Economic Transition and Gender Differentials in Wages and Productivity: Evidence from Chinese Manufacturing Enterprises

Abstract: We use firm-level data to analyze male-female wage differences in Chinese industry in the late 1990s. Our estimates indicate that employers' discrimination against women was not a significant source of the gender wage gap in Chinese manufacturing enterprises. Instead, we find that the relative wage of unskilled female to male workers was higher than their relative productivity in state-owned enterprises. This result indicates that unskilled female workers in the state sector had historically received wage premiums and consequently accounted for a disproportionate share of the sector's labor surplus.

Key words: gender wage discrimination, market competition, and economic transition

JEL Classification Code: I30; J16; J21; J64; J71; O10; R20

1. Introduction

Economic reforms and trade liberalization have brought about tremendous changes to the labor market in transition countries, raising the question of how women have fared relative to men in the transition process. Not surprisingly, the impact of economic transition on the gender wage differential and the role of discrimination as an underlying determinant have been the subject of considerable attention. Analysts have focused on two opposing forces. On the one hand, the collapse of central planning has granted managers more discretionary power to reward economically irrelevant characteristics such as gender. On the other hand, in accordance with Becker's (1957) theory of employers' discrimination, rising competition in factor and product markets as a result of reforms should punish discriminatory wage-setting behavior and thus reduce the gender wage gap. Empirically, there is also controversy over whether transition has resulted in an improvement or deterioration of women's wages relative to men's.[1]

Almost all the literature on gender wage gaps in transition economies focus on estimates of wage regressions derived, for the most part, from individual-level data. In these studies, a negative wage differential between women and men, after controlling for observed characteristics, is interpreted as evidence of gender discrimination, and the magnitude of the residual wage gap is used to gauge the degree of discrimination. Because typical wage regressions do not encompass a complete list of proxies for

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[1] Empirical studies on gender wage gaps in transition countries are extensive. In the case of China, see Meng (1998), Maurer-Fazio, Rawski and Zhange (1999), Gustafsson and Li (2000), Liu, Meng and Zhang (2000), Rozelle, et al. (2002), Maurer-Fazio and Hughes (2002), Dong, *et. al*. (2004), and Bishop, *et. al.* (2004). The studies on Central and East European countries include Brainerd (2000), Orazem and Vodopivec (2000), Hunt (2002), Jolliffe and Campos (2004) and Newell and Reilly (2001).

worker productivity determinants, it is contentious whether the residual wage gap is attributable to employers' discriminatory attitude towards women or unobservable sex differences in productivity.[2]

Moreover, a typical finding in this literature is that male-female differences in observed productive characteristics can only explain a small fraction of the gender wage gap.[3] This finding lends an unquestioned acceptance of the contention that women face wage discrimination in transition economies and consequently leads to an overt appreciation of the role of market competition as a force that contains gender wage disparities. What is largely overlooked is the possibility that under central planning the government's commitment to women's emancipation may in fact have created wage subsidies to women. In consequence, the impact of increased market competition is felt through the disappearance of wage premiums for women rather than the decline of wage discrimination during the transition as predicted by many commentators.

In the present paper, we depart from the traditional residual wage gap analysis and examine the patterns of the gender wage gap in post-reform Chinese industry using a unique enterprise-level dataset.[4] The data are derived from a large survey that covers

[2] For a critique on the traditional wage residual gap analysis, see Altonji and Blank (1998).

[3] For example, the "unexplained" component accounts for 53% to 63% of the gender wage gap in Gustafsson and Li, (2000), 89% to 92% in Liu, et. al. (2002), and 76% to 85% in Rozelle, et. al. (2002).

[4] Several researchers have studied gender wage discrimination in established market economies using firm-level data (for references, see Cox and Nye, 1989; Hellerstein and Neumark, 1999; Hellerstein, Neumark and Troske, 1999; Hellerstein, Neumark and Troske, 2000.) Although these studies demonstrate that, as a way to explore gender wage differentials, research based on firm-level data is more fruitful, this approach has not been applied to developing countries and transition economies.

about 1,000 manufacturing enterprises in five cities between the 1998 and 2000. Using the rich information provided by this dataset, we estimate the wage and productivity differentials between male and female workers and test sex discrimination by comparing the female-male differences in wages and productivity. This direct approach not only provides more decisive evidence on wage discrimination but also enables us to test the null hypothesis of no wage discrimination against either sex versus two-sided alternatives, i.e., that women are penalized or awarded by their sex attribute, thereby offering a more complete depiction of the gender consequences of economic transition. We examine further how economic structural changes, property rights reforms, trade liberalization and industrial restructuring may affect gender differentials in wages and productivity. We then go on to investigate whether, and if so how, gender patterns differ between skilled and unskilled workers.

By way of preview, we find little evidence that employers' prejudice against women is a significant source of the gender wage gap in Chinese manufacturing enterprises. Instead, our estimates show that the relative wage of unskilled female to male workers is higher than their relative productivity in SOEs, which suggests that unskilled female workers in SOEs receive wage subsidies. Our results also show that the gender differences in wages and productivity are smaller among unskilled workers in private firms and export-oriented enterprises than, respectively, SOEs and non-export oriented firms, while firms with high R&D intensity endure larger gender gaps in wages and productivity among skilled workers than those with low R&D intensity.

2. Overview of economic transition and women's wages and employment

Under central planning, the Chinese government introduced a series measures to advance the status of women in society and women's full participation in the labor force played a key role in the leadership's attempt to reduce gender inequality and discrimination against women. Most working-age women were employed on a full-time basis in SOEs and had equal entitlements with their male colleagues to lifetime guaranteed employment and a wide range of enterprise-provided welfare and benefits. With the official policy of equal pay for equal work, the gender wage gap in pre-reform China was remarkably small by international standards.[5]

Despite the significant advancements given to Chinese women under central planning, women were far from being equal with men in the labor market. Sex segregation was prevalent in the workplace (Ngo, 2002). While 'holding-up half the sky' in the workplace, women in urban China had to perform most of the unpaid work at home, just as women around the world do (Croll, 1983). Unequal division of domestic labor hindered women's job performance. Moreover, the economy under central planning was dominated by capital-intensive heavy industry which is traditionally regarded as a male sector. The official policy of women's full labor force participation under this irrational economic structure means that many women were either crowded into the overstaffed clerical and low-level administrative occupations or assigned to the positions in which women have a biological disadvantage, i.e. blue collar jobs that require physical strength. Labor manning and skill mismatch would

[5] Kidd and Meng (2000) find that female workers in Chinese state enterprises earned around 86% of the average wage received by men in 1981 and the ratio rose slightly to 87% in 1987. As a point of reference, the cross-country average nonagricultural earnings ratio of female to male is 0.73; it is 0.76 in the United States, 0.57 in South Korea, and 0.51 in Japan (Jacobsen, 1998, p350).

amplify gender disparities in labor productivity. However, the gender difference in productivity may not have much bearing on labor compensations as the wage structure of SOEs was highly compressed.

In the late 1970s, China began its gradual transition to a market-oriented economy. Early efforts to reform SOEs focused on restructuring the incentives given to workers and managers, encouraging the development of non-state sectors, fostering market competition, promoting manufacturing exports and attracting foreign investment. However, the government continued to rely on state employment to buffer urban workers against massive open unemployment. Hence, from 1978 to 1995, state payrolls increased by 38.1 million, an increase of 51 per cent, while empirical studies estimated that 20 to 40 per cent of workers in state firms were redundant in the early 1990s (e.g., Li and Xiu, 2001; Dong and Putterman, 2001).

During the early years of reforms, the prospect of wage employment for urban women continued to improve. Between 1978 and 1995, women's share in formal employment[6]increased from 32.9 to 39.4 percent--although roughly 70 percent of the increase in female employment was created in the state sector (Dong, et. al., 2006). Thus, the rise in women's employment in the early reform era may have concurred with the growth of labor surplus in SOEs.

