

# **International Trade Competition, Market Power, and Gender Wage Differentials in India's Manufacturing Sector\***

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**Abstract:** This study addresses the question of how increasing competitive forces from India's trade liberalization have affected the wages of male and female workers. Neoclassical theory implies that costly discrimination against female workers should diminish over time with increased competition (Becker 1971). We incorporate this idea into a theoretical model of competition and industry concentration in which the net effect of international trade on the gender wage gap could be positive or negative depending on changes in market parameters and the discrimination coefficient. Our study tests the theoretical model using repeated cross sections of India's NSSO household survey data merged with trade and production data from 1983 to 2004. We employ OLS and Fixed Effects techniques at the industry level to estimate the relationship between the male-female residual wage gap and measures of domestic concentration and international trade competition. Results indicate that increasing openness to trade is associated with a widening in the wage gap in India's concentrated manufacturing industries.

**Keywords:** Trade liberalization, Gender wage gaps, India, Discrimination

**JEL Codes:** F14, J16, J31, O12

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## **Introduction**

Precipitated by a balance of payments crisis, India has adopted several waves of far-reaching trade reforms since 1991. The reforms have included sharp reductions in the number of goods subject to licensing and other non-tariff barriers, reductions in export restrictions, and tariff cuts across all industries. Trade liberalization has resulted in higher levels of competition within the Indian economy, as measured by reductions in price markups over marginal cost (Krishna and Mitra 1998). This change raises an interesting question as to how the new wave of competitive forces and the growing pressure for employers to cut costs have affected the wages of male and female workers in India's manufacturing sector. With less government protection and with increased exposure to competition from abroad, employment and pay patterns in manufacturing changed markedly following the liberalization. Yet manufacturing industries experienced quite a bit of variation in the timing and extent of tariff cuts during and after the 1991 reforms. These differential rates in trade liberalization across industries provide an excellent opportunity for examining the impact of increasing exposure to international trade on gender wage differentials.

Neoclassical theory of labor market discrimination implies that increased competition from international trade will reduce the wage gap. In a market economy where discrimination is costly, employers are less able to indulge their tastes for discrimination as competitive forces drive down profit margins (Becker 1971). We incorporate this idea into a theoretical model of competition and industry concentration in which the net impact of international trade on the gender wage gap could be positive or negative depending on changes in market parameters and the discrimination coefficient. Our theoretical model introduces elements of discriminatory firm behavior into a competitive market framework to show that the implied neoclassical outcome of

a reduction in the wage gap does not necessarily hold. We then test the theory by estimating the impact of the trade reforms on gender wage differentials using five cross sections of household survey data from the National Sample Survey Organization between 1983 and 2004. We aggregate these data to the industry level and merge the data with several other industry-level data sets for international trade, output, and industry structure. The empirics examine the relationship between the male-female wage gap and variations across industry and time in the exposure to competition from international trade, while controlling for changes in worker characteristics and domestic concentration. Our identification strategy centers on comparing India's more-concentrated manufacturing industries, where firms enjoyed rents and could indulge in their taste for discrimination, with India's less-concentrated manufacturing industries, where firms experienced greater domestic competition and were less able to discriminate.

The impact of increased competitiveness from international trade on women's relative pay remains an empirical issue. Relatively few studies have gone beyond descriptive analyses of changes in women's relative wages in periods of increasing trade openness and growing competition. The limited number of studies that do employ econometric techniques to identify the impact of competition and international trade on gender wage gaps have found conflicting results. In particular, Hellerstein, Neumark, and Troske (2002), find little evidence that more discriminatory employers with market power are punished over time through buy-outs or lower growth. Berik *et al.* (2004) find evidence that increasing trade openness is associated with higher residual wage gaps between men and women in two East Asian economies, a sign the authors interpret as increased wage discrimination.<sup>1</sup> Yet Black and Brainerd (2004) reach the opposite conclusion for the United States: relatively concentrated manufacturing industries that were exposed to more competition from imports experienced shrinking residual wage gaps. Similarly

in Mexico, trade-induced competition in product markets is associated with lower gender earnings differentials (Hazarika and Otero (2004)). Cross-country studies have found mixed evidence. Using data for more than 80 lower- and higher-income economies, Oostendorp (2004) shows that increased trade is associated with reduced wage gaps. However, the opposite result is obtained in the case of skilled workers in lower-income economies.

With our focus on India's extensive trade policy reforms, this study also contributes to a lively debate in the literature on the net social benefits of India's trade liberalization. For example, evidence from a difference-in-difference approach in Topalova (2005) indicates that in districts that were more exposed to trade liberalization, both the incidence and depth of poverty decreased by less than the reductions observed in other districts that had fewer industries exposed to trade liberalization. India's trade liberalization also appears to have had negative impacts on child well-being. Findings in Edmonds *et al.* (2005) suggest that adjustment costs associated with trade liberalization were responsible for smaller declines in child labor and smaller improvements in school attendance in districts exposed to tariff cuts, compared to districts less exposed to the tariff reductions.<sup>2</sup> Trade liberalization also had differential effects on male and female employment in India. According to Bhaumik (2003), the growth in the workforce share classified as casual accelerated after 1993 as a result of the economic liberalization policies, with larger increases for female workers compared to their male counterparts in both rural and urban areas. Furthermore, disparities in the material standard of living have persisted among Indian women of different castes during the early years of economic liberalization, despite improvements in educational attainment (Deshpande 2007). However not all studies have found negative social impacts for India. In particular, Mishra and Kumar (2005) argue that higher wage premiums in sectors that disproportionately employ unskilled workers led

to an increase in their relative income and a decline in overall wage inequality. Moreover, rapid economic growth in the 1990s following India's liberalization is associated with improvements in short-term and longer-term indicators of children's nutritional status, especially for boys (Tarozzi and Mahajan 2007). Adding to this debate, we ask how the competitive market forces associated with India's trade policy reforms may have affected discriminatory pay practices in the manufacturing sector.

### **Theoretical Model: Trade Competition, Market Power, and Discrimination**

In Becker's (1971) classic work on discrimination, employers have a "taste" for discrimination and require a premium in order to interact with individuals belonging to a certain group, such as women or minorities. Members of this group will then earn a lower wage. By implication, wage differentials cannot persist in a competitive market environment; in the long run, discriminatory employers can no longer afford to indulge their taste for discrimination and will be driven out of the market. This hypothesis can be restated in an open economy context, whereby firms operating in industries that face international competition will experience greater pressure to cut costs, including costs associated with discrimination. In the longer term, discrimination is then expected to lessen in industries that are more open to trade. One can hypothesize that firms in concentrated industries face less competition from other domestic firms, and therefore experience less domestic pressure to cut costs (Borjas and Ramey 1995). If discrimination is costly, then we would expect any observed reduction in wage discrimination against female workers in concentrated industries to be caused by the competitive forces from international trade and not from other domestic firms (Black and Brainerd 2004).

In the exposition that follows, Borjas and Ramey (1995) is used as the foundation to obtain an expression for equilibrium wages received by workers employed in the concentrated

sector. By building on Becker's (1971) "taste for discrimination" parameter, we then model the distribution of equilibrium wages for male and female employees in the concentrated sector to derive an expression for the gender wage differential. It is shown that although an increase in trade still has a mitigating effect on the gender wage gap, under certain conditions, the net effect may be a widening of the wage gap between male and female workers. This widening would be consistent with some non-neoclassical arguments in which female workers may have lower bargaining power and are segregated into lower-paying, lower-status jobs.<sup>3</sup> The model developed below combines the effects from changes in market parameters, wage bargaining, and firm behavior to demonstrate that the dynamic implications from Becker's model of diminishing discrimination with increased competition does not necessarily hold.

Following Borjas and Ramey (1995), the domestic economy consists of two sectors, the competitive sector (sector 0) and the concentrated sector (sector 1). The competitive sector produces a consumption good  $y_0$ , and the concentrated sector produces a consumption good  $y_1$ . In other sections of our study, we refer to the competitive sector as the less-concentrated sector. Development of the competitive sector follows Borjas and Ramey (1995) and is not discussed in detail here. Similar to their formulation of the concentrated sector, sector 1 in our study is composed of  $n$  firms, each of whom behaves as a Cournot oligopolist. We begin by considering an inverse demand curve that relates price of good  $y_1$  relative to price of  $y_0(p_1)$  to the total demand for good  $y_1$ .<sup>4</sup> This inverse demand curve is

$$p_1 = \beta_0 - \beta_1 y_1 \quad \beta_0, \beta_1 > 0 \quad (1)$$

Total output of the concentrated sector in the domestic economy ( $y_1$ ) is composed of the sum of the output of firm  $i$ ,  $y_{1i}$ , the output of the other  $(n-1)$  firms each of whom produces  $y_1'$ ,

and  $v$ , which is the volume of net trade in good 1. We assume that  $v$  is exogenous. Re-writing equation (1), the inverse demand curve now is

$$p_1 = \beta_0 - \beta_1(y_{1i} + (n-1)y_1' + v) \quad (2)$$

Suppose that  $L_{1i}$  is the total number of workers employed by firm  $i$  in the concentrated sector. Using a similar production function as in Borjas and Ramey (1995), assume that the production of  $y_{1i}$  is directly proportional to  $L_{1i}$ . Also assume that firm  $i$  and a union with which it is associated jointly maximize rents in a Nash bargaining framework, and that the union receives a proportion  $\lambda$  of the equilibrium level of rents to distribute among workers. Where  $\omega_0$  is the wage in the competitive sector (we assume that there is no differential between male and female wages in the competitive sector), expression for rents for firm  $i$  is given by

$$p_1 y_{1i} - \omega_0 L_{1i} \quad (3)$$

Maximizing equation (3) with respect to the optimal level of production of  $y_{1i}$ , we can show that in a symmetric equilibrium,<sup>5</sup>

$$y_{1i}^* = \frac{\beta_0 - \omega_0 - \beta_1 v}{\beta_1(n+1)} \quad (4)$$

Given the rent maximizing level of output in equation (4), we can derive an expression for the equilibrium rents of firm  $i$  and its workers using equation (3). This is as below

$$\text{Rents}_i^* = \frac{(\beta_0 - \omega_0 - \beta_1 v)^2}{\beta_1(n+1)^2} \quad (5)$$

