Wage Inequality in Brazil: the Role of Trade Liberalization¤

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Abstract

Since trade liberalization started in 1988, Brazilian economy has experienced a reduction in the ratio of skilled to unskilled labor earnings. We investigate whether trade liberalization explains these wage inequality changes by performing empirical consistency checks on the causality path predicted by theory. We …nd results compatible with trade liberalization playing a role in accounting for the reduction of wage inequality in Brazil between 1988 and 1995.

1 Introduction

From 1988 to 1995 the Brazilian economy underwent a massive trade liberalization process. Non-tari¤ barriers were substituted by tari¤s, and tari¤s were reduced from an average of 31.6% in 1989 to 11.2% in 1994. Over the same period, a decrease in wage inequality was observed in Brazil: average wages of more educated workers declined in relation to that of less educated workers.[1] Neoclassical trade theory, based on factor endowments di¤erences, has very well known predictions on how relative factor prices should change in response to trade liberalization.

This paper investigates the role of trade liberalization on explaining relative wage movements in Brazil. This is accomplished by performing empirical consistency checks on the causality path predicted by trade theory, using disaggregated data on tari¤s, prices, wages, employment and skill intensity from 1988 to 1995.

When tari¤s fall non-homogeneously across sectors, relative prices change. If prices fall relatively more in sectors that use intensively skilled labor, production shifts towards unskill-intensive sectors. This triggers an increase in the demand for unskilled labor and a decrease for skilled labor, which decreases skilled-labor relative wages.

What are the empirical implications of this transmission mechanism? First, one should observe a positive correlation between price and tari¤ changes. Second, there should be a negative correlation between price and tari¤ changes and skill intensity. Finally, production (and employment) changes should be negatively correlated with skill intensity.

We …nd results compatible with trade liberalization playing a role in accounting for the reduction of wage inequality in Brazil between 1988 and 1995.

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[1] It should be noticed that income distribution in Brazil has not changed signi…cantly over the last 25 years, remaining one of the most concentrated in the world.

There is a wide empirical literature studying the contribution of international trade to changes in wage inequality. Most of this literature tries to explain the rising wage inequality in the United States since the 1980's, which coincided with a large increase of the country's international trade.(references) An increase in the ratio of skilled to unskilled labor earnings since the 1980's was observed in most developed countries (see Johnson and Sta¤ord, 1999). It investigates whether international trade was responsible for the wage inequality increase, or whether it was due to skill biased technological change. Although some papers have been successful in associating product prices relative changes to relative wages, the literature has failed to determine the extent to which prices changes are due to international trade (see Slaughter (1998) for a survey of product-price studies using US data).

With respect to less developed countries, the literature is far scantier. Hanson and Harrison (1999) show that relative wages of skilled workers have increased in Mexico following trade reform. They argue that protection was skewed towards low-skilled workers prior to the reform and, therefore, tari¤s and prices decrease was deeper in those sectors, leading to the observed wage inequality deterioration. Beyer et al.(1999) …nd that a fall in the relative price of labor intensive goods in Chile helps to explain a simultaneous rise in wage inequality. As for Argentina, Galiani and Sanguinetti (2000) try to associate the observed wage inequality increase with trade liberalization measures.

Brazil (references)

The paper is organized as follows. Section 2 discusses the theoretical motivation. Some data and preliminary results are presented in Section 3. Brazilian trade liberalization process is brie‡y described in section 4. Section 5 contains the empirical results. Section 6 concludes.

2 Theoretical motivation

In this section we describe the e¤ects of trade policy on relative wages within the neoclassical Heckscher-Ohlin model. The …rst sub-section discusses how one should apply the theoretical framework to the analysis of a trade liberalization process. The second sub-section presents the trade transmission mechanism, and the empirical consistency checks to be performed in this paper.

2.1 Trade theory and policy

The Stolper-Samuelson theorem has a clear prediction about the direction of relative wage changes in an economy switching from autarkic to free trade equilibrium, when it produces and consumes two goods and uses two factors of production. According to the theorem, there will be a real income increase for the production factor relatively more abundant, which is intensively used in the exporting sector, and a real income reduction for the other factor. An actual trade liberalization di¤ers from this theoretical benchmark in at least two important aspects:

1. there are more than two goods and two factors of production in the economy, and
2. the economy does not move from autarky to free trade.

Let us analyze each of these in turn.

More than two goods and two factors of production First, we will examine the predictions of a generalized trade model, with several goods and factors (see Johnson and Sta¤ord (1999) for a complete description of such a model).

In traditional trade models, international trade is based on di¤erences among countries, and those di¤erences may be either in their factor endowments, as in the Heckscher-Ohlin framework, or in the

technology they control, as in the Ricardian framework. A common feature in these models is that, in a small open economy, relative wages are a function of relative prices and technological parameters, when the number of goods is greater or equal to the number of factors and the economy is in the diversi…cation cone for those goods. The intuition for this result is the following. In a small open economy, relative prices of tradable goods are determined abroad, and any excess supply or demand is ful…lled by trade of goods. Wages, on its turn, are equal to the value of the factor's marginal productivity. As prices are exogenous, and marginal productivity depends solely on technological parameters, wages will depend only on prices and technological parameters, and not on factors' supply or goods' demand parameters. That is true when the economy is in the cone of diversi…cation, which is the locus of factor endowments in which there is equilibrium with full employment of all factors, given international relative prices.[2]

When the number of goods is equal to the number of factors, the quantity produced of each good is uniquely determined in equilibrium, and so is the amount of factors used in the production of each good. Hence, relative factor prices are also uniquely determined. When the number of goods exceeds that of factors, the cone of diversi…cation is compatible with more than one combination of goods being produced. Yet, for any equilibrium, relative factor prices are again well speci…ed, depending on the relative prices of tradable goods being produced, and on technological parameters.