The pace of market reforms accelerated in the 1990s. In 1994, a new Labor Law was passed sanctioning the right of employers to dismiss workers. In 1997, newly elected Premier Zhu Rongji announced a large-scale labor retrenchment program in an

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[6] It refers to the category termed as 'staff and workers' in *China's Statistical Yearbook*.

attempt to revitalize SOEs. As a result, more than 28 million state workers were laid off between 1998 and 2002 (Zhang, 2004). Women were observed to have been laid-off at rates much higher than men (Appleton, *et. al.*, 2002; Giles, Park and Cai, 2006). The industrial restructuring bought an end to the era of cradle-to-grave socialism and lifetime employment for Chinese state workers.

3. The impacts of transition and issues to be explored

The impact of the changes in the urban labor markets on the male-female wage gap is complex, as reforms affected not only how men and women are rewarded but also how they perform at work. As widely recognized in the literature, market reforms have unleashed two forces that transformed gender relations in the workplace. The state's retreat from its position of domination in society led to a reemergence of Confucian patriarchal values and increased managerial autonomy have given managers more freedom to engage in discriminatory practices. In the meantime, market competition and privatization have strengthened managers' interest in profits, bringing remuneration more in line with performance. The increase of managers' stake in the cost effectiveness of firms would decrease the gender wage gap by curtailing the managers' incentives to discriminate against women but increase the gap by eliminating wage premiums if women were overcompensated relatively to men, compared to their difference in productivity, under an administrative labor regime. Thus, the effect of market competition on the gender wage gap during the transition depends upon how employers' sex preference might have affected wage determination in its absence.

The impact of market reforms on gender differences in productivity is equally ambiguous. Market reforms and trade liberalization have shifted the economic structure away from capital-intensive heavy industries towards labor-intensive light industries and commercial and knowledge-based services. Studies on East and South Asian economies show that export-oriented growth has been associated with a feminization of employment (World Bank, 2001). The change in the composition of labor demand should improve women's prospects for wage employment and consequently increase the relative scarcity and marginal productivity of female to male workers. The emergence of the knowledge-based services sector is expected to create more positions in which men's biological advantages over women are minimal. Increased labor market flexibility also allows men and women to seek jobs that are consistent with their preferences and expertise. In addition, rapid economic growth improves greatly the availability of consumer goods and durables that lessen the burden of household chores, thereby helping improve women's performance at work. All these changes should diminish the gender difference in productivity and subsequently lower the pay differential in the long run.

However, the transition from a command to a market-oriented system also let out the forces that neutralize its equalizing effects. Increased market competition put the pressure on SOEs to replace their obsolete production process with new technology and trade liberalization accelerates the pace of technological changes. The industrial technological upgrading may intensify the gender disparity because women suffer higher costs of retraining because of gender inequality in domestic responsibilities and human capital investment. The international experience has attested to such a trend: when a country is undergoing industrial upgrading, women lose their original comparative advantage and encounter more difficulty than men adjusting to the changes

(Joekes and Weston, 1999; Fussell, 2000; Berik, 2000). Unskilled female workers may arguably be more adversely affected by restructuring than their skilled sisters because the adjustment costs for unskilled workers are likely to be higher. Furthermore, the rising influence of traditional patriarchal values may exacerbate occupational segregation by sex and further enhance men's advantage over women at the workplace. While a wage premium or penalty to sex attribute is theoretically incompatible with market forces, the persistence of gender segmentation in established market economies is well documented in the literature.[7]

In this paper, we examine the impact of economic transition on gender differentials in wages and productivity from two angles. First, we investigate what role socialist egalitarian ideology and traditional patriarchal values have as an underlying source of the pay gap between men and women in Chinese manufacturing enterprises in the late 1990s. We compare the behavior difference between SOEs and private firms. Against the null hypothesis that men and women are paid according to their marginal products, the alternatives are likely to be different between the two types of firms. Given that managers of private firms are less susceptible to the influence of egalitarian ideology than their counterparts in state enterprises and have more discretionary power to act out prejudice against women, we expect that women in private firms are more likely to be the target of sex discrimination and less likely to receive wage premiums than their sisters in SOEs.

Secondly, we investigate whether economic structural changes, increased labor market flexibility, and trade liberalization help mitigate gender differences in

[7] For a review of the literature on sex segregation, see Altonji and Blank (1998).

productivity and remuneration and whether industrial technological restructuring exacerbates gender disparities. For this purpose, we split the sample into SOEs versus private firms, export versus non-export oriented firms, and firms with high versus firms with low R & D intensity and compare the contrasts in each comparative group.

We further investigate which type of female workers—skilled or unskilled--is more likely to be the target of sex discrimination or preferential treatments and to be the victim or beneficiary of the various changes let out by the transition. With the wide acceptance of egalitarian social norms in SOEs, unskilled female workers are more likely to be the recipients of wage subsidies than skilled female workers. The expansion of the private and manufacturing export sectors which are dominated by labor intensive consumer goods production should benefit unskilled more than skilled female workers. However, it is difficult to predict ex-ante the occupation differentiated gender effects in other cases. In the next three sections, we investigate empirically how various conflicting forces play out.

4. Research methodology

4.1 Conceptual Framework

Our investigating method is developed from Becker's (1971) original model of employer discrimination. We assume that the enterprise under investigation hires male and female workers at a given wage rate for each type of workers.[8] We further assume that the recruitment of a female worker affects the utility of the employer: it reduces the utility if the employer has "a taste for discrimination" and increases the utility if the

[8] For the tractability, we omit the choice of labor in different occupational categories in the conceptual framework. The result of this framework can be easily extended to an occupation differentiated case.

employer seeks to advance the status of women in society. The utility function is specified as

$$U = U\left(\pi, L_f\right) \qquad (1)$$

where π is profit, from which the employer receives utility. The short run profit function is

$$\pi = PQ(L_m, L_f) - W_m L_M - W_f L_f \qquad (2)$$

Where Q is output, which is a function of male and female labor (L_m and L_f , respectively); P is the price of output; W_m and W_f are the wages of male labor and female labor, respectively.

When the employer's utility is maximized, the decision rule for men is the same as the one maximizing profit, i.e., the wage is equal to the value of marginal product of male labor, Q_m. But for women, the decision rule is different: the wage is equated with the value of marginal product, Q_m, plus the marginal rate of substitution of profit for women hired. Thus, we have the following decision rules:

$$PQ_m = W_m \qquad (3)$$

and

$$PQ_f + \frac{\partial U / \partial L_f}{\partial U / \partial \pi} = W_f \qquad (4)$$

where $\frac{\partial U / \partial L_f}{\partial U / \partial \pi}$ is the marginal rate of substitution of profit for female employment, and it has the same sign of the employer's marginal utility of female employment, $\partial U / \partial L_f$. If $\partial U / \partial L_f < 0$ (>0), the marginal value product of female labor is higher (lower) than the female wage rate and hence female labor is underemployed (over-employed) by the standard of profit maximization.