Using equation (5) and the fact that rents to the workforce in the concentrated sector equals  $\lambda$  proportion of equilibrium rents (that is,  $(\omega_1 - \omega_0)L_{1i} = \lambda \text{Rents}_i^*$ ), equilibrium wages for workers in the concentrated sector  $\omega_1^*$  is

$$\omega_1^* = \omega_0 + \lambda \frac{(\beta_0 - \omega_0 - \beta_1 v)}{(n+1)} \quad (6)$$

Equation (6) has two important features. First, wages in the concentrated sector differ from wages in the competitive sector by a mark-up which is often positive. This is consistent with the five years of NSSO data that we consider. Second, since average real wages in the concentrated sector are higher, women may still want to be employed in this sector despite receiving relatively lower pay.

Next, we depart from Borjas and Ramey (1995) and model the distribution of wages between male and female workers in the concentrated sector. To derive a measure for the gender wage gap in this sector, we postulate that the equilibrium wage in equation (6) is the average of the wages paid to male and female workers. Following Becker (1971), assume that male and female workers are substitutes in production, but each firm has a “taste for discrimination” against female workers. Using Becker’s idea that the firm must be willing to pay to indulge its taste for discrimination, this means that male workers are employed by firm  $i$  at a relatively higher wage. Where  $\omega_1^m$  represents wages to males in the concentrated sector and  $\omega_1^f$  represents wages to females in this sector, men get  $\gamma \lambda \text{Rents}_i^*$  and women get  $(1-\gamma) \lambda \text{Rents}_i^*$ ;  $\gamma > 0.5$  (men get a larger share of the rents to the workforce in the concentrated sector).<sup>6</sup> Then,

$$\frac{\omega_1^m}{\omega_1^f} = \frac{\gamma}{(1-\gamma)} > 1 \quad (7)$$

We can re-write equation (6) to be:

$$\omega_1^* = \omega_0 + \lambda \sqrt{\beta_1} \sqrt{R_i^*} \quad (8)$$

where  $R_i^* = \text{Rents}_i^*$ . Since equilibrium wage in equation (8) is the average of wages paid to male and female workers, it must be true that:

$$2(\omega_0 + \lambda\sqrt{\beta_1}\sqrt{R_i^*}) = \omega_1^m + \omega_1^f \quad (9)$$

From equations (7) and (9), we can derive an expression for equilibrium female wages in the concentrated sector. This expression is:

$$\omega_1^{f*} = 2(\omega_0 + \lambda\sqrt{\beta_1}\sqrt{R_i^*})(1-\gamma) \quad (10)$$

Given equation (7), equation (10) implies that the equilibrium male wage in the concentrated sector is:

$$\omega_1^{m*} = 2(\omega_0 + \lambda\sqrt{\beta_1}\sqrt{R_i^*})(\gamma) \quad (11)$$

The derivation of equilibrium wages in the concentrated sector has been done using  $\gamma$ , a measure of the unequal distribution of rents to male and female workers. In what follows, we recast this derivation in terms of the discrimination coefficient  $d$ , which can vary between zero and positive infinity. Then the relation between male and female wages in the concentrated sector is  $\omega_1^{m*} = \omega_1^{f*} (1+d)$ .

The ratio of male and female wages using Becker's  $d$  and equation (7) implies that  $(1+d) = \frac{\gamma}{(1-\gamma)}$ , which in turn means that  $\gamma = \frac{(1+d)}{(2+d)}$ . Substituting this into equation (11) implies that:

$$\omega_1^{m*} = 2(\omega_0 + \lambda\sqrt{\beta_1}\sqrt{R_i^*}) \frac{(1+d)}{(2+d)} = \frac{2(1+d)}{(2+d)} \omega_1^* \quad (12)$$

Similarly from equation (10),

$$\omega_1^{f*} = 2(\omega_0 + \lambda\sqrt{\beta_1}\sqrt{R_i^*}) \frac{1}{(2+d)} = \frac{2}{(2+d)} \omega_1^* \quad (13)$$

From equations (12) and (13), it is straightforward to see that if  $d = 0$  (no discrimination), male and female workers get an equal share of equilibrium rents. If  $d > 0$ , male workers receive a larger share of equilibrium rents.

We conclude our theory by defining  $\psi$ , the difference between male and female wages in the concentrated sector. The innovation is to demonstrate that although an increase in trade has a negative effect on the gender wage gap, changes in the taste for discrimination parameter  $d$  can be such that the *net* effect on the male-female wage gap may be positive. This is done by using equations (12) and (13) to show that

$$\psi = \frac{2d}{(2+d)} \left( \omega_0 + \lambda \frac{(\beta_0 - \omega_0 - \beta_1 v)}{n+1} \right) = \frac{2d}{(2+d)} \omega_1^* \quad (14)$$

So  $\psi$ , the gender wage differential in the concentrated sector, is a function of the discrimination coefficient  $d$  and the equilibrium real wage  $\omega_1^*$ . To study net effects (on  $\psi$ ), we are interested in the following partial derivatives of equation (14):

$$\frac{\partial \psi}{\partial v} = -\frac{2d\lambda\beta_1}{(2+d)(n+1)} < 0 \quad (15)$$

and

$$\frac{\partial \psi}{\partial d} = \frac{4}{(2+d)^2} \left( \omega_0 + \lambda \frac{(\beta_0 - \omega_0 - \beta_1 v)}{n+1} \right) > 0 \quad (16)$$

Equation (15) states that as the volume of trade increases, the gender wage differential will decrease. However, the partial derivative in equation (16) demonstrates that the gender wage differential will increase with an increase in the “taste for discrimination” parameter  $d$ . With changes in  $v$  and  $d$ , the net effect on the gender wage gap  $\psi$ , which is the sum of the effects in equations (15) and (16), is ambiguous. This net effect depends on which change, the expression in (15) or (16), outweighs the other.

What may cause  $d$  to change? In order to address this question, we use the expression for equilibrium male wages in the concentrated sector to endogenize  $d$  and study its determinants. We know from equation (12) that  $\omega_1^{m*} = 2(\omega_0 + \lambda\sqrt{\beta_1}\sqrt{R_i^*})\frac{(1+d)}{(2+d)}$ . Solving for  $d$  from this expression gives:

$$d = \frac{2\omega_0 + 2\lambda\frac{(\beta_0 - \omega_0 - \beta_1 v)}{(n+1)} - 2\omega_1^{m*}}{\omega_1^{m*} - 2\omega_0 - 2\lambda\frac{(\beta_0 - \omega_0 - \beta_1 v)}{(n+1)}} \quad (17)$$

From equation (17),

$$\frac{\partial d}{\partial v} = \frac{\omega_1^{m*}}{[\omega_1^{m*} - 2\omega_0 - 2\lambda\frac{(\beta_0 - \omega_0 - \beta_1 v)}{(n+1)}]^2} \frac{(2\lambda\beta_1)}{(n+1)} \quad (18)$$

Since  $\omega_1^{m*}, \lambda, \beta_1, n$  are positive parameters, it is clear that  $\frac{\partial d}{\partial v} > 0$ . That is, increased trade leads to an increase in the taste for discrimination parameter. This prediction is consistent with the theoretical model developed in Rosen (2003). Rosen extends the Becker argument in a framework that includes search frictions in the labor market as well as wages set by bargaining. The discrimination coefficient is a firm-specific disutility associated with hiring female workers, and this coefficient affects firm profits through wages and hiring. Although discriminatory firms employ male and female workers, firms with high discrimination coefficients are more selective in their hiring decisions for female workers than male workers, causing them to hire fewer than the optimal number of female workers. At the same time, discriminatory firms pay their female workers relatively low wages, which contributes to a total wage bill that is less than the wage bill of non-discriminatory firms. Because the positive profit impact from a lower wage bill dominates the negative profit impact from the suboptimal hiring decisions, discriminatory firms are more

profitable. In this framework, competitive market forces drive out non-discriminatory firms instead of discriminatory firms. Placing our study in the context of Rosen (2003), the discrimination coefficient across firms may rise with international trade since firms with lower  $d$  are less profitable and so exit the market. Remaining in the market are more discriminatory firms who, through the bargaining process, protect male workers at the expense of female workers with relatively high wage payments and more favorable employment decisions. The theoretical implications of this model are tested in the empirics that follow.

