom**",** in: Baldwin, R. et-al. (eds.) *Market integration, regionalism and the global economy,* Cambridge University Press, pp. 153-

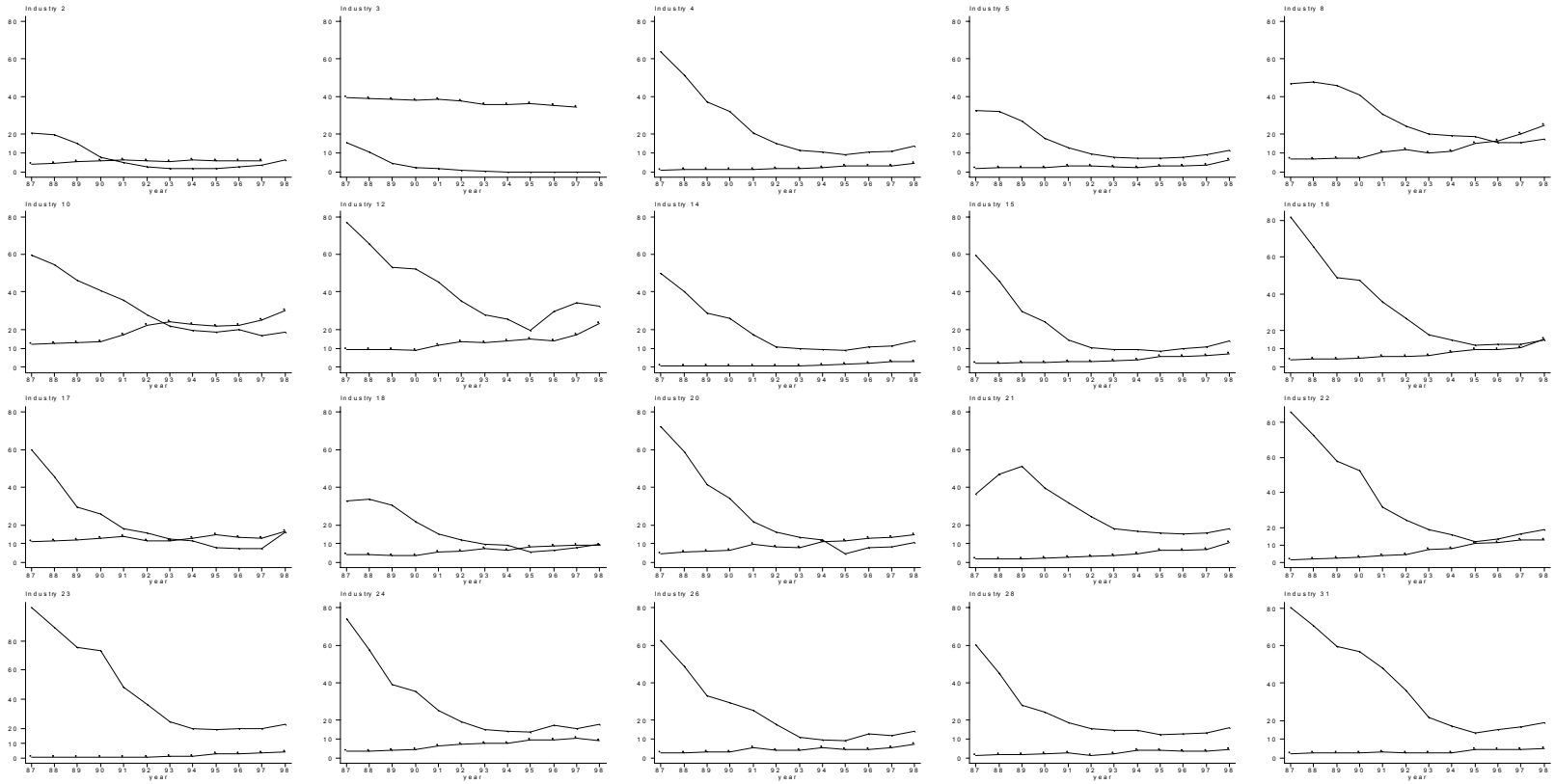
181.