From equations (3) and (4), whether women receive wage premiums or suffer from discrimination can be tested by comparing the ratio of marginal products of female to male workers with the wage ratio. Specifically, if the employer's sex preference does not play a role in his/her recruitment decision, the ratio of marginal products of female to male labor, Q_f / Q_m, is equal to the wage ratio of female to male workers, W_f / W_m; if the employer has a prejudice against women, Q_f / Q_m is larger than W_f / W_m; and if the employer pursues the political objective of gender equality beyond economic considerations, Q_f / Q_m is smaller than W_f / W_m.[9]

4.2 Empirical Specification

A. Wage differentials by gender

We need to estimate the relative wage of female as compared to male workers from wage regressions because the compensation information available in our dataset only provides us with a measure of the average wage of all employees in a firm instead of wages by sex. We assume that the mean wage of a firm, W, is an weighted average of wages for female unskilled workers, female skilled workers, male skilled workers, and male unskilled workers, denoted respectively as W_{us}^f, W_s^f, W_s^m and W_{us}^m, specified as

[9] In the presence of labor surplus, the difference between Q_f / Q_m and W_f / W_m is also indicative of which sex assumes a larger share of the misallocation.

$$
\begin{aligned}
W &= W_s^m (M_s / L) + W_{us}^m (M_{us} / L) + W_s^f (F_s / L) + W_{us}^f (F_{us} / L) \\
&= W_s^m + (M_{us} / L)(W_{us}^m - W_s^m) + (F_s / L)(W_s^f - W_s^m) + (F_{us} / L)(W_{us}^f - W_s^m)
\end{aligned} \tag{5}
$$

where M_s, M_{us}, F_s *and* F_{us}, stand for skilled male, unskilled male, skilled female, and unskilled female workers, respectively, and L is the total workforce of the enterprise.[10] We consider two forms of specification for the wage equation (5). First, we assume that any female-male wage differential is the same for skilled and unskilled groups, i.e., $W_{us}^f / W_{us}^m = W_s^f / W_s^m = W^f / W^m = \phi$. Let η denote the relative wage of unskilled male to skilled male workers, i.e., $W_{us}^m / W_s^m = \eta$, and write the relative wage of unskilled female to skilled male workers as $W_{us}^f / W_s^m = \eta\phi$. The natural logarithm of (5) can be seen as

$$
\ln(W) = \ln(W_{s_s}^m) + \ln[(1 - \frac{L_f}{L})(1 + (\eta - 1)\frac{M_{us}}{L_m}) + \phi\frac{L_f}{L}(1 + (\eta - 1)\frac{F_{us}}{L_f})] \tag{5.1}
$$

We then relax the assumption that the gender wage gap is invariant cross occupation groups. Let $W_{us}^m / W_s^m = \phi_{mus}$, $W_s^f / W_s^m = \phi_{fs}$ and $W_{us}^f / W_s^m = \phi_{fus}$. The wage equation of (5) in log form is specified as

$$
\ln(W) = \ln(W_{s_s}^m) + \ln[(1 + (\phi_{mus} - 1)\frac{M_{us}}{L} + (\phi_{fs} - 1)\frac{F_s}{L} + (\phi_{fus} - 1)\frac{F_{us}}{L})] \tag{5.2}
$$

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[10] The empirical framework follows Hellerstein and Neumark (1999). We make two major improvements on Hellerstein and Neumark's analysis. Due to data limitations, Hellerstein and Neumark assumed that the proportion of workers in each occupation class is invariant for men and women and that the relative wage and productivity of female to male workers are the same for all occupation categories. Both restrictive assumptions are relaxed in our analysis. Several authors have applied a geometric aggregation scheme to estimate wage differentials between occupations or sexes (e.g., Svejnar, 1984; Margaret Maure-Fazio, et. al., 1999). We also estimated the specifications based on a geometrical aggregation of wages and labor quality and found the results to be similar to those presented in this paper.

In (5.2), ϕ_{fs} measures the relative wage of skilled female to skilled male workers and the wage ratio of unskilled female to unskilled male workers is given by ϕ_{fus}/ϕ_{mus}. The estimate of ϕ in (5.1) can be interpreted as the average of ϕ_{fs} and ϕ_{fus}/ϕ_{mus}.

Since W_s^m is unobservable, equations (5.1) and (5.2) can be made operational by replacing $\log(W_s^m)$ by a linear stochastic function of its determinants, $\lambda_0 + X'\lambda + \varepsilon$. Thus, we have

$$\ln(W) = \lambda_0 + \ln[(1-\frac{L_f}{L})(1+(\eta-1)\frac{M_{us}}{L_m}) + \phi\frac{L_f}{L}(1+(\eta-1)\frac{F_{us}}{L_f})] + X'\lambda + u \quad (6.1)$$

and

$$\ln(W) = \lambda_0 + \ln[(1+(\phi_{mus}-1)\frac{M_{us}}{L} + (\phi_{fs}-1)\frac{F_s}{L} + (\phi_{fus}-1)\frac{F_{us}}{L})] + X'\lambda + u \quad (6.2)$$

where X is a vector of variables that determine the wage holding constant the effects of sex and occupation; the Greek letter in (6.1) and (6.2) are the unknown parameters, and u is the random disturbance term. The estimates of ϕ in (6.1) and ϕ_{fs}, ϕ_{fus}/ϕ_{mus} and ϕ_{fus} in (6.2) are the focus of our investigation. $\phi<1$ implies that the wage of a female worker is lower than that of a male; $\phi_{fs} < 1$ and $\phi_{fus}/\phi_{mus} < 1$ indicate that female workers earn less than male workers for skilled and unskilled occupation group, respectively; $\phi_{fus} < 1$ means that the wage of a unskilled female worker is lower than that of a skilled male workers.

B. Productivity differentials by gender

The estimates of productivity differences between female and male workers are obtained from the production function regression. The production function is taken to be Cobb-Douglas and written as

$$Q = A(EL)^{\alpha} K^{\beta} \tag{7}$$

where A is technical coefficient, Q is output measured by value added[11], K is capital, and L is labor, E is the average quality of labor.

Consistent with the specification of the wage equation, E is assumed to be arithmetically aggregated over men and women and skilled and unskilled labor and it can be seen as

$$\begin{aligned} E &= q_s^m (M_s / L) + q_{us}^m (M_{us} / L) + q_s^f (F_s / L) + q_{us}^f (F_{us} / L) \\ &= q_s^m + (M_{us} / L)(q_{us}^m - q_s^m) + (F_s / L)(q_s^f - q_s^m) + (F_{us} / L)(q_{us}^f - q_s^m) \end{aligned} \tag{8}$$

where q_j^i, i = m, f and j = s, us, is a labor quality for a given group indicated by its superscript and subscript. The two specifications of labor index in log form in the analogy of (5.1) and (5.2) are written as

$$\ln(E) = \ln(q_s{}^m) + \ln[(1 - \frac{L_f}{L})(1 + (\mu - 1)\frac{M_{us}}{L_m}) + \rho \frac{L_f}{L}(1 + (\mu - 1)\frac{F_{us}}{L_f})] \tag{8.1}$$

and

$$\ln(E) = \ln(q_s{}^m) + \ln[(1 + (\mu_{mus} - 1)\frac{M_{us}}{L} + (\mu_{fs} - 1)\frac{F_s}{L} + (\mu_{fus} - 1)\frac{F_{us}}{L})] \tag{8.2}$$

In (8.1) the male-female differential in labor quality is assumed to be the same for skilled and unskilled groups, i.e., $q_{us}^f / q_{us}^m = q_s^f / q_s^m = q^f / q^m = \rho$; μ is the relative quality of unskilled male to skilled male workers, i.e., $q_{us}^m / q_s^m = \mu$; and the relative quality of

[11] Griliches and Ringstad (1971) summarized the advantages of using value added as the dependent variable for production function.

unskilled female to skilled male workers, q_{us}^f / q_s^m, is equal to ρμ. In (8.2), the assumption that the male-female differential in quality is invariant cross occupation groups is relaxed. μ_{mus}, μ_{fs}, and μ_{fus} denote the quality ratio of an unskilled male to a skilled male worker q_{us}^m / q_s^m, of a skilled female to a skilled male worker q_s^f / q_s^m, and of an unskilled female to a skilled male worker q_{us}^f / q_s^m, respectively. The relative quality of an unskilled female to an unskilled male worker is given by μ_{fus}/μ_{mus}.