### **Data Description**

To explore the labor market impacts of trade policy reforms, we use five cross sections of household survey data collected by the National Sample Survey Organization (NSSO). The data include the years 1983 (38<sup>th</sup> round), 1987-1988 (43<sup>rd</sup> round), 1993-1994 (50<sup>th</sup> round), 1999-2000 (55<sup>th</sup> round), and 2004 (60<sup>th</sup> round), providing us with data coverage before, during, and after the trade liberalization. For each round, we utilize the Employment and Unemployment module - Household Schedule 10. To construct our labor force sample, we retain all regular wage employees of prime working age (ages 15-60) with positive weekly cash wages in the manufacturing sector.<sup>7</sup> All employment and wage variables are aggregated to the industry level using India's National Industrial Classification (NIC) system, which is based on international standards. The two earlier rounds of NSSO data use the 1970 NIC codes, the 50<sup>th</sup> round uses the 1987 NIC codes, and the two later rounds of NSSO data use the 1998 NIC codes. There are major differences at all levels of disaggregation beyond the one-digit level between these NIC codes; these are incorporated in our empirical analysis.

Data on export and import values across manufacturing industries, from 1980 to 2004, are constructed using the World Bank's Trade, Production and Protection Database (Nicita and

Olarreaga 2006). We construct three measures of industry-level trade openness: exports/output, imports/output, and (exports+imports)/output. The data source also has information on tariff rates against which we compare the measures of trade openness. Although both tariff rates and trade shares are appropriate for an empirical test that focuses on industry-level competition, the empirical analysis focuses mostly on trade shares because the tariff data are plagued with missing values. Data on output across manufacturing industries are obtained from India's Annual Survey of Industries (ASI).<sup>8</sup> Because the domestic output data are in rupees and the trade series are in dollars, we use average annual rupee/US\$ exchange rates to convert output into dollars. The ASI data are used to construct an index of domestic concentration across manufacturing industries. This index is based on the number of enterprises relative to output, by industry. All our data sources are summarized in Appendix Table 1. As with the household data, various years of ASI data are classified according to different versions of India's NIC classification system: the 1970 NIC codes are used up to and including ASI 1988-89, the 1987 NIC codes are used from ASI 1989-90 through ASI 1997-98, the 1998 NIC codes are used from ASI 1998-99 through ASI 2003-04, and the 2004 NIC codes are used for ASI 2004-05.

Because tests of the theoretical model are conducted at the industry level, all data series are aggregated to the same sets of industries using consistent industry codes. We adopted the same categorization as the World Bank Trade, Production and Protection series, which uses the ISIC (revision 2) classification at the three digit level and contains 28 industry categories per year. The NSSO labor data and the ASI production data are converted to this classification scheme using the concordance schedule we created based on information in Sivadasan and Slemrod (2006) and Central Statistical Organization (1970, 1987, 1998, 2004). The concordance schedule is reported in Appendix Table 2. To the best of our knowledge, this table is the only

published source for concordance matching between the ISIC classification and four waves of NIC classifications, from 1970 to 2004.

### **Descriptive Analysis: Trade Liberalization and Gender Wage Differentials**

Like many developing countries in the post-WWII era, India based its economic development and trade policies on an import substitution strategy. The country had some of the highest tariff rates and most restrictive non-tariff barriers in the region (Krishna and Mitra 1998, Topalova 2005). Yet in 1990 and early 1991, a series of external, political, and macroeconomic shocks—including an oil price hike spurred by the Gulf War, a reduction in remittances from Indians employed in the Middle East, a shake-up in investor confidence following the assassination of Rajiv Gandhi, and growing fiscal and trade deficits—precipitated a financial crisis (Edmonds *et al.* 2005). The Indian government requested stand-by assistance from the International Monetary Fund in August 1991, and in return, agreed to what had become a fairly standard policy prescription of stabilization and structural adjustment policies. The government aimed to reduce tariff levels on a wide range of imported products, lower the variation across sectors in tariff rates, simplify the tariff structure, and remove many of the exemptions (Krishna and Mitra 1998, Topalova 2005). Several new waves of reforms occurred in 1994 and 1997, with a slowdown in the pace of trade liberalization after 1997 as pressures from international agencies and creditors subsided.

Manufacturing industries across the board experienced some degree of tariff reductions during and after the initial sweeping 1991 reform package, and India's imports and exports grew dramatically as a result. Figure 1, which reports trends in exports and imports as a share of production, shows that both the aggregate export share and import share jumped sharply after 1991 and continued to rise steadily until the late 1990s. With a slowing in the pace of trade

liberalization, the growth in trade ratios eased during the early 2000s, especially for imports. Superimposed onto this diagram are residual wage gaps found by the Oaxaca-Blinder decomposition procedure with results suggesting that in the midst of India's comprehensive trade liberalization, the residual wage gap between men and women increased.

The Oaxaca-Blinder procedure helps to understand the extent to which the overall wage gap can be explained by observed productivity characteristics between men and women (Oaxaca 1973; Blinder 1973). This procedure decomposes the wage gap in a particular year into a portion explained by average group differences in productivity characteristics and a residual portion that is commonly attributed to discrimination. For a given cross-section, one decomposes the gender wage gap by expressing the natural logarithm of real wages ( $w$ ) for male workers ( $i=m$ ) and female workers ( $i=f$ ) as follows:

$$w_i = X_i \beta_i + \varepsilon_i. \quad (19)$$

The notation  $X$  denotes a set of worker characteristics that affect wages. Within  $X$ , we use a set of dummy variables for education level attained; an indicator variable for whether the individual has any technical education; years of potential experience and its square; number of pre-school children in the household; and binary variables for regional location, rural status, marital status, low-caste status, self-employed status, religion, and household headship. The location dummy variables control for regional differences in laws and regulations in India (Besley and Burgess 2004). The notation  $\varepsilon$  is a random error term assumed to be normally distributed with variance  $\sigma^2$ . One can then describe the gender gap as follows:

$$w_m - w_f = (X_m \beta_m - X_f \beta_f) + (\varepsilon_m - \varepsilon_f). \quad (20)$$

If one evaluates the regressions at the means of the log-wage distributions, the last term becomes zero. Adding and subtracting  $X_f \beta_m$  to obtain worker attributes in terms of "male prices" gives

$$w_m - w_f = (X_m - X_f)\beta_m + X_f(\beta_m - \beta_f) + (\varepsilon_m - \varepsilon_f). \quad (21)$$

The left-hand side of equation (21) is the total log-wage differential. On the right-hand side, the first term is the explained gap (the portion of the gap attributed to gender differences in measured productivity characteristics) and the second term is the residual gap (the portion attributed to gender differences in market returns to those characteristics). The remaining term is generally ignored as the decomposition is usually conducted at the means; otherwise, the sum of the last two terms is considered the residual gap.

In performing the decomposition, the convention in the literature is to use the male coefficients since it is presumed that male wages better reflect the market payoffs for productivity characteristics. Appendix Table 3 reports the sample means and standard deviations for men and women in 1983 and 2004, and Appendix Table 4 shows the male coefficients estimated from wage regressions in each year. These regressions are weighted using sample weights provided in the NSSO data for the relevant years; the weights correct for the fact that the proportion of individuals and households in each sample differs from the proportion in the true population. Use of these weights thus adjusts the coefficients to make them nationally representative. In Appendix Table 4, the excluded education level is no schooling (illiterate), and the excluded regional dummy relates to states in the western region of India. As evident, general education, technical education and experience have positive effects on wages. Wages are lower for self-employed individuals, for individuals belonging to castes that are perceived as inferior, and, in some years, for individuals employed in rural areas of India. Furthermore, on average, wages appear to be higher in the western regions as compared to other locations in India. The male wage regression coefficients are then applied to female worker characteristics to construct measures of the residual wage gap.

Results from the Oaxaca-Blinder decomposition are reported in Table 1. The table shows that in 1983, the total male-female wage gap in log points stood at 0.612. This gap can be converted to a ratio of geometric means by exponentiating its negative, yielding a female to male wage ratio of just 54.2 percent. The total wage gap fluctuated somewhat over time, ending with a wider gap of 0.677 log points in 2004. This end point is equivalent to a relative female wage of 50.8 percent, which is extremely low by international standards. Table 1 also shows that in all years, more than half of the total gender wage gap in India remains unexplained by education, experience, and other human capital characteristics. In 1983, 56.9 percent of the wage gap remained unexplained, and after a dip in the mid-1980s, the portion of the wage gap that cannot be explained grew to 78.6 percent by 2004. During the late 1980s and early 1990s, the explained wage gap actually increased, a result that is consistent with findings in Kijima (2006) of a widening in the overall distribution of observed skills during that period. After 1993-94, the explained gap steadily fell as women gained relatively more education and experience.

Working against this improvement was a steady widening in the residual gap between men and women for most of the period. This widening in the gap could be explained by the growing dispersion in returns to observed skills (as argued in Kijima 2006), growing importance of unobserved skills, and by rising discrimination. The steadily increasing trend in the residual wage gap is evident in Figure 1, which shows that the period of rising trade openness in the 1990s coincided with an increase in the residual pay differential between men and women. This descriptive analysis suggests that growing competition from greater exposure to world markets is associated with downward pressure on women's relative pay.

Individual firms in India faced competition not only from abroad but also from other domestic firms in the same industry. One way to measure domestic competition is firm

concentration, and a commonly-used indicator is the number of industry-specific establishments divided by an industry-specific measure of scale. We construct the index of domestic concentration as  $(1 - \# \text{establishments}/\text{output})$ , so that higher values correspond with greater concentration (that is, fewer establishments). The average index from 1980 to 2004 is reported in Table 2. Results indicate that petroleum refinery, industrial chemicals, and iron and steel rank are the most concentrated industries in India, while wood products, furniture, tobacco, and pottery rank are the least concentrated industries.