A di¤erent situation arises when the number of factors exceeds the number of goods. In that case, the cone of diversi…cation dimension is smaller than the factor space, and, in general, the economy will not be in the diversi…cation cone, in which case relative factor prices depend on preference parameter and factor supplies, in addition to prices and technological parameters. It is important to note that even if factor endowments are in the cone of diversi…cation, there will be more than one vector of relative factor prices compatible with equilibrium.

In sum, if the economy is in the cone of diversi…cation and the number of goods is greater or equal to the number of factors, then factor relative prices depend on relative prices of tradable goods being produced, and technological parameters. If the economy is outside the diversi…cation cone, or the number of goods is smaller than the number of factors, then relative factor prices will depend on relative prices of goods being produced, technological and taste parameters, and factor supplies.

Liberalization from restricted trade to less restricted trade As already mentioned, Stolper-Samuelson theorem applies to an economy switching from autarky to free trade. The Brazilian economy moved from an equilibrium with di¤erentiated tari¤s across industries, to another with lower but still di¤erentiated tari¤s across industries. How does the description above comply with restricted trade? Trade constraints distort relative prices. In the small country case, domestic prices are given by:

$$p_i = (1 + t_i)\, e p_i^{\ast} \tag{1}$$

where p_i represents the domestic price for good i; t_i is the import tari¤ or the export subsidy (or more generally, any type of rents generated by other trade barriers, like quantitative restrictions); e is the nominal exchange rate; and $p_i^{\ast}$ is the international price of good i. Domestic relative prices are, thus, given by:

$$\frac{p_i}{p_j} = \frac{p_i^{\ast}(1 + t_i)}{p_j^{\ast}(1 + t_j)}. \tag{2}$$

Hence, the analysis above also applies to the equilibrium with trade restrictions, given the domestic relative price of tradable goods in equation (2). The e¤ect of trade liberalization on relative factor

[2] The existence of non-tradable goods does not alter the main implications of the analysis. The only e¤ect of non-tradables is to decrease the size of the diversi…cation cone.

prices happens through its e¤ect on domestic relative prices, as speci…ed in equation (2). Note, though, that relative factor prices may also be a function of taste parameters and factor supplies, depending on whether the economy is in the cone of diversi…cation, and whether the number of goods is greater or equal to the number of factors.

2.2 Trade transmission mechanism

In this sub-section we describe the transmission mechanism through which trade a¤ects relative wages, and the empirical consistency checks implied by it.

The process is initiated by a change in tari¤s that might not be homogeneous across sectors, which would a¤ect relative prices as in equation (2). Actual tari¤ changes may have a relation with skilled-labor intensity. Let us study what happens when tari¤s fall relatively more in sectors that use intensively skilled labor, which causes a decrease in relative prices of these sectors. The new price incentives shift production from skill- towards unskill-intensive sectors. This triggers an increase in the demand for unskilled labor and a decrease for skilled labor. For a given labor supply, skilled-labor relative wages decrease in order to restore equilibrium in the labor market.

What are the empirical implications of the transmission mechanism described above? If trade liberalization is responsible for the decrease in relative skilled labor earnings observed in Brazil, one should investigate the following relationships.

1. Were relative prices a¤ected by trade liberalization? This can be examined through the estimation of price equations based on the relationship established in equation (1). One should observe a positive correlation between price and tari¤ changes.

2. Were relative price and tari¤ changes related to skilled-labor intensity? To be consistent with the decrease in wage inequality, one should observe a relative decrease in tari¤s and prices in sectors that use skilled labor intensively. This should be re‡ected in the data through a negative correlation between price and tari¤ changes and skill intensity.

3. Has relative production (and employment) fallen in skill-intensive sectors? This can be investigated by regressing production (and employment) changes on skill intensity, which should be negatively correlated.

3 Data and preliminary results

In this section we present data on wage inequality during trade liberalization period in Brazil. We also show some preliminary results on the consistency checks described in the previous section. We use industry data for the period 1988 to 1995, disaggregated at the sectoral level. Education, wage and employment data are from annual Brazilian household surveys (Pesquisa Nacional de Amostra Domiciliares - PNAD) conducted by the Brazilian Census Bureau (IBGE, see www.ibge.gov.br). Hourly labor income from the main job is used as wage measure. Production data come from the industrial surveys (Pesquisa Industrial Anual - PIA), conducted by IBGE. The Brazilian producer price index (Índice de Preços por Atacado, IPA), collected by Getulio Vargas Foundation, was made compatible to the PIA sectoral de…nitions. Data on tari¤s are from Kume (2000). Data from PNAD are available disaggregated for 22 manufacturing sectors, while data from PIA and Kume (2000) come at the <nível de desagregação?>.

Table 1 shows the evolution of the proportion of skilled labor employment and the ratio of skilled to unskilled labor wages in the manufacturing sector. We use two thresholds to de…ne skill level. The High

School Cut refers to workers with complete high school degrees, whereas College Cut refers to workers with at least one year of college education.[3]

As shown in Table 1, the proportion of skilled labor employed (as measured by the High School Cut) increased from 21.9% in 1988 to 24.2% in 1995, while their relative wages dropped from 3.10 in 1988 to 2.59 in 1995.