Taking natural log of (7), substituting (8.1) and (8.2) for log (E), and replacing the unobserved term, $\ln A + \alpha \ln(q_s^m)$ by a stochastic function, $\gamma_0 + Z'\gamma + u$, we get the empirical versions of the production function paralleling the wage equations of (6.1) and (6.2) below

$$\ln(Q) = \gamma_0 + \alpha \ln[(1 - \frac{L_f}{L})(1 + (\mu - 1)\frac{M_{us}}{L_m}) + \rho \frac{L_f}{L}(1 + (\mu - 1)\frac{F_{us}}{L_f})] + \alpha \ln(L) + \beta \ln(K) + Z'\gamma + v \quad (9.1)$$

and

$$\ln(Q) = \gamma_0 + \alpha \ln[(1 + (\mu_{mus} - 1)\frac{M_{us}}{L} + (\mu_{fs} - 1)\frac{F_s}{L} + (\mu_{fus} - 1)\frac{F_{us}}{L})] + \alpha \ln(L) + \beta \ln(K) + Z'\gamma + v \quad (9.2)$$

where Z is a vector of covariate controls; the Greek letters are unknown parameters; and v is the random disturbance term. The parameters of most interest are ρ in (9.1) and μ_{fs}, μ_{fus}/μ_{mus} and μ_{fus} in (9.2). It can be shown that ρ is the marginal value product of a female relative to a male worker for a given occupation group, and that μ_{fs} and μ_{fus}/μ_{mus} are, respectively, the relative marginal value product of female to male labor for skilled and unskilled groups and μ_{fus} is the ratio of marginal product of unskilled female to skilled male workers. Thus, $\rho < 1$, $\eta_{fs} < 1$, or $\eta_{fus}/\eta_{mus} < 1$ imply that women are less productive than men for a given occupation group, and vice versa and $\mu_{fus} < 1$ means that unskilled female workers are less productive than skilled male workers.

The covariate controls in Z contain the same variables as those in X for the wage equations. We allow wages and productivity to vary systematically across industrial sectors and cities and over time, and we also control for firm characteristics, such as ownership, firm age, size, market share, export share, and propensity to R&D investment. The selection of covariates takes into account the effects of sex segregation by industrial sector and by firm attribute. As shown in the next section, these variables are indeed correlated with the sex distribution of the labor force; neglecting the effects of sex segregation on these regards would bias the estimates of the gender differences in wages and productivity.

In the empirical analysis, the wage equation and the production function for each specification are estimated as a seemingly unrelated non-linear system to take into account non-zero covariance of wages and productivity. The null hypothesis of no wage discrimination against either sex is tested in the forms of $\phi = \rho$, $\phi_{fs} = \mu_{fs}$, $\phi_{fus}/\phi_{mus} = \mu_{fus}/\mu_{mus}$, and $\phi_{fus} = \mu_{fus.}$ For the sake of comparison, we also explore the relationship between the compensation and the productivity of unskilled to skilled male workers by testing the null hypotheses that $\eta = \mu$ and $\phi_{mus} = \mu_{mus}$.

5. Data, Variables and Summary Statistics

Our data are derived from the Investment Climate Survey undertaken in China by the World Bank in 2001. The survey covers 1,500 firms in five cities - Beijing, Tianjin, Shanghai, Guangzhou and Chengdu, with 998 randomly selected from the manufacturing sector and 502 from the knowledge-based service sector. Our analysis focuses on the manufacturing sector because the measure of output of service firms is more problematic. The survey collected detailed information on firms' operation and various characteristics for the period from 1998 to 2000-- an important period during which Chinese industrial enterprises underwent large scale labor retrenchment. However, information on the sex composition of a firm's workforce is available only for 1998 and 2000, therefore only these two cross-sections of observations are used in the empirical analysis.[12]

The variables involved in the regression analysis are defined as follows. Output is measured by value-added deflated by GDP deflator with 2000 as the base year, which is defined as sales revenue minus the sum of the cost of raw material, inventory of finished product of the previous year and inventory of raw material of the previous year. Capital is the net value of fixed assets, which is also discounted by GDP deflator with 2000 as base year. Labor is the average number of total on-post employees in a given year. The variable for wage is derived by dividing total labor compensation by total employment, deflated by consumer price index with 2000 as base year. Skilled labor includes managerial personnel, engineers, and technicians, and the remainder represents unskilled labor.

With respect to the covariate controls, firm age is defined as the number of years a firm has been in existence. Firm size is measured by a dummy variable, *Small*, which is defined, based on the median value of the sample, as equal to *one* if the number of workers is less than 240 and *zero* otherwise. Market share is the share of major products in domestic markets, and export share is percentage of exports in sales

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[12] Because the data contain a gap in time series, we are unable to control unobservable characteristics using the fixed-effects technique.

revenue. The proxy variable for R & D intensity, *Innovation*, is derived as the sum of dummies for the responses to the question of whether, since the beginning of the period of investigation, the enterprise has introduced innovations in each of the five areas such as new products or new business lines, making new process improvements, and adopting new management techniques or new quality control methods. Dummy variables are introduced to control for variations across regions, industrial sectors, and time periods. Based on equity shares held by various agents at the time of the survey, enterprises with over 50% of public ownership are defined as SOEs while enterprises with over 50% (inclusive) of private ownership are defined as private firms.[13]

Summary statistics of the variables used in the regression analysis are presented in Appendix Table a1. With respect to the sample makeup, SOEs account for about 53.7 percent of the observations and private firms for the remaining 46.3 percent. Consistent with women's high employment rate in urban China, the proportion of female workers is, on average, 44.6 percent for the whole sample, with the mean value for private firms being slightly higher than that for SOEs. There are noticeable differences between SOEs and private firms: wages are, on average, higher in private firms than SOEs; a typical private firm is younger and smaller and more likely produces goods for international markets; the distribution of SOEs is more skewed towards capital-intensive sectors such as vehicles and vehicle parts.

The correlation coefficients of female shares and other firm characteristics presented in Table a2 confirm the presence of sex segregation by firm type and by

[13] Private firms include both firms established by domestic or foreign private investors as well as privatized enterprises, with the makeup being dominated by the former category.

occupation. These statistics show that the share of female workers in a firm's labor force is positively correlated with the proportion of unskilled workers, private equity, exports share, firm age and size, and negatively with market share, capital-labor ratio, and proclivity to invest in new technology. Thus, it is imperative to control for variations across sectors, firm types and occupational categories in order to obtain consistent estimates of the gender differentials in wages and productivity.

6. Empirical Results

The joint estimates of the wage equation and the production function are presented in Tables 1 to 4. Judging by the values of R^2 reported in each table, the wage equation and the production function both fit the data well in most cases.

6.1. Results of equations (6.1) and (9.1)

We begin with the wage equation (6.1) and the production function (9.1)—the more restrictive specification (see Tables 1 and 2). [14]

A. Results for the full sample

Before discussing the coefficients on the proportions of female workers and unskilled workers--the primary interest of our analysis, we first take a look at the estimates of firm characteristics and factor inputs (see Table 1). All the estimates of firm characteristics in the wage equations have expected sign and are statistically significant (see Panel A). Consistent with economic intuitions, the estimates show that wages are higher in the firms that are younger, more oriented towards international

[14] To check the robustness of estimates, we also estimated the restive version of the wage equation and the production function assuming that firms adopt the translog production technology. The results are qualitatively different from those reported in Tables 3 and 4.

markets, and privately owned, and have more market power and higher propensity to adopt new technology.

Turning to the production function (see Panel B), the estimates of labor and capital assets all have expected sign and are quantitatively plausible and significant at the 1% level. The estimates for firm age, technological innovation and private firms are statistically significant. These estimates indicate that the productivity of older firms and firms that are less likely to invest in new technologies is significantly lower and that private firms are more productive than SOEs. Comparing the estimates between the wage equation and the production function, we note that there is greater heterogeneity between firms in wages than in productivity.[15]

We now turn to the gender differences in wages and productivity.[16] The estimate of the female-male wage ratio ϕ is highly significant and has a value of 0.774.[17] The null hypothesis that $\phi = 1$ is rejected at the 5 percent level (see Panel C of Table 3), suggesting that women earn significantly less than men. The key parameter of interest in the production function is ρ, the ratio of marginal product of female to male workers. Significant at the 1 percent level, the estimate of ρ is 0.724. The null hypothesis that the marginal output of women is equal to that of men, i.e., $\rho = 1$, is

[15] Arguably, the variables for market share and export share may be endogenous in the wage equation. To check the robustness of the results, we also estimated the wage equation and the production function without controlling for firm characteristics and found the results not to be substantively different from those reported in Tables 3 to 6.