To better understand changing trade patterns across industries, we grouped industries into two groups, “more-concentrated” and “less-concentrated,” and constructed average export ratios and average import ratios according to these classifications. As shown in Figure 2, industries that experienced more domestic competition (that is, the less-concentrated group) also opened more to international trade after the reforms. Both imports/output and exports/output in less-concentrated industries grew more than the corresponding trade ratios in more-concentrated industries. The figure also shows that imports dominate exports in more-concentrated industries, while exports dominate imports in less-concentrated industries. In a sense, more-concentrated industries are “buying” more than “selling,” while the opposite holds in less-concentrated industries.

Although trade activity differs considerably across these two classifications of industries, both groups experienced substantial cuts in tariff rates. Comprehensive data sources on trade policies are less readily available compared to trade values; the data we located in the World Bank’s Trade, Production and Protection Database covered assorted years between 1990 and 2004. These data took the form of industry-level tariff rates for 28 manufacturing sectors, constructed as simple averages of tariffs applied on goods entering the country. We further

averaged these industry-level tariffs (using employment shares as weights) into two series, for more- and less-concentrated industries. As shown in Figure 2, tariff rates have fallen drastically since 1990 across industries. On average, the cuts were slightly bigger in less-concentrated industries, falling by 55.4 percentage points from 84.0 percent in 1990 to 28.6 percent in 2004. In more-concentrated industries, average tariff rates fell by 53.8 percentage points, from 84.0 percent to 30.1 percent in the same period. Within these aggregate measures, the beverages industry (a more-concentrated industry) stands out for exceptionally high tariffs that took a relatively long time to be reduced, while most other industries went through drastic tariff cuts immediately after the 1991 reforms. The plastic products, printing, tobacco, and “other manufactured products” industries, all considered less-concentrated, saw particularly large reductions immediately after 1991. While these tariff cuts may be a more direct measure of the trade policy reforms than the corresponding increases in trade shares, tariff measures are not used in the formal estimation strategy due to the sketchy nature of the data.

According to implications of the Becker theory, one would expect the share of female employment to rise in more-concentrated industries after trade liberalization, as the squeeze on profits would induce firms to hire more of the relatively cheaper source of female labor. The descriptive evidence in Table 3 on employment distributions and the female share of the regular salaried workforce provides some support of this hypothesis. As reported at the bottom of the table, women’s representation in the manufacturing sector’s regular salaried labor force has increased from 7.6% in 1983 to 14.0% in 2004. Within manufacturing, India’s employment distribution resembles that of many developing countries, with relatively high female representation in low-skilled labor intensive industries such as apparel, pottery, glass products, and tobacco, and relatively high male representation in higher-skilled labor and capital intensive

industries such as petroleum refinery, paper and products, non-ferrous metals, fabricated metal products, and machinery.

Between 1983 (pre-liberalization) and 2004 (post-liberalization), most industries in the more-concentrated and less-concentrated groupings experienced an increase in women's representation in the workforce, coinciding with the feminization of the manufacturing sector workforce. For example, electric machinery saw an increase in the female share of its regular salaried workforce from 4.6 percent to 19.5 percent, and wearing apparel experienced an increase from 16.1 percent to 23.1 percent. One of the most noticeable changes in the male employment distribution was a movement out of textiles, a more-concentrated industry, into a variety of less-concentrated industries. In the female employment distribution, a very large shift out of the tobacco industry is one of the forces behind women's increased employment in other industries. When we construct weighted averages for the more- and less-concentrated groups, we find that between 1983 and 2004, the gain in average percent female for more-concentrated industries exceeded the gain for less-concentrated industries.

### **Testing the Theoretical Model with Industry-Level Regressions**

Next, we perform industry-level regressions to test the theoretical model of foreign trade competition, market power, and discrimination. Consistent with the model's specification of a sector that is competitive domestically (sector 0) and a sector that is concentrated (sector 1), our estimation strategy is grounded in a comparison by concentration status. The estimation also builds on the idea that international trade works through different channels, including the discrimination coefficient, to affect the gender wage differential. Underlying the empirical tests is a difference-in-differences strategy, modeled after Black and Brainerd (2004), which uses residual wage gaps between men and women as the proxy for discrimination. The approach

effectively entails taking the difference in residual wage gaps between more-concentrated industries that were relatively open and closed to trade, and subtracting from this total the difference in residual wage gaps between less-concentrated industries that were relatively open and closed to trade, as follows:

$$\left( gap_{more\ concentrated}^{open\ to\ trade} - gap_{more\ concentrated}^{closed\ to\ trade} \right) - \left( gap_{less\ concentrated}^{open\ to\ trade} - gap_{less\ concentrated}^{closed\ to\ trade} \right) \quad (22)$$

This approach is represented by the following estimation equation:

$$W_{imt} - W_{ift} = \beta_0 + C_{it} \beta_1 + T_{it} \beta_2 + Y \beta_3 + C_{it} T_{it} \beta_4 + C_{it} Y \beta_5 + T_{it} Y \beta_6 + C_{it} T_{it} Y \beta_7 + \varepsilon_{it}. \quad (23)$$

The notation  $W_{imt}$  denotes total male residual wages in industry  $i$  and year  $t$ , and  $W_{ift}$  denotes total female residual wages in industry  $i$  and year  $t$ . The residual wage series for male and female workers, which can be interpreted as the portion of wages that remain unexplained by observed skill characteristics, are constructed following the Oaxaca-Blinder decomposition procedure. These residual wages are then aggregated across industry and year. The notation  $C_{it}$  is a continuous variable that measures domestic concentration by industry and year;  $T_{it}$  represents competition from international trade and is measured by the share of trade in GDP across industry and year; and  $Y$  represents the year, measured in alternative specification tests as either a time trend or a dummy variable that equals one for the post-liberalization years. Note that our use of a year variable to capture the time element differs from Black and Brainerd (2004), who recode their variables as long differences between the end year and beginning year in order to capture changes over time. Following the intuition in Besley and Burgess (2004), the interaction terms with the year variable may be interpreted as reflecting the time path of trade shares (and domestic concentration). The final term contains the interaction between domestic concentration and international competition and year ( $C_{it}T_{it}Y$ ). We focus on this term's coefficient as it

represents the impact of international trade competition in more-concentrated industries over time.

We estimate Equation (23) using two alternative methods that varied in the treatment of the underlying dynamics of specific industry effects. In the first approach, we use Ordinary Least Squares (OLS) applied to the panel dataset of industry-level observations over time. All regressions are weighted with industry-level employment shares. Results are reported in Table 4 for six different models. The models differ according to the measurement of trade shares and the measurement of the year variable: models 1 and 4 use export shares, models 2 and 5 use import shares, and models 3 and 6 use total trade (exports plus imports) shares. With respect to the year variable, models 1, 2, and 3 use a time trend, while models 4, 5, and 6 use a dummy variable for the post-liberalization period. To help guide the reader's eye, the coefficients on the key interaction term are highlighted in bold.

We begin our discussion of Table 4 by highlighting the positive coefficient estimate on the interaction term for concentration, trade, and year. This result indicates that across most model specifications, increasing trade openness in more-concentrated industries after trade liberalization is associated with higher wage gaps between men and women. The coefficient on this interaction term is positive in all six models, and it is statistically significant in the four models where trade is measured by exports and total trade. Furthermore, the coefficient on the interaction term for trade and year is negative across models and precisely estimated in four of the specifications. This negative coefficient has the interpretation that in the post-liberalization period among less concentrated industries, the residual wage gap decreased in industries that experienced greater international trade (compared to industries that experienced lower international trade). In the context of our theory, the combination of these two sets of results

suggest that in India, the effects of changes in the taste for discrimination parameter  $d$  in concentrated industries outweigh the mitigating effects of trade on gender pay differentials. The observed changes in gender pay differentials are likely to have arisen due to pressures from international trade rather than domestic forces since more-concentrated industries experience less domestic competition.

Our second approach to estimating Equation (23) is based on a fixed effects strategy to control for time-invariant, industry-specific characteristics that may impact wage gap determinants. These results are found in Table 5, which has a similar structure in terms of how models 1 through 6 are estimated. Regressions are also weighted with industry-level employment shares. As in the case of the OLS results, fixed effects estimates of the coefficient on the key interaction term for concentration, trade, and year are positive and measured with precision in four of the six models we consider. The results suggest that trade also has some mitigating effects on the wage gap, consistent with the theoretical model. Yet the triple interaction term indicates that after trade liberalization, the net effect of increases in trade and in the discrimination coefficient on the residual wage gap is positive. For imports in particular, the introduction of industry dummies appears to absorb some of the variation in the data to reduce the magnitude of the estimated coefficients on the interaction terms of interest. Once we account for industry effects that remain invariant over time, import competition facing Indian firms in manufacturing appears to have a less potent impact on wage gaps compared to competition in world export markets.