Table 1 - Skilled-Labor Share and Relative Wages

Year	Skilled-Labor Share $\frac{L^S}{L^U+L^S}$		Relative Wages $\frac{w^S}{w^U}$	
	High School Cut	College Cut	High School Cut	College Cut
1988	21.9%	9.5%	3.10	4.56
1989	21.1%	9.1%	3.00	4.33
1990	22.7%	10.0%	2.91	4.00
1992	22.1%	8.8%	2.70	3.77
1993	22.8%	8.7%	2.60	3.96
1995	24.2%	9.4%	2.59	3.97

The reported simultaneous reduction in skilled-labor relative earnings and increase in its relative employment can only be attained with a rise in skilled labor relative supply. In fact, data from PNAD and other sources, not reported here, con…rm that there has been an increase on average education for the population as a whole in Brazil (see Fernandes and Menezes Filho, 2000).

Figures 1 and 2 hint that labor supply changes may not account for the whole explanation on the course of wage inequality in Brazil. The …gures display, respectively, the evolution of skilled-labor employment share and relative wages, using the High School Cut measure, for a larger time span than Table 1: from 1981 to 1997. The variables are calculated both for the manufacturing sector and for the economy as a whole. One can observe, in Figure 1, a steady increase of skilled-labor employment proportion over the period, with minor ‡uctuations for the manufacturing series. By contrast, Figure 2 shows that wage di¤erentials remained stable until 1988, and started to decline substantially right at the beginning of the trade liberalization period.

In order to further investigate the role of labor supply changes on wage inequality, we perform a standard decomposition of skilled-labor relative demand in within and between industry changes (see Berman, Bound and Griliches, 1994, Autor, Katz and Krueger, 1998 and Robertson, 2001). This decomposition shows that even when relative employment and earnings moved simultaneously, labor supply could not be the only source of wage di¤erentials changes.

As represented in equation 3,

$$\Delta\left(\frac{L^S}{L^U+L^S}\right) = \sum_j s_j \Delta\left(\frac{L^S}{L^U+L^S}\right)_j + \sum_j \left(\frac{L^S}{L^U+L^S}\right)_j \Delta s_j, \qquad (3)$$

changes in skilled-labor employment share ($\Delta\left[\frac{L^S}{L^U+L^S}\right]$) may be decomposed in two parts:

1. within industry changes, which are changes in skilled-labor employment between industries ($\Delta\left[\frac{L^S}{L^U+L^S}\right]_j$) for a given employment share in each industry (s_j);

[3] Note that the College Cut proportion is less than half the High School Cut proportion. Data not reported here show an even lower proportion, less than 5%, for complete college education. This is clearly not a relevant fraction of the labor force. With such a low endowment of college educated workers, it is reasonable to believe that the Brazilian economy is producing in a cone of diversi…cation that does not contain goods that use mostly intensively that factor of production. Therefore, we choose to use the High School Cut in all empirical exercises performed in this paper.

2. and between industry changes, which are changes in each industry employment share (Δs_j), for a given employment share in each industry ($\frac{L^S}{L^U + L^S}_j$).

According to the Rybczynski theorem, for a small open economy, a factor endowment increase raises the output of sectors which use that factor intensively, and decreases the output of the other sectors. In this setting there is no alteration in the factor proportion used in each industry. In terms of equation 3, an increase in skilled-labor supply is represented by a positive left hand side. Since factor proportions do not change in each industry, the first term in the right hand side, which represents the within industry effect, should be zero. The whole effect lies in the second term - the between industry effect-, which should be positive.

What would be the results of this exercise if trade were the only source behind the changes in wage inequality? As described in the trade transmission mechanism in Section 2, trade should have caused a decrease in relative prices of skill-intensive sectors in order to produce the observed decrease in wage inequality. On the one hand, these price incentives would decrease production in those sectors, which denote a negative between industry effect. On the other hand, the relative wage incentives would shift labor demand towards skilled workers within each industry, that is, a positive within industry effect. With given factor supplies, the two effects should offset each other.

Table 2 presents the decomposition results for both employment and wage bill skilled workers shares. Confirming the labor supply movement displayed in Figure 1, skilled-labor employment share increased on average 2.67% by year between 1988 and 1995. The decomposition reveals that the within effect is positive and the between effect is negative. Two conclusions emerge from this analysis: (1) labor supply changes alone cannot account for these results, and (2) the results are compatible with the trade explanation.

Table 2 - Employment and Wage Bill Shares Decompositions: 1988-95

	Total	Within Sectors	Between Sectors
Annual Change in Skilled Workers Employment Share	0,0267 (100%)	0,0334 (125%)	-0,0067 (-25%)
Annual Change in Skilled Workers Wage Bill Share	0,0084 (100%)	0,0256 (304%)	-0,0172 (-204%)

Table 2 also shows that the wage bill share of skilled workers increased over the period. However, it increased on average less than the employment share, 0.84% by year. This is compatible with the observed decrease in skilled labor relative wages. Consequently, the skilled worker wage bill share between sector effect is larger compared to that of employment share. The employment share decomposition presented a negative between effect, which means that, on average, employment share decreased in industries that use skilled labor more intensively. As these sectors use more of the factor that had its remuneration decreased, it is logical that their overall wage bill share should decrease by a larger proportion than the employment share.

Figure 3 illustrates the employment share between industry effect. It presents the employment share evolution of skilled-labor intensive sectors. Skilled-labor intensive sectors are defined here as those with skilled-labor proportions larger than the median in the beginning of the period. The figure shows that the employment share of skilled-labor intensive sectors has decreased over the period, dropping from 45.4% in 1988 to 41.4% in 1995. Output share, also shown in the figure, follows the same decreasing pattern.

As described above, the trade transmission is through a decrease in skill-intensive sector relative prices. This is supported by the evidence shown in Figure 4, which plots sectoral data on changes in prices from 1988 to 1995 by skill intensity. The regression line displayed has a negative slope, indicating that relative prices decreased in skill-intensive sectors.