[16] While we control for firm characteristics in all regressions, in the remaining section we confine our discussion to the estimates of relative wages and productivity for the sake of streamlining the exposition.

[17] The estimate of the gender wage ratio obtained from the sample of combining both the manufacturing and the service sectors is 0.852, which is fairly close to the estimate obtained from national representative data we mentioned earlier.

rejected at the 10 percent level, indicating that women are less productive than men. Numerically, the estimated wage ratio (0.774) exceeds the ratio of marginal productivity (0.724) by 5 percentage points. The null hypothesis that the male-female differential in wages is equal to their difference in marginal productivity cannot be rejected at any conventional level of significance (with the p value of 0.749).[18]

Turning to the estimates of the wage and productivity coefficients on the proportion of unskilled workers, η and μ, we note that all are significantly different from zero but less than unity. As indicated by these estimates, while unskilled workers, on average, receive about 23.9 percent of the pay of skilled workers, their marginal productivity is only about 11 percent of that of skilled workers. The wage ratio exceeds the ratio of marginal productivity by 12 percentage points, and the difference is highly significant. This result unveils that unskilled workers receive wage premiums, which is consistent with the well documented stylized fact that the labor surplus in Chinese manufacturing firms is predominantly unskilled labor.[19]

B. Results by ownership

The estimates for SOEs and private firms are presented in the last two columns of Table 1. The estimated gender wage ratio, ϕ, and the marginal productivity ratio, ρ,

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[18] It is noteworthy that our estimates of the gender wage and productivity ratios are very close to the estimates by Hellerstein and Neumark (1999) for Israeli manufacturing firms. They find that the marginal product of women is about 80 percent of that of men, while their wages are 75 percent of the pay for men.

[19] According to the Second Investment Climate Survey undertaken by the World Bank in China, which covers 2,400 firms in 18 cities, about a third of the state enterprises in the sample had redundant workers and the average rate of redundancy was about 10% in 2002, and in the state enterprises that had labor surplus nearly a third of unskilled workers were in surplus. The mean redundancy rate claimed by the managers of private firms was negligibly small - less then one percent (Dong and Xu, 2005).

are both smaller in SOEs than in private firms (0.686 versus 0.784 for wages and 0.418 versus 1.073 for productivity); the estimates of ϕ and ρ are all significantly less than one for SOEs but insignificant for private firms. The finding that the male-female difference in productivity is larger in SOEs than private firms supports the contention that economic structural changes and increased labor market flexibility help to narrow the male-female disparity in productivity.

With respect to reward patterns, we note that the sex wage ratio is greater than the sex ratio of marginal productivity in SOES, whereas the converse is true for private firms. However, the null hypothesis of no wage discrimination against either sex, i.e. $\phi = \rho$, cannot be rejected for private firms at any conventional level of significance, but rejected at the 10 percent level for SOEs in support of the alternative that women receive wage subsidies. In light of SOEs' longstanding problem of overstaffing, this result also implies that the problem is more severe among female than male workers.

Despite the sharp contrast in gender relations, the wage-setting patterns for skilled and unskilled workers are similar between the two types of firms - SOEs and private firms both appear to over-compensate unskilled relative to skilled workers with the null hypothesis of $\mu = \eta$ being rejected at the 10 percent level for SOEs and the 5 percent level for private firms. While the result for SOEs is consistent with the sector's compressed wage structure, the outcome of private firms begs a different explanation. During the period of investigation the Chinese economy was experiencing contraction due to the Asian currency crisis; perceiving the shock to be transitory, firms may choose to hoard those workers that were temporarily in surplus to minimize recruitment costs.

C. By trade orientation and R&D intensity

To assess the gender impact of trade liberalization, we divide the sample into two groups with a division line at 10% of an enterprises' sales revenue. Enterprises whose exports account for over 10% (inclusive) of sales revenue are defined as export enterprises (export-oriented enterprises), while enterprises whose export accounts for less than 10% of their sales revenue are defined as domestic-sales enterprises. A comparison of the estimates between export and non-export oriented firms (the first two columns of Table 2) strongly supports the conjecture that the expansion of manufacturing exports lessens gender differentials in wages and productivity. The estimated wage and productivity ratio for the export-oriented firms are 1.086 and 1.443. However, the hypotheses of $\phi = 1$ and $\rho = 1$ cannot be rejected, implying that women and men employed in export-oriented firms receive more or less the same pay and are equally productive. In contrast, women in domestic sales firms receive only 59.2 percent of the pay of their male co-workers and their marginal productivity is equally as low, only 55.9 percent that of men. Despite the contrast, the hypothesis that the gender wage ratio is equal to the productivity ratio, $\phi = \rho$, can't be rejected for either ownership type.

To assess how industrial technological restructuring may affect gender relations, we split the sample by an integer close to the mean value of the variable of *innovation*-2. Firms that have a R&D intensity score greater than 2 inclusively are defined as high R&D firms, while firms that have a R&D intensity score less than 2 are called low R&D firms. As can be seen in the last two columns of Table 2, the gender gap in productivity is wider for the high R&D firms than the low R&D firms: the estimate of ρ

is 0.475 for the former and 1.091 for the latter. In addition, the estimate of ρ is significantly less than one for the former but insignificant for the latter. Despite the difference in productivity, estimates of the gender wage ratio ϕ are more or less the same for the two types of firms (0.806 versus 0.807). The null hypothesis that the wage ratio of female to male workers is equal to their relative productivity is not rejected for the low R&D intensity firms but rejected at the 10 percent level for the high R&D intensity firms in favor of the alternative hypothesis that the gender wage ratio of female to male workers is higher than the productivity ratio. The firms that were more likely to pursue technological innovation appear to have financially compensated women for their losses.

6.2 Results of equations (6.2) and (9.2)

The estimates of the wage equation (6.2) and the production function (9.2) are presented in Tables 3 and 4. In this specification we relax the assumption that the wage and the productivity ratios of female to male workers are constant across occupational categories.

A. Results for the full sample

Looking at the estimates for the full sample resented in the first column of Table 3, we note that all the estimates of wage and marginal output ratios are significant at the 5 percent level or lower. The gender differences appear to be wider among unskilled workers than skilled workers. Evidently the wage and productivity ratios of skilled female to skilled male workers (Φ_{fs} and μ_{fs}) are respectively 0.684 and 0.770; by contrast, the respective ratios of unskilled female to unskilled male workers (Φ_{fu}/ Φ_{mu}

and μ_{fu}/μ_{mu}) are 0.566 and 0.547. The hypothesis that female and male workers are equally productive cannot be rejected for skilled workers but rejected for unskilled workers (Panel C); however, both skilled and unskilled female workers earn significantly less than their male counterparts. The null hypotheses of no discrimination against either sex among skilled workers ($\Phi_{fs} = \mu_{fs}$) and among unskilled workers ($\Phi_{fu}/\Phi_{mu} = \mu_{fu}/\mu_{mu}$) are both not rejected, indicating that the gender wage gap reflects primarily the productivity gap for manufacturing workers in each occupational group.

Turning to the comparison of skilled versus unskilled male workers, we find that the wage ratios of unskilled female to skilled male workers (Φ_{fu}) and unskilled male to skilled male workers (Φ_{mu}) are significantly larger than the respective marginal output ratios (μ_{fu} and μ_{mu}). It is evident that unskilled workers, both female and male alike, are overcompensated relative to skilled male workers.