Implicit in this approach is the assumption that trade shares are an appropriate measure of international competition and are exogenous to the residual wage gap between men and women. Black and Brainerd (2004) cite extensive evidence that supports the use of trade shares as a

measure of competition from international trade. They also suggest a simple test to support the exogeneity assumption: if exogeneity does not hold, then industries with a larger residual wage gap in the beginning year would presumably experience greater trade competition. We conduct a similar test with the India data for the relationship between the residual wage gap in 1983 and the change in the import share from 1983 to 2004 and find a correlation coefficient of just 0.23. Although this test is by no means definitive, it provides evidence in support of the exogeneity assumption. Our empirical approach also assumes that India's manufacturing sector did exhibit patterns of wage discrimination against women, an assumption that is supported by previous studies for India that have found substantial gender wage gaps even after controlling for detailed skill characteristics (Duraisamy and Duraisamy 1996; Kingdon and Unni 2001). Another assumption underlying the model and empirical strategy is that before the reforms, wage discrimination was higher in more-concentrated industries versus less-concentrated industries. To test the validity of this assumption, we divided industries into more- and less-concentrated categories by specific years, and then constructed population-weighted averages of the residual wage gaps for both concentration categories. Our estimates support our assumption since in the pre-reform years, the residual wage gap is higher in more-concentrated industries as compared to less-concentrated industries.

Our approach allows the domestic concentration index to vary over time. An argument against this specification is that trade liberalization could have influenced the concentration index, so that the effects of international competition also work through our measure of concentration. One way to address this concern is to keep the competition index as a fixed industry characteristic from the pre-liberalization period. We constructed a new concentration index to reflect the industry-specific average for 1980 to 1990, and fixed this index across years  $t$

in the empirical estimation. Results indicate some loss in precision for the export interaction coefficients and some gain in precision for the import interactions coefficients.<sup>9</sup> However, none of the coefficient estimates change sign, so qualitatively our conclusions remain the same.

The results of our empirical models fit into a framework in which groups of workers who have relatively weak bargaining power and lower workplace status may be less able to negotiate for favorable working conditions and higher pay. Thus women are placed in a vulnerable position as firms compete in the global market place. Outside evidence offers several examples of how female workers may have less bargaining power and limited wage gains as compared to their male counterparts. In particular, a survey of female manufacturing workers in India indicates that women are clustered into low-wage jobs, and when they do hold the same job as men, they are still paid less (South Asian Research and Development Initiative 1999). This source also reports that women are not as likely as men to receive overtime pay when they work additional hours, and they have inferior access to training and promotion. In addition, union leaders and members are predominately male. Reasons for this include intimidation tactics that make women afraid to join, and union meetings at night when women are engaged in child care. These examples provide some context within which to understand why discrimination might persist or worsen in the case of growing competitive pressures from trade liberalization.

### **Policy Implications**

This study has found that increasing trade openness in more-concentrated industries is associated with growing unadjusted and residual wage gaps between men and women employed in India's manufacturing industries. According to this study's identification strategy, competition from international trade is associated with an increase in wage discrepancies between men and women. These results support the prediction of our theoretical model that under the condition of

an increasing “taste for discrimination,” international trade can, on net, lead to wider wage gaps between men and women. In a scenario with declining rents in the more-concentrated sector post-liberalization, firms appear to have favored male workers over female workers in the wage bargaining process. Rather than competition from international trade putting pressure on firms to eliminate costly discrimination against women, pressures to cut costs due to international competition are hurting women’s relative pay. Lack of enforcement of labor standards that prohibit sex-based discrimination, combined with employer and union practices that favor male workers, leaves women with less bargaining power and limited wage gains compared to men.<sup>10</sup>

If women are bearing a disproportionately large share of the costs of trade liberalization, then a number of policy measures that build women’s human capital and strengthen the social safety net may help ease the burden. A policy priority is to achieve gender equality at all education levels so that women have access to the same range of occupational choices as men. Improved educational opportunities also include greater access for working-age women to vocational education; this may be especially useful for women who are displaced as a consequence of increased competition from abroad. Closely related, access to firm-specific training and new programs for accreditation for workers’ skills can also help to close the gender gap. By building and up-grading skills, vocational education programs and improved opportunities for on-the-job training can help improve women’s ability to obtain a wider range of jobs, which, in turn, can help boost women’s relative pay. Additionally, stronger enforcement of India’s equal pay and equal opportunity legislation, which dates back to the late 1950s, will reduce discriminatory pay practices that appear to be contributing to rising residual wage gaps in the manufacturing sector.

In this discussion on improving women's relative compensation, it is important to note that attempts to raise the wages of female workers may be counterproductive if firms relocate in order to avoid paying higher wages (Seguino and Grown 2006). Hence, although wage hikes may be justified in terms of the additional productivity they induce, women employed in highly mobile firms are unlikely to benefit from such legislation. Moreover, employees of such firms may be further adversely affected since mobile firms are also less likely to invest in training. Alternatively, improved enforcement of labor standards and full employment policies can help provide women with more job security, and assist women in gaining access to a wide range of better-paying jobs in occupations that have traditionally been male-dominated. Raising the likelihood that higher wages will stimulate productivity gains and prioritizing gender equality in an open economy may also necessitate measures that slow the speed with which firms can leave a country in response to higher wage legislations (Seguino and Grown 2006). Capital mobility is also an issue within India. In such a large country with heterogeneous labor markets and business institutions across regions, the response to pressures from trade liberalization can differ across firms within the same manufacturing sectors. Findings in Aghion et al. (2005) indicate that local policies and institutional settings played an important role in the reallocation of manufacturing production across regions in India. Careful institutional reforms at the local level will affect whether regions experience manufacturing sector gains or losses as a result of trade reforms at the national level.

To the extent that productivity enhancing policies are not enough to safeguard women who are adversely affected by trade, improved social safety nets can help to ease the burden that many low-wage women face. For example, greater public provision of day-care services for very young children and after-school services for school-age children can help to ease the time and

budgetary constraints that face India's factory workers. Furthermore, women employed in export-producing factories often remit high shares of their income back to families in the rural sector, at potentially great personal cost. Poor social safety nets in the rural sector contribute to the reliance on remittances from these women. Policy reforms that create a viable social infrastructure in the rural sector, including social security, will lessen the dependence on remittances and ease the pressure on such workers. By analyzing the effects of the Indian trade liberalization on women's compensation, and by highlighting the fact that female employees of manufacturing industries appear to fare less well as compared to their male counterparts, this study makes an important contribution to the literature and further demonstrates that not everyone benefited equally as a consequence of the reforms.

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**Table 1.** Oaxaca-Blinder Decomposition Results for Male-Female Wage Gap  
(in log points)

	<i>1983</i>	<i>1987-1988</i>	<i>1993-94</i>	<i>1999-2000</i>	<i>2004</i>
Total M-F Wage Gap	0.612	0.616	0.765	0.757	0.677
Explained	0.264	0.287	0.344	0.277	0.145
Unexplained (residual)	0.348	0.329	0.421	0.480	0.532
% Gap Unexplained	56.9%	53.4%	55.0%	63.4%	78.6%

Note. The total wage gap is male wages – female wages; the explained wage gap is gender differences in observed characteristics weighted by male coefficients; and the residual wage gap is the portion that cannot be explained by differences in characteristics. All results are in log points except bottom row, which is in percentage points.

**Table 2.** Index of Domestic Concentration, 1980-2004

<i>ISIC</i>	<i>Industry Label</i>	<i>(1-No. Establishments/Output)</i>
<i>More Concentrated</i>		
353	Petroleum refinery	0.999
351	Industrial chemicals	0.978
371	Iron and steel	0.968
354	Miscellaneous petroleum and coal products	0.958
384	Transport equipment	0.955
313	Beverages	0.943
383	Machinery (electric)	0.940
352	Other chemicals	0.938
355	Rubber products	0.920
372	Non-ferrous metals	0.919
324	Footwear (except rubber or plastic)	0.913
321	Textiles	0.909
341	Paper and products	0.906
311	Food products	0.893
382	Machinery (except electrical)	0.888
<i>Less Concentrated</i>		
362	Glass and products	0.876
323	Leather products	0.869
385	Professional and scientific equipment	0.864
322	Wearing apparel (except footwear)	0.850
356	Plastic products	0.829
390	Other manufactured products	0.826
369	Other non-metallic mineral products	0.791
342	Printing and publishing	0.764
381	Fabricated metal products	0.763
361	Pottery, china, earthenware	0.679
314	Tobacco	0.567
332	Furniture (except metal)	0.295
331	Wood products (except furniture)	0.259

Note. Results show the annual average from 1980-81 to 2004-05 for the industry specific calculation (1–No. establishments/output). ISIC codes are from Revision 2.  
Source: Authors' calculations based on data sources in Appendix Table 1.