Is trade responsible for the observed movement in prices? Figure 5 compares the evolution of skill-intensive sectors relative prices and tari¤s. These are measured by the ratios of the weighted average price (tari¤) for skill-intensive sectors and the weighted average price (tari¤) for the other sectors, with skilled-labor intensity de…ned as in Figure 3. The …gure shows that relative prices and tari¤s move together from 1988 to 1992, but diverge from then on.

Before turning into the regression analysis, we brie‡y describe the process of trade liberalization in Brazil. In particular, we look at the tari¤ protection pattern by skill intensity before and during trade liberalization.

4 Trade liberalization

Brazil has a long tradition of restrictive trade policy. From World War II to 1973 the country pursued an import substitution strategy, along with several other Latin American countries. Such strategy was based on domestic market protection and subsidies to chosen industries. From 1960 to 1973 there was a gradual import liberalization, combined with export promotion policies, including frequent exchange rate devaluations. As a result of these policies, Brazilian exports became considerably more diversi…ed. For example, co¤ee exports, which accounted for 40% of total exports in 1964, reduced its share to only 20% in 1973. The impact on imports was not as signi…cant. There was some import substitution in intermediate and capital goods, but imports remained highly concentrated in those goods, as well as in oil, which accounted for 20% of total imports in 1974.

The 1970's two oil crises brought about large trade imbalances. The Brazilian government chose to use restrictive trade policy instead of letting exchange rate devaluations restore trade balance. Tari¤s and non-tari¤ barriers were imposed, along with export promotion policies to compensate the anti-export bias generated by the import restrictions. The debt crisis of the 1980's called for large trade surpluses, which was attained by the intensi…cation of trade restrictions, and an industrial policy which gave …scal incentives and cheap credit to selected …rms.

In sum, trade barriers were built over several decades, but responding to di¤erent policy orientations. Trade policy before 1974 was designed as an incentive to selected sectors as part of the import substitution strategy. After 1974, trade policies in form of both tari¤ and non-tari¤ barriers increases were a reaction to macroeconomic instability caused by the oil shocks and the debt crisis.

The e¤ect of these policies on relative prices distorted microeconomic incentives. By the end of the 1980's a maze of policy incentives was in place. An interesting question is whether the tari¤ structure favored skill-intensive sectors. Figure 6 shows that Brazilian tari¤ protection pattern in 1988 had no relation with skill-intensity. This comes as no surprise given that trade barriers were raised to cope with macroeconomic problems, and not to protect sectors in which Brazil had no comparative advantage.

A most needed trade liberalization process was initiated in 1988 and intensi…ed by a new government in 1990, in conjunction with the implementation of a regional trade block, Mercosul.[4] Trade liberalization was to be carried on in three steps:

1. the abolition of all 'special regimes' for imports;

[4] The Mercosul agreement established a customs union between Brazil, Argentina, Uruguay and Paraguay. It was signed in 1991, and determined that tari¤s among member countries would be eliminated by 1995, and common external tari¤s would be gradually implemented, with all exceptions eliminated by 2006.

2. the abolition of all quantitative restrictions and their replacement by tari¤s;

3. the lowering of tari¤s, according to a preannounced schedule to be carried on in 4 years. By the end of the liberalization process in 1995, all tari¤s would lie in the range 0-40%, averaging 20%.

Trade liberalization was even deeper than planned. However, after the 1994 Mexican crisis, there was a partial reversal of the process. Some quantitative import restrictions were temporarily re-introduced, and some tari¤s raised. Nonetheless, the average tari¤ level was below 14% by November 1995. The bulk of trade liberalization occurred from 1988 to 1995, with minor tari¤ changes since then.

Figure 7 shows that tari¤ changes from 1988 to 1995 seem to have declined slightly more in skill-intensive sectors, although not signi…cantly, as will be further investigated in the regression analysis in the next section. Brazilian tari¤ pattern contrasts with what was observed in Mexico. Hanson and Harrison (1999) and Robertson (2001) show that Mexican tari¤s were relatively lower in skill-intensive sectors before trade liberalization, and decreased less in those sectors.

5 Empirical results

Our empirical methodology consists of separately testing each step of the trade transmission mechanism described in Section 2. The strategy is to perform consistency checks on the causality path predicted by theory.

5.1 Prices and tari¤s

In this sub-section we test the …rst step of the empirical methodology, that is, if there is a positive correlation between price and tari¤ changes.

From equation (1), we can relate domestic prices changes to changes in trade barriers and in international prices as follows:

$$¢ \log p_i = ¢ \log (1 + t_i) + ¢ \log e + ¢ \log p_i^{¤}. \quad (4)$$

Since the nominal exchange rate is the same for every sector, and data on rents generated by other trade barriers is unavailable, the equation to be estimated takes the following form:

$$¢ \log p_i = ®_0 + ®_1 ¢ \log (1 + ¿_i) + ®_2 ¢ \log p_i^{¤} + "_i \quad (5)$$

where $¿_i$ is the import tari¤ for sector i. Changes in the nominal exchange rate are a component of the constant term, $®_0$; whereas changes in the rents generated by other trade barriers are captured by the error term, $"_i$. The expected values for parameters $®_1$ and $®_2$ are 1, under perfect competition and when goods are perfect substitutes.

Equation (5) is estimated using a panel of yearly observations from 1988 to 1995, for a sample of 60 sectors. The …rst column of Table 3 presents the estimation results when the change in tari¤s is the only explanatory variable, while the second column includes US price changes[5]. The estimated tari¤ change coe¢cient is positive and signi…cantly di¤erent from zero in both regressions. Moreover, one cannot reject that the coe¢cient is equal to one. However, the US price changes coe¢cient is not signi…cantly di¤erent from zero.

[5] US price data are from the Bureau of Labor Statistics website. The number of sectors used in the second column regression is smaller to make sectors compatible with US data.