B. By ownership

We now examine whether the gender consequences of ownership change differ between skilled and unskilled workers (see the last two columns of Table 3). In line with the finding presented earlier, the estimated gender disparity in productivity is noticeably small in private firms compared to SOEs by all three indicators, $\mu_{fs,}$ $\mu_{fu,}$ and μ_{fu}/μ_{mu} (Panel B of Table 3). The relative productivity of a female skilled to a male skilled worker μ_{fs} is strikingly higher than that for unskilled workers μ_{fu}/μ_{mu} in SOEs--0.642 for the former and 0.156 for the latter and the hypothesis that female and male workers are equally productive can't be rejected for skilled workers but rejected for unskilled workers (Panel C of Table 3). An opposite pattern is observed in the private sector: the relative productivity of female to male workers among unskilled workers is higher than skilled workers—1.275 for the former and 0.872 for the latter, although the tests for the hypotheses that μ_{fe} = 1 and μ_{fu}/μ_{mu} =1 indicate that female and male workers are equally productive for both skilled and unskilled groups. The differences between the two ownership categories show that the expansion of the private sector narrows the gender disparity in productivity largely through creating more female-intensive unskilled positions.

Turning to the estimated wage ratios, we note that the wage of female workers is significantly lower than that of male workers for both occupation groups in SOEs; in contrast, the wage of female workers is not significantly different from that of male workers for the skilled class but significantly lower for the unskilled class in private firms. The test of the equality of gender differentials for skilled workers ($\Phi_{fs} = \mu_{fs}$) performed for each type of firms yields a similar conclusion that the gender wage ratio equates the gender productivity ratio. However, there are striking differences in the gender pattern of how unskilled female and male workers are remunerated between SOEs and private firms. For SOEs, the wage ratio of an unskilled female to an unskilled male (Φ_{fu}/ Φ_{mu}) and to a skilled male worker (Φ_{fu}) is significantly greater than the respective productivity ratio μ_{fu}/μ_{mu} and μ_{fu}; the p value for the test on $\Phi_{fu}/ \Phi_{mu} = \mu_{fu}/\mu_{mu}$ is 0.069 and the p value for $\Phi_{fu} = \mu_{fu}$ is 0.010. Evidently unskilled female workers are overcompensated both relative to unskilled and skilled male workers in SOEs. However, the equality of wage and marginal productivity ratios of unskilled male to skilled male workers, i.e., $\Phi_{mu} = \mu_{mu}$, is not rejected at any conventional level of significance. Recall the finding from the more restrictive specification presented earlier that SOEs pay wage subsides to both female and unskilled workers, the gender and occupation differentiated estimates suggest that the wage premiums be awarded chiefly to unskilled female workers in that sector.

Looking at the estimates for private firms, we find that the wage ratio of unskilled female to unskilled male workers $\Phi_{fu}/\ \Phi_{mu}$ is lower than the productivity ratio μ_{fu}/μ_{mu} by a noticeable margin (0.559 versus 1.275), which indicates that unskilled female workers in private firms may face discrimination.. However the difference between the two ratios is statistically insignificant. As with the test for unskilled workers ($\Phi_{fu}/\ \Phi_{mu} = \mu_{fu}/\mu_{mu}$), the equality of the wage and the productivity ratios of unskilled female to skilled male workers ($\Phi_{fu} = \mu_{fu}$) also cannot be rejected at any conventional level of significance. While the aforementioned tests show that male and female workers are paid mainly according to their relative marginal productivity in private firms, the test on the equality of the wage and productivity ratios of unskilled to skilled male workers ($\Phi_{mu} = \mu_{mu}$) suggests that private firms pay wage subsidies to unskilled male workers. Interestingly, while we find that both types of manufacturing firms overpay unskilled workers, unskilled women appear to be the main beneficiary in SOEs while unskilled men the main recipient of wage subsidies in private firms.

C. By trade orientation and R&D intensity

We first examine the estimates by trade orientation (the first two columns of Table 4). These estimates confirm the result reported earlier that the gender differentials in wages and productivity are smaller in the export- than the non-export oriented firms. Manufacturing exports seem particularly beneficial to unskilled female workers in that while the estimated gender wage and productivity ratios for skilled worker (Φ_{fs} and μ_{fs}) are not significantly different from unity for both types of firms, the wage and productivity ratio of unskilled female to unskilled male workers for the export-oriented firms (respectively 0.893 and 0.866) exceed the respective ratios for the domestic sales firms (respectively 0.159 and 0.281) by a strikingly large margin. Despite the differences, the hypothesis that women and men are paid according to their relative marginal productivity cannot be rejected at any conventional level of significance regardless of trade orientation. Both types of firms appear to subsidize unskilled workers—male workers alone in the domestic sales firms and both female and male alike in the export firms.

With respect to the estimates by R&D intensity, to recap, the result of the more restrictive specification shows that the gender gap in productivity is larger in the high R&S firms than in the low R&D firms. According to the gender and occupation differentiated estimates presented in the last two columns of Table 6, the industrial upgrading seems to adversely affect skilled female workers more than unskilled female workers. The wage and productivity ratios of a female to a male in the low R&D firms are 0.985 and 1.347 for skilled workers and 0.400 and 0.465 for unskilled workers. In contrast, the two gender ratios for the high R&D firms are 0.436 and 0.438 for skilled workers and 1.009 and 0.553 for unskilled workers. For the low R&D firms the hypothesis that workers in a comparative group are paid according to the relative marginal productivity is not rejected for all four sex and occupation differentiated groups (Panel C of Table 6). However, the tests of the equality of the wage and the productivity ratios for the high R&D firms yield diverse results. While the hypothesis of no discrimination against either sex is rejected for neither skilled nor unskilled groups, the tests on the equality of the wage and productivity ratios of a unskilled female or a unskilled male to a skilled male worker ($\Phi_{fu} = \mu_{fu}$ and $\Phi_{mu} = \mu_{mu}$) show that unskilled workers--both female and male--are overpaid relative to skilled male workers.

7. Conclusion

In this paper we use a unique enterprise-level dataset to analyze the gender wage differential in post-reform Chinese industry. Our analysis is the first to study the impact of economic transition on the gender wage differential and wage discrimination by looking simultaneously at productivity and wages. Our investigation provides little support for the hypothesis that the gender wage differential in Chinese industrial enterprises reflects employers' taste for discrimination against women. We find that both SOEs and private firms pay skilled male and female workers primarily according to their marginal productivity. However, the relative wage of unskilled female to male workers is significantly higher than their relative marginal productivity in SOEs, which indicates that unskilled female workers receive wage premiums. These results suggest that the gender impact of market competition during the transition is more complicated than what has been predicted by studies based on wage regression analysis. While managerial interest in profits may be the underlying force keeping the pay gap between skilled female and male workers in line with their gap in productivity, unskilled female workers in the state sector—the main beneficiaries of the socialist egalitarian legacy -- would be hardest hit by the acceleration of market reforms, suffering greater wage losses and being laid off at higher rates. This prediction is largely confirmed by the experience of women in the post-restructuring period.

We analyze further how economic transition may affect the gender difference in productivity—ultimate source of the gender wage gap. Our estimates show that women as a group endure less gender disparities in productivity as well as wages in private and export-oriented firms than SOEs and domestic sales firms, respectively. This finding lends support for the conjecture that the shift of the economic structure from capital intensive heavy industries to labor intensive light industries, increased labor market flexibility, and trade liberalization are instrumental to improving women's position in the labor market. However, our results also indicate that the industrial restructuring tends to further advance men's productivity advantage over women, exacerbating the gender wage gap in the long run.

Breaking the sex distribution by occupation, we find that the various changes unleashed by the transition effects skilled and unskilled female workers differently. Industrial upgrading tends to enhance men's productivity advantage over women more among skilled than unskilled workers. The growth of the private sector and manufacturing exports improves the position of unskilled female workers more than that of skilled female workers. These intriguing findings demonstrate once again that the gender consequences of economic transition are complex; the transition has created both new opportunities and challenges for women depending upon their human capital characteristics. Our analysis proves that the approach based on firm-level data is more fruitful than the traditional residual wage gap analysis in untangling the interwoven gender outcomes of the transition.