Figure 1—Tariffs in 1986 and 1998



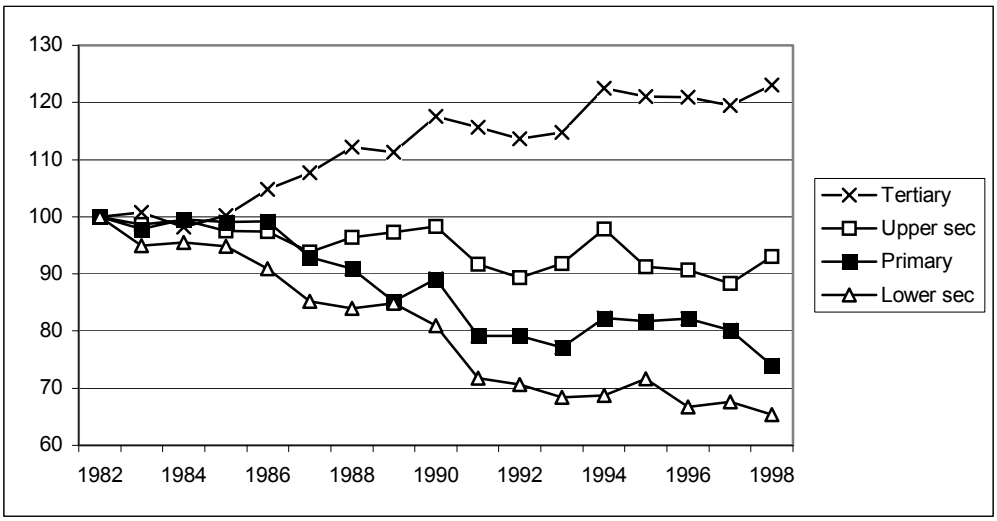
Note: Symbols are industry codes.

Figure 2—Industry Import Penetration and Tariffs



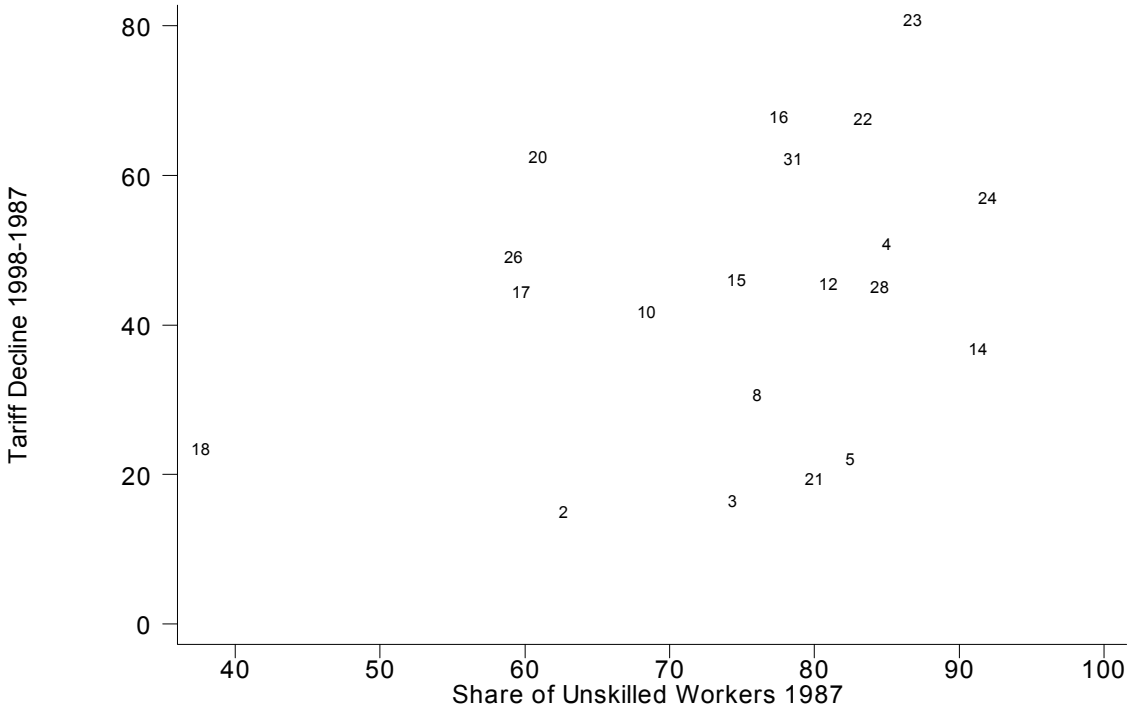
Note: import penetration (circles), tariff (line)