Table 3 - Prices and Tari¤s - 1988-95

Dependent Variable: Change in Prices		
	(1)	(2)
Change in Tari¤s	0.702	0.639
	(0.209)	(0.223)
Change in US Prices	_	0.041
		(0.105)
N	420	350
R^2	0.99	0.99

Notes: Weighted Least Squares Regressions (weights are the sector shares in total production).Time Dummies are included in all regressions. Robust standard errors are in parentheses.

As already suggested in section 3, these results con…rm that sectoral prices and tari¤s move together for most of the period. It should be noticed that there were signi…cant changes in non-tari¤ trade barriers between 1988 and 1990, which could have distorted the actual link between prices and tari¤s.

5.2 Prices, tari¤s and skill intensity

The second step in our empirical methodology is performed in this sub-section. It consists of examining the correlation between prices (and tari¤s) changes and skill intensity. This is accomplished by estimating the following equation:

$$¢ \log x_{it} = \bar{}_0 + \bar{}_1 \log \left(\frac{L^S}{L^U + L^S} \right)_{i;t\,¡\,1} + \acute{}_{it}, \qquad (6)$$

where x_i stands for prices or tari¤s in sector i, and $\left(\frac{L^S}{L^U + L^S} \right)_{i;t\,¡\,1}$ is the share of skilled labor employed in sector i. According to the discussion in section 2, theory predicts a negative value for $\bar{}_1$.

Two alternative skill measures are used: education attainment and proportion of white-collar workers. Most studies use white-collar workers proportion as the measure for skilled labor share, due to unavailability of data on education in many countries. Obviously, both measures do not perfectly re‡ect skill intensity, which is an unobservable variable. Education attainment fails to re‡ect skill intensity when, for instance, a highly educated worker is performing a task that does not require skill. On the other hand, not all white-collar workers tasks require skill, and some blue-collar workers can have highly skill demanding assignments. Nonetheless, we believe that education attainment is a more appropriate measure of skill intensity.

Three regressions are estimated for each dependent variable: the …rst one uses education attainment to de…ne skill; the second uses the white-collar/blue-collar classi…cation; and the third uses education share, controlling for the interaction between the two skill measures.[6]

Table 4 presents equation (6) estimation results for both price and tari¤ changes used as dependent variable. The panel regressions with …xed e¤ects are estimated for the sample of 60 sectors, from 1988 to 1995. The price change regressions are in the …rst three columns. The results are sensitive to skill measure choice. When education is used to de…ne skill, the coe¢cient is negative and signi…cant, as expected by theory. For the white-collar workers measure, coe¢cients are not signi…cantly di¤erent from zero. Finally, when the interaction term is used, the education share coe¢cient is still signi…cant and negative, and the interaction term parameter is signi…cant and positive. Since both skill measures are

[6] Data on white-collar and blue-collar workers, at the <agregação> level, come from the industrial surveys (Pesquisa Industrial Anual - PIA), conducted by IBGE.

constrained to be less than one by definition, the overall effect of increasing the proportion of educated labor on price changes is negative for any given level of white-collar workers proportion.

Table 4 - Prices, Tariffs and Skill Intensity: 1988-95

	Dependent Variable					
Skilled-Labor Share	Change in Prices			Change in Tariffs		
	(1)	(2)	(3)	(4)	(5)	(6)
Education Share	-0.038	_	-0.111	-0.004	_	-0.009
	(0.015)		(0.033)	(0.005)		(0.015)
White-Collar Share	_	0.005	_	_	-0.001	_
		(0.019)			(0.006)	
Education X White-Collar Share	_	_	0.048	_	_	0.005
			(0.022)			(0.009)
N	420	420	420	420	420	420
R^2	0.99	0.99	0.99	0.19	0.19	0.20

Notes: Weighted Least Squares Regressions (weights are the sector shares in total production). Time Dummies are included in all regressions. Robust standard errors are in parentheses.

Hence, on average, prices increased more in sectors that use unskilled labor intensively. As discussed in section 2, this is consistent with the observed decrease of skilled/unskilled wage differential, no matter whether trade or labor supply changes were responsible for the wage changes. Were trade the main cause of relative wage changes, the liberalization pattern should also be negatively correlated with skill intensity, that is, sectors that use skilled labor more intensively should have suffered deeper liberalization.

The next three columns of Table 4 present the results of tariff change regressions. Both skill intensity measures coefficients are not significantly different from zero in all specifications. Therefore, although prices and tariffs movements are correlated, as seen in the previous sub-section, no consistent relation was observed between tariff changes and skill intensity in Brazil. There are three possibilities:

1. price changes were not caused by trade,
2. price changes were caused by tariffs, but not captured here due to different pass-through coefficients among sectors,
3. trade was responsible for the price changes, but tariffs are a poor measure of trade policy changes due to non-tariff trade barriers.

5.3 Employment, production and skill intensity

This sub-section presents the results of the analysis of the third step of our empirical methodology. As discussed in section 2, this is a crucial step to identify the relevance of trade liberalization on explaining wage inequality recent changes in Brazil. It consists of testing whether there is a negative correlation between employment changes and skill intensity.

This is achieved by estimating the following equation:

$$\Delta \log y_i = \gamma_0 + \gamma_1 \log \left(\frac{L^S}{L^U + L^S} \right)_i + \varepsilon_i, \qquad (7)$$

where y_i denotes employment in sector i. For trade to be essential to explain observed relative wage movements, $°_1$ must be negative.

Three regressions are estimated: the …rst one uses education attainment to de…ne skill; the second uses the white-collar/blue-collar classi…cation; and the third uses education share, controlling for the interaction between the two skill measures.