**Table 3.** Employment Distribution and Female Share of the Workforce, by Industry (1983-2004)

	1983			2004		
	Male	Female	% Fem.	Male	Female	% Fem.
<b><i>More Concentrated</i></b>						
Petroleum refinery	0.1	0.3	14.0	0.8	0.3	5.9
Industrial chemicals	2.9	0.0	0.0	1.7	1.4	12.2
Iron and steel	7.9	3.3	3.3	3.4	2.6	10.9
Misc. petroleum and coal products	0.1	0.0	0.0	0.4	0.2	7.8
Transport equipment	5.8	1.5	2.0	5.7	5.0	12.5
Beverages	0.6	0.2	2.4	0.6	0.8	17.9
Machinery (electric)	5.5	3.2	4.6	2.8	4.1	19.5
Other chemicals	4.8	4.6	7.3	4.1	4.9	16.4
Rubber products	1.1	0.1	0.5	1.5	1.7	15.9
Non-ferrous metals	1.2	0.2	1.6	2.4	0.8	5.2
Footwear (except rubber or plastic)	0.6	0.7	8.7	1.0	0.9	12.6
Textiles	24.5	16.7	5.3	19.9	12.3	9.2
Paper and products	1.5	0.6	3.2	3.9	0.4	1.6
Food products	9.7	5.7	4.5	9.0	8.7	13.7
Machinery (except electrical)	6.2	0.9	1.2	6.2	3.2	7.7
<b><i>Less Concentrated</i></b>						
Glass and products	1.1	1.3	9.1	0.7	4.6	53.2
Leather products	0.6	0.8	9.8	0.8	1.1	18.7
Professional and scientific equipment	0.6	0.6	7.4	0.4	0.2	9.3
Wearing apparel (except footwear)	3.2	7.6	16.1	6.3	11.7	23.1
Plastic products	1.1	0.9	6.5	2.8	1.1	6.3
Other manufactured products	3.0	1.8	4.7	4.2	2.2	8.0
Other non-metallic mineral products	3.9	3.5	6.8	3.9	3.1	11.2
Printing and publishing	3.6	3.3	7.0	4.4	4.6	14.6
Fabricated metal products	4.8	1.3	2.2	6.7	3.7	8.4
Pottery china earthenware	0.2	0.6	21.5	0.0	0.3	56.3
Tobacco	2.4	39.7	58.0	2.0	16.2	56.7
Furniture (except metal)	0.6	0.0	0.0	2.1	1.5	10.3
Wood products (except furniture)	2.3	0.6	1.9	2.7	2.1	11.1
<b>All Industries Total</b>	<b>100.0</b>	<b>100.0</b>	<b>7.6</b>	<b>100.0</b>	<b>100.0</b>	<b>14.0</b>
<b>More Concentrated Total</b>	<b>72.7</b>	<b>38.0</b>	<b>4.1</b>	<b>63.2</b>	<b>47.5</b>	<b>10.9</b>
<b>Less Concentrated Total</b>	<b>27.3</b>	<b>62.0</b>	<b>15.7</b>	<b>36.8</b>	<b>52.5</b>	<b>18.8</b>

Source: Authors' calculations using population-weighted averages based on NSSO data.

**Table 4.** Ordinary Least Squares Estimates of Male-Female Residual Wage Gaps by Industry  
(in log points; standard errors in parentheses).

	<i>Model 1</i>	<i>Model 2</i>	<i>Model 3</i>	<i>Model 4</i>	<i>Model 5</i>	<i>Model 6</i>
Concentration	0.447 (0.403)	0.043 (0.295)	0.954 (0.665)	-0.019 (0.210)	0.157 (0.155)	0.526 (0.419)
Trade	0.389** (0.189)	0.124 (0.145)	0.493* (0.256)	0.122 (0.131)	0.069 (0.089)	0.267 (0.186)
Year	0.387** (0.174)	0.024 (0.162)	0.447* (0.269)	1.084** (0.520)	0.267 (0.414)	1.513* (0.807)
Concen x Trade	-0.395* (0.230)	-0.282* (0.165)	-0.617* (0.313)	-0.104 (0.162)	-0.199* (0.102)	-0.372 (0.238)
Concen x Year	-0.376* (0.194)	0.005 (0.182)	-0.458 (0.300)	-1.151* (0.594)	-0.264 (0.481)	-1.717* (0.948)
Trade x Year	-0.185** (0.086)	-0.030 (0.080)	-0.197* (0.112)	-0.442* (0.228)	-0.139 (0.247)	-0.611* (0.321)
<b>Concen x Trade x Year</b>	<b>0.203**</b> <b>(0.097)</b>	<b>0.055</b> <b>(0.087)</b>	<b>0.229*</b> <b>(0.123)</b>	<b>0.508*</b> <b>(0.266)</b>	<b>0.217</b> <b>(0.275)</b>	<b>0.744**</b> <b>(0.374)</b>
Constant	-0.346 (0.350)	0.263 (0.261)	-0.609 (0.530)	0.158 (0.174)	0.221 (0.137)	-0.121 (0.291)
No. observations	140	140	140	140	140	140
R <sup>2</sup>	0.099	0.204	0.085	0.087	0.187	0.070

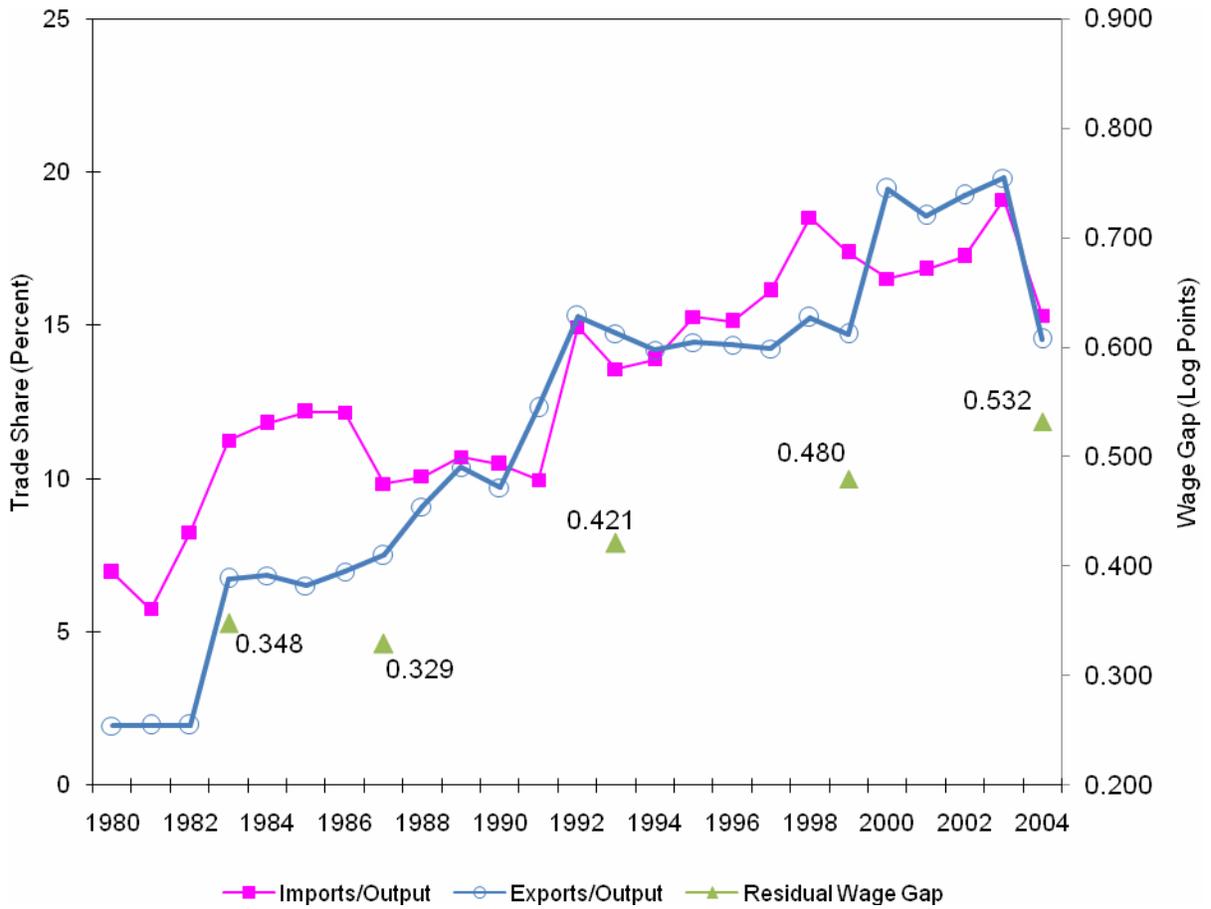
Note. The dependent variable across models is the residual wage gap. In Models 1 and 4, trade is exports/output; in Models 2 and 5, trade is imports/output; and in Models 3 and 6, trade is (exports+imports)/output. Also, in Models 1 through 3, year is a time trend; and in Models 4 through 6, year is a post-liberalization dummy. All regressions are weighted with industry-level employment shares. The notation \*\*\* denotes statistically significant at the 0.01 level; \*\* at the 0.05 level, and \* at the 0.10 level.

**Table 5.** Fixed Effects Estimates of Male-Female Residual Wage Gaps by Industry  
(in log points; standard errors in parentheses).