Our analysis is subject to an important caveat. We test the type of gender discrimination that is defined, according to the Becker's theory of employer discrimination, as the wage gap between men and women that exceeds the gap in marginal productivity. While we find little evidence that women were underpaid in

Chinese manufacturing enterprises in this regard, we do find that workers in firms with more female workers receive lower wages and are less productive. The negative association between the proportion of females in a firm and wages and productivity in itself could be a manifestation of the presence of other forms of gender discrimination. It is well established that discrimination against women in hiring or promotion restricts the employment of women into a subset of firms, industries, or occupations. The resulting outward shift of the labor supply curve in the sectors into which women are crowded decreases both the marginal product of labor and wages in these sectors (Bergmann, 1974). Moreover, the male-female difference in productivity may also be attributable to gender inequality in domestic responsibilities and human capital investment, which is, to a large extent, a result of traditional patriarchal values in Chinese society. Our empirical findings cannot rule out discrimination associated with sex segregation or prejudice against women in intra-household allocation. Understanding of the forms of discrimination which are consistent with the equality of the gender gaps in wages and productivity should be the primarily focus of future research because they cannot be easily eliminated by market competition.

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Table 1: Joint Estimates of Wage Equation (6.1) and Production Function (9.1), by Ownership

	Manufacturing Sector	Manufacturing sector	
		SOEs	Private firms
Φ (share of female workers)	0.774 (0.134)a	0.686 (0.152)a	0.784 (0.200)a
η (share of unskilled workers)	0.239 (0.039)a	0.233 (0.054)a	0.279 (0.062)a
Firm age	-0.010 (0.002)a	-0.008 (0.002)a	-0.011 (0.007)
Small firm	0.093 (0.056)c	0.156 (0.072)b	-0.032 (0.087)
Market share	0.064 (0.026)b	-0.013 (0.037)	0.131 (0.025)b
Export share	0.004 (0.001)a	0.005 (0.001)a	0.003 (0.002)c
Innovation	0.062 (0.015)a	0.065 (0.018)a	0.053 (0.023)b
Private firm	0.193 (0.063)a		
R^2	0.275	0.297	0.215
ρ (share of female workers)	0.724 (0.193)a	0.418 (0.186)a	1.073 (0.366)a
μ (share of unskilled workers)	0.117 (0.033)a	0.151 (0.054)a	0.133 (0.046)a
Log labor	0.266 (0.023)a	0.177 (0.030)a	0.355 (0.033)a
Log capital	0.737 (0.045)a	0.818 (0.064)a	0.675 (0.064)a
Firm age	-0.013 (0.002)a	-0.010 (0.002)a	-0.011 (0.004)b
Small firm	0.091 (0.091)	0.143 (0.134)	0.013 (0.121)
Market share	0.031 (0.044)	-0.047 (0.030)	0.107 (0.026)a
Export share	0.001 (0.001)	0.002 (0.002)	-0.001 (0.001)
Innovation	0.079 (0.018)a	0.098 (0.025)a	0.057 (0.025)b
Private firm	0.486 (0.065)a		
R^2	0.724	0.685	0.772
Correlation of the two equations	0.451	0.521	0.352
Obs.	1335	724	611

Table 1: Joint Estimates of Wage equation (6.1) and Production Function (9.1), by Ownership (continued)

	Manufacturing Sector	SOEs	Private firms
$\Phi = 1$	0.046	0.016	0.139
$\rho = 1$	0.075	0.001	0.421
$\eta = 1$	0.000	0.000	0.000
$\mu = 1$	0.000	0.000	0.000
$\rho = \Phi$	0.749	0.069	0.368
$\mu = \eta$	0.000	0.074	0.014

Notes: All equations include constant term, dummy variables for city, industrial branch, and year. The heteroscedastic-consistent standard error is reported in parentheses. a, b, and c denote significance levels of 1%, 5% and 10%, respectively. The p values for the null hypotheses of $\rho = \Phi$ and $\mu = \eta$ are obtained for two-sided alternatives and the rest for a one-sided alternative.

Table 2 Joint Estimates of Wage Equation (6.1) and Production Function (9.1), by Firm characteristics

	Non-export oriented firms	Export oriented firms	Low R&D intensity firms	High R & D intensity firms
Φ (share of female workers)	0.592 (0.148)a	1.086 (0.252)a	0.806 (0.209)a	0.807 (0.185)a
η (share of unskilled workers)	0.177 (0.035)a	0.528 (0.154)a	0.200 (0.049)a	0.273 (0.058)a
R^2	0.330	0.206	0.322	0.258
ρ (share of female workers)	0.559 (0.200)a	1.443 (0.687)b	1.091 (0.485)b	0.475 (0.168)a
μ (share of unskilled workers)	0.109 (0.038)a	0.108 (0.049)b	0.113 (0.047)b	0.109 (0.040)b
Log labor	0.234 (0.029)a	0.307 (0.034)a	0.226 (0.035)a	0.289 (0.029)a
Log capital	0.780 (0.058)a	0.675 (0.068)a	0.788 (0.076)a	0.717 (0.057)a
R^2	0.737	0.665	0.678	0.730
Correlation of the two equations	0.478	0.456	0.495	0.443
Obs.	884	451	528	807
$\Phi = 1$	0.003	0.368	0.177	0.149
$\rho = 1$	0.014	0.259	0.429	0.001
$\eta = 1$	0.000	0.000	0.000	0.000
$\mu = 1$	0.000	0.000	0.000	0.000
$\rho = \Phi$	0.828	0.560	0.468	0.071
$\mu = \eta$	0.049	0.002	0.049	0.001

Notes: All equations include constant term, dummy variables for city, industrial branch, year and private firms, and variables for firm size, age, market share, export share and technological innovation. The heteroscedastic-consistent standard error is reported in parentheses. a, b, and c denote significance levels of 1%, 5% and 10%, respectively. P values for the null hypotheses of $\rho = \Phi$ and $\mu = \eta$ are obtained for two-sided alternatives and the rest for a one-sided alternative.

Table 3: Joint Estimates of Wage Equation (6.2) and Production Function (9.2), by Sector and by Ownership

	Manufacturing sector	Manufacturing sector	
		SOEs	Private firms
Φ_{mu}(share of unskilled males)	0.269 (0.055)a	0.222 (0.060)a	0.361 (0.111)a
Φ_{fu}(share of unskilled females)	0.153 (0.034)a	0.125 (0.034)a	0.202 (0.071)a
Φ_{fs}(share of skilled females)	0.684 (0.227)a	0.405 (0.225)c	1.031 (0.442)b
Φ_{fu}/ Φ_{mu}	0.566 (0.151)a	0.561 (0.191)a	0.559 (0.212)a
R^2	0.272	0.293	0.219
μ_{mu} (share of unskilled males)	0.127 (0.043)a	0.179 (0.062)a	0.092 (0.057)
μ_{fu} (share of unskilled females)	0.070 (0.028)a	0.028 (0.036)	0.118 (0.052)b
μ_{fs} (share of skilled females)	0.770 (0.270)a	0.642 (0.320)b	0.872 (0.452)b
μ_{fu}/μ_{mu}	0.547 (0.253)b	0.156 (0.208)	1.275 (0.828)
Log labor	0.263 (0.023)a	0.175 (0.030)a	0.354 (0.033)a
Log capital	0.750 (0.045)a	0.832 (0.064)a	0.674 (0.064)a
R^2	0.725	0.688	0.769
Correlation of the two equations	0.404	0.509	0.351
Obs.	1355	740	615
Φ_{fs} =1	0.082	0.004	0.472
μ_{fs} =1	0.197	0.132	0.388
Φ_{fu}/ Φ_{mu} = 1	0.002	0.011	0.019
μ_{fu}/μ_{mu} =1	0.037	0.000	0.370
Φ_{fu} = 1	0.000	0.000	0.000
μ_{fu} =1	0.000	0.000	0.000
Φ_{mu} = 1	0.000	0.000	0.000
μ_{mu} = 1	0.000	0.000	0.000
$\mu_{fs} = \Phi_{fs}$	0.706	0.329	0.734
$\mu_{fu}/\mu_{mu} = \Phi_{fu}/ \Phi_{mu}$	0.937	0.069	0.358
$\mu_{fu} = \Phi_{fu}$	0.013	0.010	0.233
$\mu_{mu} = \Phi_{mu}$	0.007	0.469	0.009

Notes: All equations include constant term, dummy variables for city, industrial branch, and year. Regression (2) also contains firm age, size, market share, export share, R & D intensity, and private firm dummy equations and these variables are excluded in Regression (1). The heteroscedastic-consistent standard error is reported in parentheses. a, b, and c denote significance levels of 1%, 5% and 10%, respectively. P values for the null hypotheses of $\mu_{fs} = \Phi_{fs}$ to $\mu_{mu} = \Phi_{mu}$ are derived for two-sided alternatives and the rest for a one-sided alternative.