Table 5 shows the results for a panel estimation for both employment and production changes used as dependent variables. The employment change regressions are in the …rst three columns. The results are sensitive to the choice of skill measure. When education is used to de…ne skill, the coe¢cient is negative and signi…cant. This is compatible with trade being the most relevant factor driving the wage di¤erentials. For the white-collar/blue-collar workers measure, coe¢cients are not signi…cantly di¤erent from zero. Finally, the education share coe¢cient is still signi…cant and negative when controlling for the interaction term, which is found to be signi…cant and positive. The overall e¤ect of increasing the proportion of educated labor on employment changes is negative for any given level of white-collar workers proportion.

The production change regressions are in the last three columns. When only one skill intensity measure is used, coe¢cients are not signi…cantly di¤erent from zero. However, the education share coe¢cient is signi…cant and negative when controlling for the interaction term, which is found to be signi…cant and positive. The overall e¤ect of increasing the proportion of educated labor on production changes is negative for any given level of white-collar workers proportion.

Table 5 - Employment, Production and Skill Intensity: 1988-95

	Dependent Variable					
Skilled-Labor Share	Change in Employment			Change in Production		
	(1)	(2)	(3)	(4)	(5)	(6)
Education Share	-0.016	_	-0.073	0.021	_	-0.098
	(0.008)		(0.018)	(0.023)		(0.044)
White-Collar Share	_	0.014	_	_	0.065	_
		(0.010)			(0.032)	
Education X White-Collar Share	_	_	0.038	_	_	0.079
			(0.011)			(0.033)
N	420	420	420	420	420	420
R^2	0.10	0.10	0.13	0.89	0.89	0.89

Notes: Weighted Least Squares Regressions (weights are the sector shares in total production). Time Dummies are included in all regressions. Robust standard errors are in parentheses.

6 Concluding remarks

Since trade liberalization started in 1988, Brazilian economy has experienced a reduction in the ratio of skilled to unskilled labor earnings. In this paper we examined the role of trade liberalization on explaining wage inequality changes by performing empirical consistency checks on the causality path predicted by theory.

We provide evidence that:

1. tari¤s and prices are positively correlated;

2. prices changes and skill intensity are negatively correlated;

3. employment and production changes are negatively correlated with skill intensity.

These results are compatible with trade liberalization playing a role in explaining the reduction of wage inequality in Brazil between 1988 and 1995. Note that the third result dismisses the possibility that labor supply changes alone were responsible for the observed drop in wage inequality.

Although prices and tari¤s changes are correlated, we found no evidence that tari¤s fall was deeper in skill intensive sectors. This may be explained by a combination of factors. First, the Brazilian economy had several non-tari¤ barriers, which were removed from 1988 to 1990. Tari¤ changes during that time may not be a good measure of trade liberalization. Second, the pass-through coe¢cient from tari¤s to prices may di¤er across sectors. If that is the case, it is possible that the observed price change was indeed caused by trade liberalization, even though the pattern of tari¤ reduction was not clearly linked to skill intensity. This issue requires further investigation.

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Figure 1- Supply of Education over Time