	<i>Model 1</i>	<i>Model 2</i>	<i>Model 3</i>	<i>Model 4</i>	<i>Model 5</i>	<i>Model 6</i>
Concentration	0.522 (0.552)	-0.672 (0.491)	0.710 (0.592)	0.511 (0.567)	-0.309 (0.442)	0.453 (0.607)
Trade	0.636*** (0.212)	0.205 (0.185)	0.623*** (0.224)	0.466** (0.217)	0.099 (0.143)	0.453** (0.216)
Year	0.362 (0.275)	0.035 (0.176)	0.413 (0.336)	0.621 (0.587)	0.208 (0.332)	1.084 (0.824)
Concen x Trade	-0.754*** (0.250)	-0.260 (0.206)	-0.650** (0.258)	-0.506** (0.250)	-0.108 (0.157)	-0.404 (0.250)
Concen x Year	-0.347 (0.286)	0.020 (0.191)	-0.442 (0.346)	-0.750 (0.678)	-0.145 (0.391)	-1.360 (0.966)
Trade x Year	-0.199* (0.110)	-0.024 (0.070)	-0.184 (0.121)	-0.418* (0.251)	-0.094 (0.200)	-0.484 (0.321)
<b>Concen x Trade x Year</b>	<b>0.234**</b> <b>(0.118)</b>	<b>0.037</b> <b>(0.073)</b>	<b>0.218*</b> <b>(0.125)</b>	<b>0.543*</b> <b>(0.296)</b>	<b>0.126</b> <b>(0.227)</b>	<b>0.616*</b> <b>(0.376)</b>
No. observations	140	140	140	140	140	140
R <sup>2</sup>	0.718	0.705	0.715	0.704	0.689	0.704

Note. The dependent variable across models is the residual wage gap. In Models 1 and 4, trade is exports/output; in Models 2 and 5, trade is imports/output; and in Models 3 and 6, trade is (exports+imports)/output. Also, in Models 1 through 3, year is a time trend; and in Models 4 through 6, year is a post-liberalization dummy. All regressions are weighted with industry-level employment shares. The notation \*\*\* denotes statistically significant at the 0.01 level; \*\* at the 0.05 level, and \* at the 0.10 level.

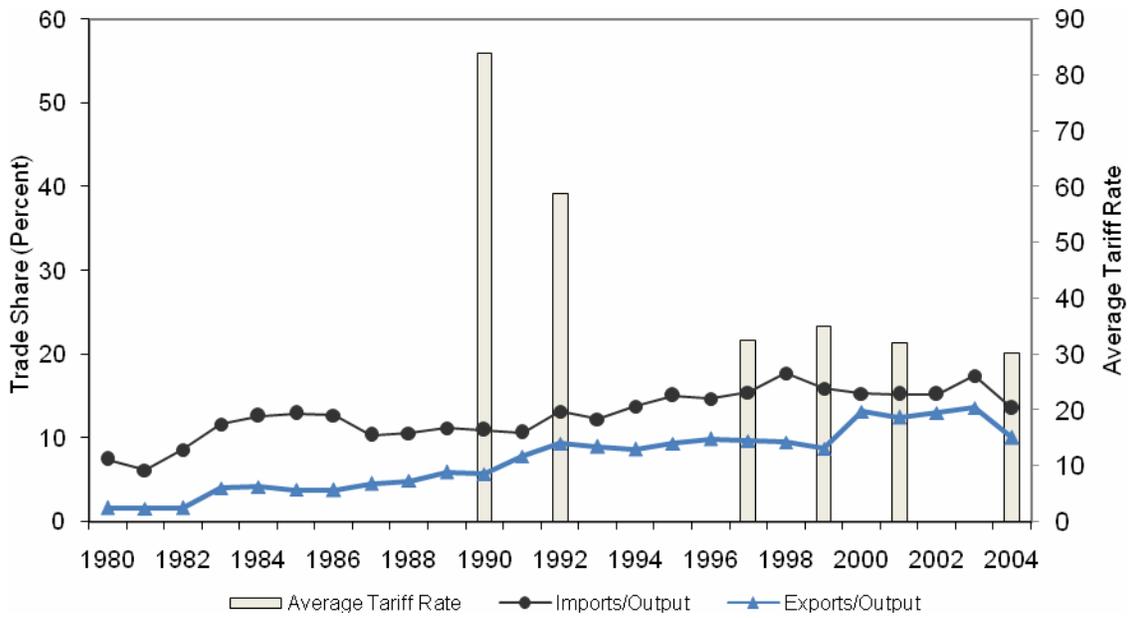
**Figure 1.** Trade Ratios and Male-Female Residual Wage Gap, 1980-2004



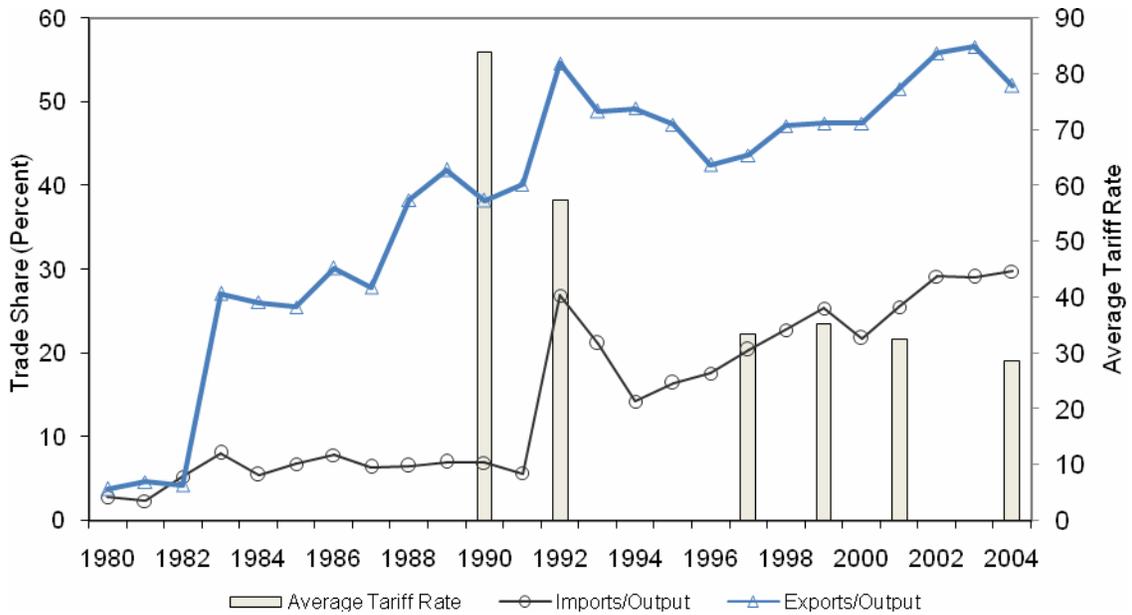
Source: Authors' calculations based on data sources in Appendix Table 1.

**Figure 2.** Average Trade Ratios and Tariff Rates by Levels of Domestic Concentration

Panel A: More Concentrated Industries



Panel B: Less Concentrated Industries



Note: Industry-level tariffs are the average of tariff rates applied on good entering the country, and average tariffs by concentration are calculated by applying average employment shares to the industry-level tariffs.

Source: Authors' calculations based on data sources in Appendix Table 1.

**Appendix Table 1.** Descriptive and Regression Analyses: Variables and Data Sources

<i>Variable</i>	<i>Description</i>	<i>Data Source</i>
Gender Wage Gap	Male wages – female wages, by industry (unadjusted wages and residual wages)	National Sample Survey Organization (NSSO) 1983, 1987-88, 1999-2000, 2004
Wage Deflator	Wholesale price index for manufactured products	Ministry of Commerce and Industry, Government of India, 1980-81 – 2004-05
Export Value	Dollar value of India’s exports, by industry	Trade, Production and Protection Database (Nicita & Olarreaga 2006), 1980 – 2004
Import Value	Dollar value of India’s imports, by industry	Trade, Production and Protection Database (Nicita & Olarreaga 2006), 1980 – 2004
Tariffs	Average tariff rates, by industry	Trade, Production and Protection Database (Nicita & Olarreaga 2006), 1980 – 2004
Domestic Output	Total output, in rupees, by industry	Annual Survey of Industries (ASI), 1980-81 – 2004-05
Exchange Rate	Average annual rupee/US\$ exchange rate	Reserve Bank of India, 1980-81 – 2004-05
Domestic Concentration	(1 – No. establishments/output), by industry	Annual Survey of Industries (ASI), 1980-81 – 2004-05

**Appendix Table 2.** Concordance Between ISIC Revision 2, NIC 1970, NIC 1987, NIC 1998, and NIC 2004 Codes

<i>Labels</i>	<i>ISIC</i>	<i>NIC 1970</i>	<i>NIC 1987</i>	<i>NIC 1998</i>	<i>NIC 2004</i>
Food products	311-2	200-219	200-219	1511-1549	1511-1549
Beverages	313	220-224	220-224	1551-1554	1551-1554
Tobacco	314	225-229	225-229	1600	1600
Textiles	321	230-263, 266-269	230-264, 267-269	1711-1730	1711-1730
Wearing apparel (except footwear)	322	264-265	265-266	1810	1810
Leather products	323	290, 292-293, 295-299	290, 292-293, 295-299	1820-1912	1820-1912
Footwear (except rubber or plastic)	324	291	291	1920	1920
Wood products (except furniture)	331	270-275, 279	270-275, 279	2010-2029	2010-2029
Furniture (except metal)	332	276-277	276-277	3610	3610
Paper and products	341	280-283	280-283	2101-2109	2101-2109
Printing and publishing	342	284-289	284-289	2211-2230	2211-2230
Industrial chemicals	351	294, 310-311, 316	294, 300-302, 306	2411-2413, 2430	2411-2413, 2430
Other chemicals	352	312-315, 317-319	303-305, 307-309	2421-2429	2421-2429
Petroleum refinery	353	304	314-315	2320	2320
Miscellaneous petroleum and coal products	354	305-307	316-319	2310, 2330	2310, 2330
Rubber products	355	300-302	310-312	2511-2519	2511-2519
Plastic products	356	303	313	2520	2520
Pottery, china, earthenware	361	322-323	322-323	2691	2691
Glass and products	362	321	321	2610	2610
Other non-metallic mineral products	369	320, 324-329	320, 324-329	2692-2699	2692-2699
Iron and steel	371	330-332	330-332	2710	2711-2719
Non-ferrous metals	372	333-339, 344	333-339, 344-345	2720-2732, 2891-2892	2720-2732, 2891-2892
Fabricated metal products	381	340-343, 345-349	340-343, 346-349	2811-2812, 2893-2899	2811-2812, 2893-2899
Machinery (except electrical)	382	350-359	350-359, 388, 390-394, 397-399	2813, 2911-2930, 3000	2813, 2911-2930, 3000
Machinery (electric)	383	360-369	360-369, 395-396	3110-3230	3110-3230
Transport equipment	384	370-379	370-379	3410-3599	3410-3599
Professional and scientific equipment	385	380-382	380-382	3311-3330	3311-3330
Other manufactured products	390	383-389	383-387, 389	3691-3699	3691-3699

Source: Created by authors, with reference to Sivadasan and Slemrod (2006) and Central Statistical Organization (1970, 1987, 1998, 2004).