Figure 3--Growth in Returns to Education 1982 to 1998



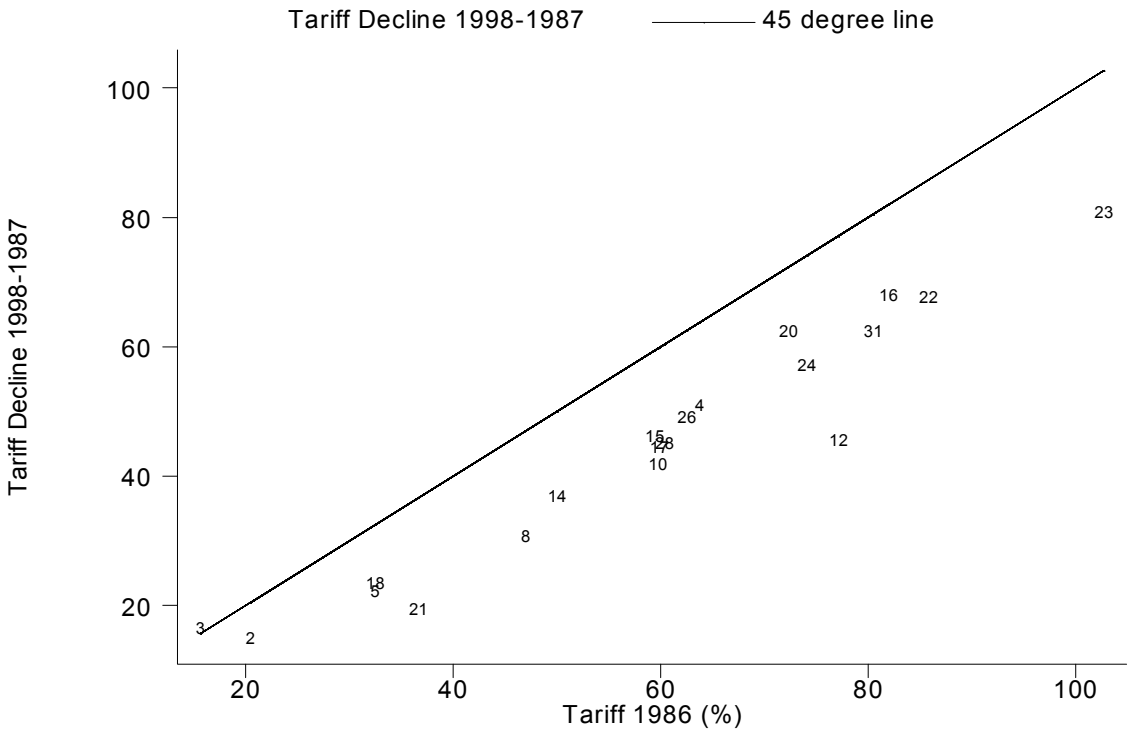
Source: Blom, Holm-Nielsen and Verner (2001).

Figure 4—Tariff Reductions and the Share of Unskilled Workers



Note: Symbols are industry codes.

Figure 5—Tariff Decline 1998-1987 and Tariffs in 1986



Note: Symbols are industry codes.

Table 1--Tariffs 1987-1998

Year	Mean	S.D.
1987	58.8	22.8
1988	50.1	18.3
1989	39.1	16.4
1990	34.1	17.0
1991	25.2	13.3
1992	19.1	10.3
1993	14.4	7.2
1994	12.9	6.2
1995	10.9	5.7
1996	12.5	6.6
1997	12.8	7.0
1998	15.4	6.5

Note: There are 20 industries in each year.

Table 2--Trade Exposure 1987-1998

Year	Import Penetration		Export to Output	
	Mean	S.D.	Mean	S.D.
1987	.057	.086	.097	.112
1988	.059	.085	.095	.113
1989	.061	.084	.094	.115
1990	.064	.084	.092	.116
1991	.076	.086	.109	.124
1992	.077	.088	.134	.136
1993	.080	.084	.130	.132
1994	.086	.083	.115	.112
1995	.098	.081	.110	.108
1996	.098	.081	.114	.118
1997	.106	.083	.117	.122
1998	.116	.078	.112	.101

Note: There are 20 industries in each year except in 1998, where we are missing the information on two industries.

Table 3--Industry Share in Total Manufacturing Employment

Industry Code	Industry Share in Manufacturing Employment		
	1987	1992	1998
2	.0102	.0125	.0124
3	.0151	.0142	.0112
4	.0546	.0538	.0477
5	.1678	.1694	.1792
8	.0715	.0616	.0568
10	.0585	.0485	.0428
12	.1117	.1038	.1068
14	.0574	.0662	.0757
15	.0692	.0720	.0813
16	.0163	.0187	.0181
17	.0543	.0507	.0349
18	.0210	.0223	.0200
20	.0211	.0206	.0236
21	.0281	.0295	.0338
22	.0447	.0406	.0247
23	.0384	.0402	.0399
24	.0454	.0436	.0536
26	.0031	.0033	.0021
28	.0880	.1032	.1144
31	.0236	.0254	.0209

Table 4--Industry Share of Employment and Trade Exposure

	(1)	(2)	(3)
Tariff	.00005	-.00002	.00000
	(.0001)	(.0001)	(.0001)
Lagged Import Penetration		-.1370 **	-.1537 **
		(.0574)	(.0463)
Lagged Import Penetration*Tariff			.0031 **
			(.0009)
Lagged Export to Output Ratio		.0329	.0335
		(.0236)	(.0221)
Year Indicators	yes	yes	yes
Industry Indicators	yes	yes	yes

Note: ** and * indicate 5 and 10 % significance, respectively. Reported standard errors are robust and clustered on industry. N is 240.