Table 4: Joint Estimates of Wage Equation (6.2) and Production Function (9.2), by Firm Characteristics

	Non-export oriented firms	Export oriented firms	Low R & D intensity firms	High R & D intensity firms
A. Wage equation				
Φ_{mu}(share of unskilled males)	0.247	0.531	0.305	0.220
	(0.056)a	(0.204)a	(0.095)a	(0.064)a
Φ_{fu}(share of unskilled females)	0.039	0.474	0.122	0.222
	(0.035)	(0.158)a	(0.043)a	(0.053)a
Φ_{fs}(share of skilled females)	0.771	0.933	0.985	0.436
	(0.260)a	(0.740)	(0.422)b	(0.272)b
Φ_{fu}/Φ_{mu}	0.159	0.893	0.400	1.009
	(0.152)	(0.225)a	(0.149)a	(0.340)a
R^2	0.331	0.205	0.327	0.258
B. Production function				
μ_{mu} (share of unskilled males)	0.122	0.144	0.174	0.104
	(0.043)a	(0.109)	(0.090)b	(0.047)b
μ_{fu} (share of unskilled females)	0.034	0.125	0.081	0.057
	(0.032)	(0.072)c	(0.052)	(0.031)c
μ_{fs} (share of skilled females)	0.671	1.308	1.347	0.438
	(0.283)b	(0.757)c	(0.672)b	(0.263)c
μ_{fu}/μ_{mu}	0.281	0.866	0.465	0.553
	(0.269)	(0.648)	(0.307)	(0.392)c
Log labor	0.230	0.306	0.228	0.282
	(0.029)a	(0.034)a	(0.034)a	(0.030)a
Log capital	0.797	0.672	0.799	0.731
	(0.057)a	(0.068)a	(0.074)a	(0.057)a
R^2	0.738	0.663	0.674	0.732
Correlation of the two equations	0.504	0.452	0.423	0.478
Obs.	899	456	547	808
C. Test statistics (p values)				
$\Phi_{fs} = 1$	0.378	0.927	0.971	0.038
$\mu_{fs} = 1$	0.245	0.685	0.606	0.033
$\Phi_{fu}/\Phi_{mu} = 1$	0.000	0.633	0.000	0.980
$\mu_{fu}/\mu_{mu} = 1$	0.008	0.836	0.082	0.253
$\Phi_{fu} = 1$	0.000	0.000	0.000	0.000
$\mu_{fu} = 1$	0.000	0.000	0.000	0.000
$\Phi_{mu} = 1$	0.000	0.021	0.000	0.000
$\mu_{mu} = 1$	0.000	0.000	0.000	0.000
$\mu_{fs} = \Phi_{fs}$	0.676	0.607	0.513	0.994
$\mu_{fu}/\mu_{mu} = \Phi_{fu}/\Phi_{mu}$	0.642	0.963	0.811	0.306
$\mu_{fu} = \Phi_{fu}$	0.897	0.016	0.395	0.002
$\mu_{mu} = \Phi_{mu}$	0.022	0.034	0.159	0.067

Notes: All equations include constant term, dummy variables for city, industrial branch, year and private firms, and variables for firm size, age, market share, export share and technological innovation. The heteroscedastic-consistent standard error is reported in parentheses. a, b, and c denote significance levels of 1%, 5% and 10%, respectively. P values for the null hypotheses of $\mu_{fs} = \Phi_{fs}$ to $\mu_{mu} = \Phi_{mu}$ are derived for two-sided alternatives and the rest for a one-sided alternative.

Appendix:

Table a1 Summary statistics of variables involved in regression analysis

Variables	Manufacturing sector	SOEs	Private firms
Proportion of Females	0.446	0.440	0.464
	(0.218)	(0.198)	(0.242)
Proportion of unskilled workers	0.770	0.763	0.783
	(0.169)	(0.170)	(0.176)
Share of unskilled among female workers	0.777	0.773	0.796
	(0.207	(0.204)	(0.225)
Share of unskilled among male workers	0.730	0.737	0.724
	(0.188)	(0.189)	(0.205)
Share of skilled males	0.149	0.151	0.143
	(0.130)	(0.130)	(0.135)
Share of unskilled males	0.405	0.408	0.393
	(0.194)	(0.177)	(0.216)
Share of skilled females	0.081	0.085	0.073
	(0.071)	(0.074)	(0.072)
Share of unskilled females	0.365	0.355	0.390
	(0.223)	(0.202)	(0.249)
Log average wage	2.216	2.022	2.437
	(1.077)	(1.048)	(1.100)
Log value added	9.283	8.905	9.551
	(1.912)	(1.938)	(1.933)
Log labor	5.540	5.538	5.373
	(1.418)	(1.465)	(1.411)
Log capital assets	9.587	9.450	9.441
	(2.242)	(2.317)	(2.311)
Innovation	2.008	2.163	2.008
	(1.707)	(1.835)	(1.708)
Market share	0.182	0.172	0.166
	(0.735)	(0.546)	(0.652)
Export share (%)	23.757	11.890	36.271
	(37.789)	(27.456)	(43.111)
Firm age (year)	14.263	19.983	6.362
	(15.924)	(18.293)	(8.277)
		0.454	0.534
Small firm	0.474	(0.498)	(0.499)
Private firm	0.463	---	---
Apparel and leather	0.212	0.205	0.218
Consumer products	0.168	0.170	0.166
Electronic components	0.203	0.199	0.208
Electronic equipments	0.187	0.180	0.195
Vehicles and	0.230	0.266	0.213

parts			
Tianjin	0.228	0.233	0.172
Shanghai	0.211	0.144	0.262
Guangzhou	0.210	0.186	0.209
Chengdu	0.177	0.188	0.205
Beijing	0.174	0.248	0.152
Observations	1335	724	611

Notes: Sample means are presented with standard deviations in parentheses. Summary statistics of industry and time dummy variables are omitted to streamline exposition.

Table a2 Correlation of female share and firm characteristics

	% female	% unskilled	Private equity (%)	% exports	Firm age	Market share	Log labor
% female	1.000						
% unskilled	0.323*	1.000					
Private equity (%)	0.056*	0.057*	1.000				
% exports	0.395*	0.198*	0.343*	1.000			
Firm age	0.072*	0.128*	-0.443*	-0.170*	1.000		
Market share	-0.069*	-0.025	-0.012	-0.085*	0.038	1.000	
Log labor	0.180*	0.267*	-0.098*	0.178*	0.316*	0.043	1.000
Log (K/L)	-0.172*	-0.189*	-0.035*	0.069*	0.102*	0.073*	0.265*
Innovation	-0.143*	-0.139*	-0.012	-0.036*	0.030*	0.070*	0.300*

	Log(K/L)	Innovation
Log (K/L)	1.000	
Innovation	0.262*	1.000

Note: * indicates significance at the 5% level or lower.