**Appendix Table 3.** Summary Statistics for Regular Salaried Wage Earners in Manufacturing, 1983-2004

<b>Variable</b>	<i>Male 1983</i>	<i>Female 1983</i>	<i>Male 2004</i>	<i>Female 2004</i>
Log real weekly cash wages in rupees	4.055 (1.015)	3.443 (0.900)	4.816 (0.936)	4.138 (1.113)
Dummy for illiterate individual	0.151 (0.359)	0.455 (0.498)	0.095 (0.294)	0.303 (0.460)
Dummy for individual with below primary years of schooling	0.135 (0.342)	0.137 (0.344)	0.056 (0.230)	0.035 (0.184)
Dummy for individual with primary school	0.197 (0.398)	0.114 (0.318)	0.160 (0.367)	0.158 (0.365)
Dummy for individual with middle school	0.199 (0.399)	0.108 (0.310)	0.272 (0.445)	0.119 (0.325)
Dummy for individual with secondary school	0.231 (0.421)	0.150 (0.357)	0.251 (0.433)	0.157 (0.364)
Dummy for individual with graduate school	0.087 (0.281)	0.037 (0.190)	0.166 (0.372)	0.228 (0.420)
Years of potential experience for individual	20.542 (11.920)	19.605 (12.361)	18.092 (11.060)	19.509 (12.712)
Years of potential experience for individual squared/100	5.641 (5.894)	5.369 (6.070)	4.496 (5.000)	5.419 (5.929)
Dummy for individual with no technical education	0.913 (0.281)	0.945 (0.228)	0.874 (0.332)	0.896 (0.306)
Dummy for individual who is currently married	0.752 (0.432)	0.596 (0.491)	0.698 (0.459)	0.643 (0.480)
Dummy for scheduled-tribe/scheduled-caste individual	0.154 (0.361)	0.200 (0.400)	0.166 (0.372)	0.156 (0.364)
Dummy for self-employed individual	0.084 (0.277)	0.168 (0.374)	0.060 (0.238)	0.130 (0.336)
Dummy for individual of Hindu religion	0.843 (0.364)	0.827 (0.379)	0.856 (0.351)	0.878 (0.328)
Dummy for households with male heads	0.967 (0.178)	0.770 (0.421)	0.951 (0.216)	0.767 (0.423)
Dummy for rural areas	0.222 (0.415)	0.395 (0.489)	0.286 (0.452)	0.413 (0.493)
Number of pre-school children in household	0.599 (0.844)	0.557 (0.847)	0.450 (0.728)	0.280 (0.616)
Dummy for northern states of India	0.206 (0.404)	0.122 (0.328)	0.261 (0.439)	0.078 (0.269)
Dummy for southern states of India	0.254 (0.435)	0.507 (0.500)	0.248 (0.432)	0.479 (0.500)
Dummy for eastern states of India	0.174 (0.389)	0.059 (0.235)	0.070 (0.254)	0.071 (0.258)
Dummy for western states of India	0.367 (0.482)	0.312 (0.464)	0.420 (0.494)	0.371 (0.484)
Number of observations	10909	834	3540	548

Standard deviations in parentheses. Sample in each year consists of regular salaried workers between 15-60 years of age with positive cash wages in the manufacturing industry.

**Appendix Table 4.** Coefficient Estimates from Male Wage Regressions  
(in log points; standard errors in parentheses).

	<i>1983</i>	<i>1987-1988</i>	<i>1993-1994</i>	<i>1999-2000</i>	<i>2004</i>
Dummy for individual with below primary years of schooling	0.084** (0.034)	0.061 (0.038)	0.194*** (0.026)	0.031 (0.051)	0.130* (0.073)
Dummy for individual with primary school	0.165*** (0.032)	0.112*** (0.036)	0.221*** (0.024)	-0.022 (0.047)	0.296*** (0.057)
Dummy for individual with middle school	0.232*** (0.033)	0.241*** (0.038)	0.427*** (0.024)	0.119*** (0.043)	0.338*** (0.055)
Dummy for individual with secondary school	0.547*** (0.035)	0.561*** (0.037)	0.661*** (0.024)	0.401*** (0.042)	0.710*** (0.057)
Dummy for individual with graduate school	1.038*** (0.044)	1.070*** (0.043)	1.174*** (0.029)	0.966*** (0.048)	1.252*** (0.065)
Years of potential experience for individual	0.049*** (0.003)	0.051*** (0.004)	0.047*** (0.002)	0.046*** (0.003)	0.060*** (0.005)
Years of potential experience for individual squared/100	-0.063*** (0.006)	-0.065*** (0.007)	-0.055*** (0.005)	-0.069*** (0.006)	-0.086*** (0.011)
Dummy for individual with no technical education	-0.217*** (0.035)	-0.309*** (0.033)	-0.288*** (0.021)	-0.287*** (0.038)	-0.316*** (0.047)
Dummy for individual who is currently married	0.120*** (0.027)	0.150*** (0.031)	0.160*** (0.020)	0.122*** (0.028)	-0.040 (0.043)
Dummy for scheduled-tribe/scheduled-caste individual	-0.074*** (0.026)	-0.039 (0.030)	-0.074*** (0.019)	-0.045** (0.023)	-0.115*** (0.038)
Dummy for self-employed individual	-0.177*** (0.034)	-0.197*** (0.036)	-0.159*** (0.024)	-0.029 (0.028)	-0.158*** (0.059)
Dummy for individual of Hindu religion	0.002 (0.025)	0.018 (0.027)	-0.005 (0.018)	-0.049 (0.031)	0.040 (0.040)
Dummy for households with male heads	0.080 (0.052)	0.152*** (0.053)	0.158*** (0.033)	0.202** (0.095)	0.198*** (0.064)
Dummy for rural areas	-0.059*** (0.023)	0.199*** (0.036)	-0.027* (0.015)	-0.003 (0.024)	0.022 (0.031)
Number of pre-school children in household	0.006 (0.011)	-0.012 (0.012)	-0.005 (0.009)	0.012 (0.015)	0.015 (0.020)
Dummy for northern states of India	-0.105*** (0.025)	0.017 (0.027)	-0.042** (0.017)	0.208*** (0.027)	0.171*** (0.035)
Dummy for southern states of India	-0.253*** (0.024)	-0.208*** (0.025)	-0.214*** (0.016)	-0.005 (0.026)	-0.113*** (0.035)
Dummy for eastern states of India	-0.187*** (0.027)	-0.036 (0.030)	-0.203*** (0.019)	0.325*** (0.041)	0.056 (0.056)
Constant	3.287*** (0.077)	3.191*** (0.079)	3.782*** (0.050)	3.610*** (0.114)	3.662*** (0.108)
No. observations	10, 904	10, 142	14, 559	8,150	3, 540
Adjusted R <sup>2</sup>	0.139	0.171	0.258	0.163	0.260

Note. All estimates are from weighted Ordinary Least Squares regressions. The notation \*\*\* indicates statistically significant at the 0.01 level; \*\* at the 0.05 level, and \* at the 0.10 level.

## Endnotes

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<sup>1</sup> Agesa and Hamilton (2004) apply a similar methodology to data from the United States in the context of the racial wage gap for men, and they also find little evidence that increasing competition from international trade reduces the racial wage gap.

<sup>2</sup> The idea that children bear some of the adjustment costs of trade reforms is consistent with findings in Menon (2005) which finds that states in India that are unionized have higher incidences of labor unrest, disruptions in household earnings, and child labor.

<sup>3</sup> See, for example, Darity and Williams (1985) and Williams (1987).

<sup>4</sup> The consumer optimization problem from which this inverse demand curve is derived is as in Borjas and Ramey (1995).

<sup>5</sup> The main assumption of the Cournot model is that each firm takes the other firm's quantities produced as given.

<sup>6</sup> Black and Brainerd (2004) discuss a similar notion of discrimination as manifested in the unequal distribution of rents in the concentrated sector. However, they provide no theoretical structure.

<sup>7</sup> To prevent distortions from outliers in the mean regressions, individuals with extremely low or high weekly cash wages are dropped from the sample. We trim the bottom and top 0.1 percentiles from the wage distribution.

<sup>8</sup> The ASI cover the years 1980-81 through 2004-05, where 1980-81 represents April 1980 through March 1981, and so forth.

<sup>9</sup> These results are available upon request.

<sup>10</sup> This idea is also supported with evidence in Seguino (1997), which finds that large gender wage gaps in South Korea persisted or grew worse in the face of rapid export growth that depended on female labor.