Table 5--Share of Skilled Workers in Industry Employment

Industry Code	Share of Workers with Complete Secondary or University Degree in Industry			Share of Workers with Complete University Degree in Industry		
	1987	1992	1998	1987	1992	1998
2	.373	.438	.356	.184	.165	.134
3	.257	.347	.280	.081	.084	.104
4	.150	.168	.180	.055	.045	.057
5	.175	.211	.220	.054	.060	.042
8	.240	.291	.380	.070	.084	.095
10	.316	.370	.440	.122	.142	.138
12	.190	.227	.333	.052	.059	.070
14	.087	.093	.130	.013	.012	.021
15	.254	.319	.377	.075	.095	.104
16	.225	.219	.190	.073	.057	.041
17	.402	.458	.487	.137	.139	.153
18	.624	.659	.739	.268	.259	.310
20	.391	.442	.538	.148	.118	.158
21	.200	.182	.256	.055	.036	.073
22	.166	.204	.298	.048	.051	.084
23	.132	.182	.190	.027	.032	.026
24	.080	.098	.133	.015	.021	.006
26	.408	.440	.514	.107	.160	.114
28	.155	.165	.220	.045	.042	.051
31	.215	.215	.378	.044	.065	.079

Note: Skilled workers are workers with complete secondary or university education.

Table 6--Share of Skilled Workers and Trade Exposure

	(1)	(2)	(3)
Tariff	-.0002	.0000	.0000
	(.0004)	(.0005)	(.0005)
Lagged Import Penetration		.4584 **	.4600 **
		(.1585)	(.1599)
Lagged Import Penetration*Tariff			-.0003
			(.0041)
Lagged Export to Output Ratio		-.0466	-.0466
		(.1221)	(.1222)
Year Indicators	yes	yes	yes
Industry Indicators	yes	yes	yes

Note: ** and * indicate 5 and 10 % significance, respectively. Reported standard errors are robust and clustered on industry. N is 240.

Table 7-- Industry Wage Premiums and Trade Exposure

	(1)	(2)	(3)	(4)
Tariff	-.0006	-.0005	-.0005	-.0004
	(.0006)	(.0005)	(.0004)	(.0006)
Lagged Export to Output		.1959 **	.2199 **	.2096 **
		(.0986)	(.0932)	(.0952)
Lagged Import Penetration		.1869	.1367	.2313
		(.2504)	(.2219)	(.2721)
Tariff*Lagged Imp. Penetration			-.0091	
			(.0105)	
Lagged Exports*Ex.Rate				-.0304
				(.0773)
Lagged Imports*Ex.Rate				-.0357
				(.1229)
Year Indicators	yes	yes	yes	yes
Industry Indicators	yes	yes	yes	yes

Note: ** and * indicate 5 and 10 % significance, respectively. Reported standard errors are robust and clustered by industry. N is 240.

Table 8-- Industry Specific Skill Premiums and Trade Exposure

	(1)	(2)	(3)	(4)
Nominal tariff	-.0023 **	-.0017 **	-.0015 **	-.0013 **
	(.0008)	(.0007)	(.0008)	(.0006)
Lagged Export to Output		.0473	.1086	.0570
		(.2476)	(.2536)	(.2480)
Lagged Import Penetration		.5724	.4986	-.1083
		(.4132)	(.4155)	(.4035)
Tariff*Imp. Pentration			-.0120	
			(.0085)	
Lagged Exports*Ex.Rate				-.2308
				(.1784)
Lagged Imports*Ex.Rate				.4844 **
				(.1479)
Year Indicators	yes	yes	yes	yes
Industry Indicators	yes	yes	yes	yes

Note: ** and * indicate 5 and 10 % significance, respectively. Reported standard errors are robust and clustered by industry. N is 240.

Table 9-- Industry Specific Skill Premiums and Trade Exposure, First Differences, 2SLS results

	(1)	(2)
Nominal tariff	-.0014	-.0020
	(.0005)	(.0008)
Year Indicators	yes	yes

Note: ** and * indicate 5 and 10 % significance, respectively. Reported standard errors are robust and clustered by industry. N is 240.