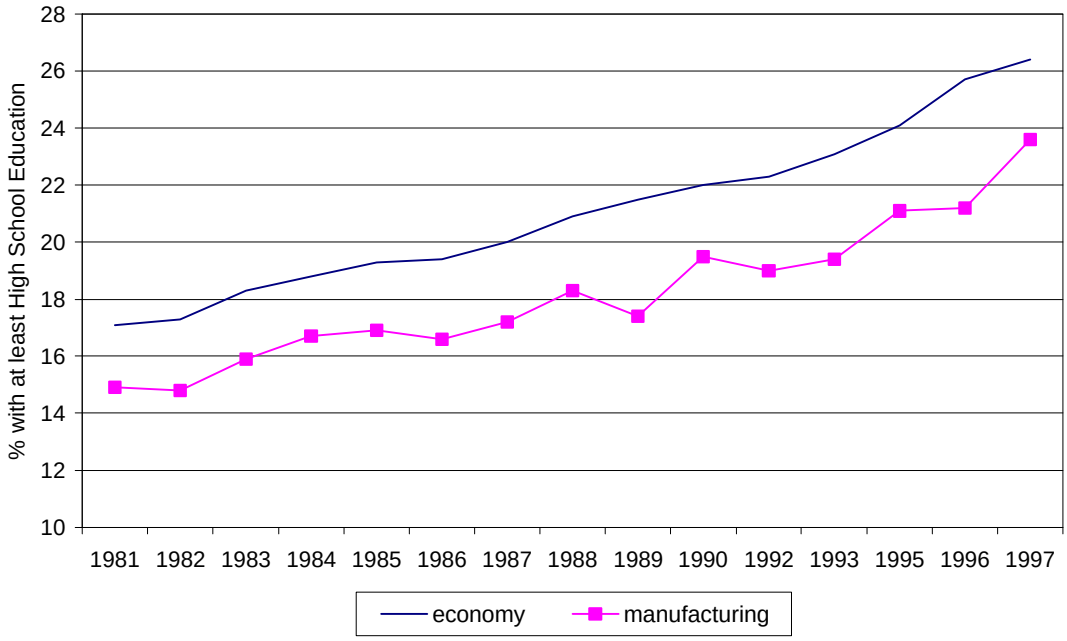

Figure 2 - Education Wage Differentials Over Time

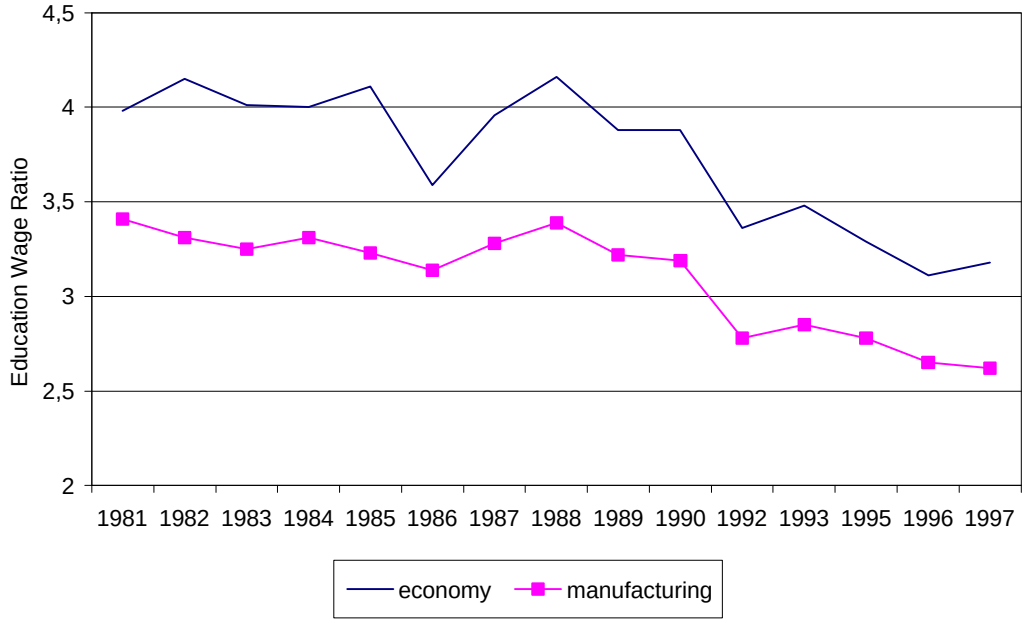

Fig.3 Output and Employment: SKill Intensive Sectors Shares

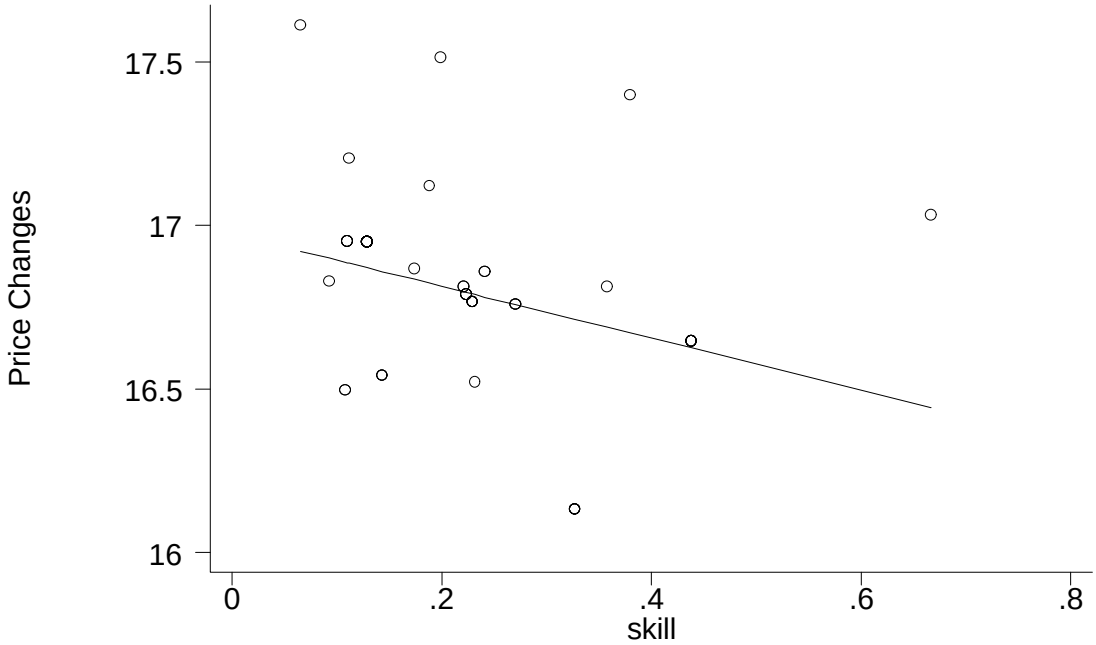

Fig.4 Price Changes by Skill Intensity: 1995-1988

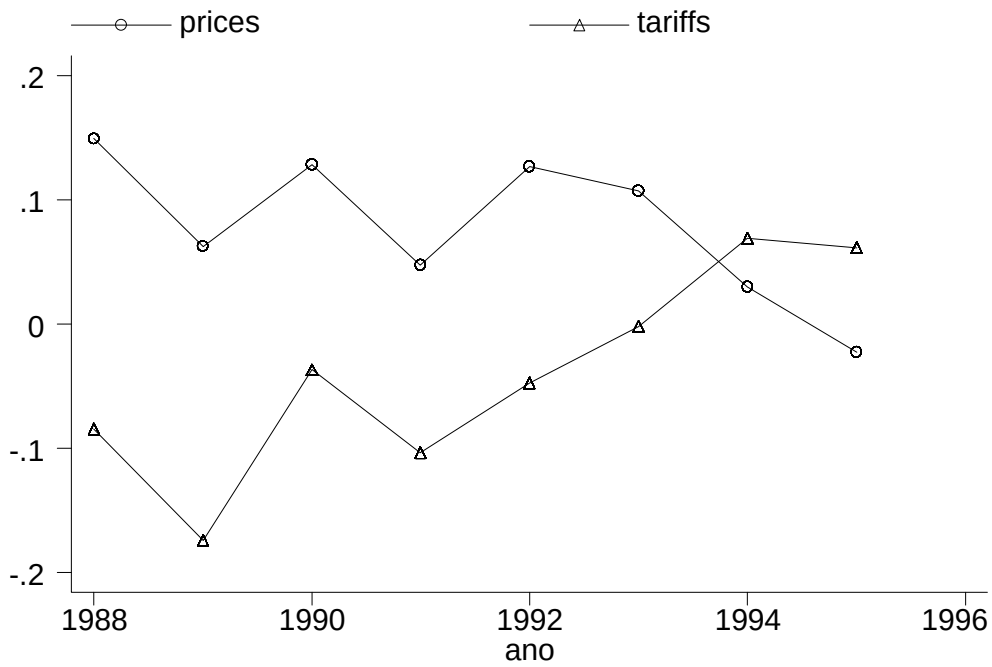

Fig.5 Skill-Intensive Sectors Relative Prices and Tariffs

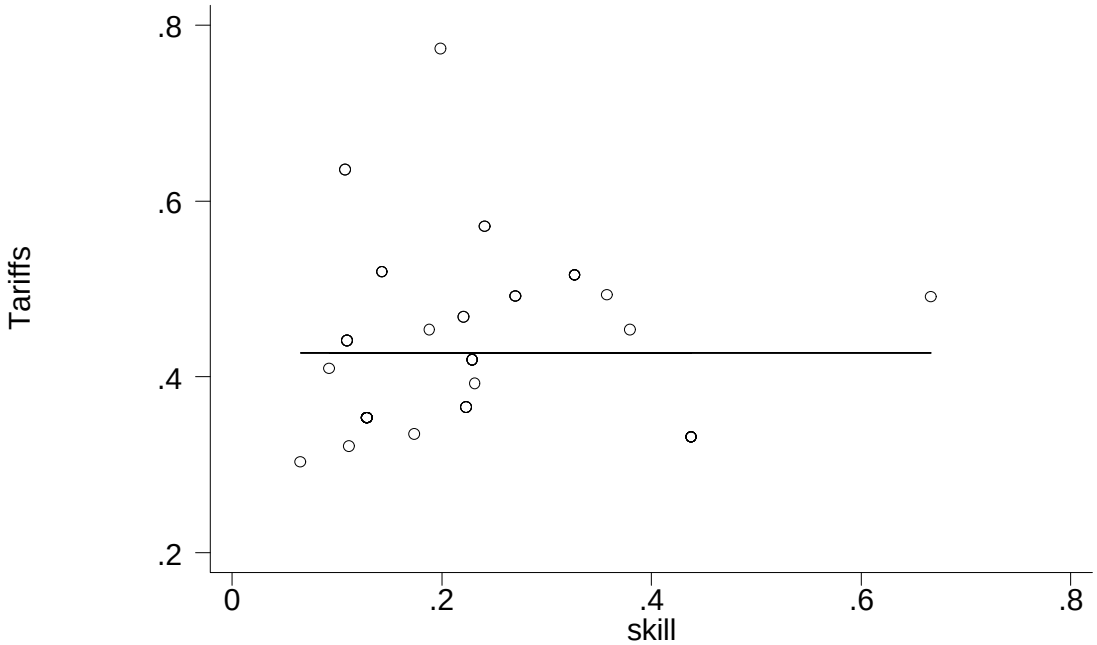

Fig.6 Tariffs by Skill Intensity: 1988

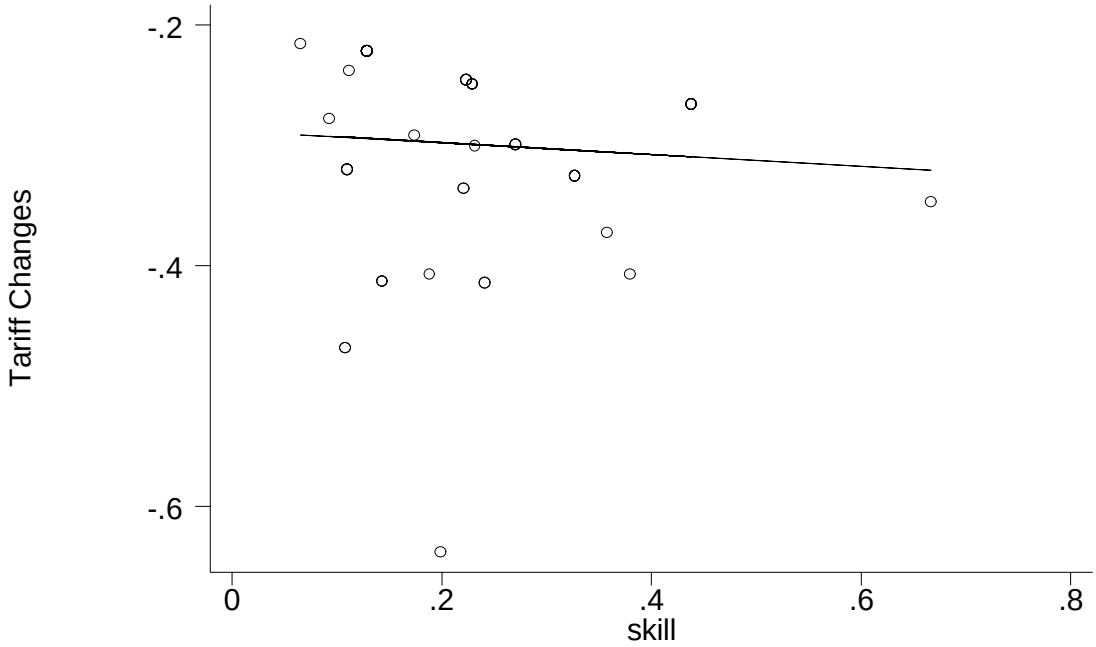

Fig.7 Tariff Changes by Skill Intensity: 1995-1988