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Trends in China's gender employment and pay gap: Estimating gender pay gaps with employment selection

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ABSTRACT

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In contrast to the United States and European countries, China has witnessed a widening gender pay gap in the past two decades. Nevertheless, the size of the gender pay gap could still be underestimated as a result of not accounting for the low-wage women who have dropped out of the labor force. As shown by a large and representative set of household survey data in China, since the 1980s the female employment rate has been falling and the gap between male and female employment rates has been increasing. We estimate the gap size using Heckman's selection-correction model and bounds of the raw gender pay gap, taking into consideration the different male and female employment rates in China. The results support the view that the gender pay gap estimate is biased without taking into account employment selectivity. *Journal of Comparative Economics* **42** (3) (2014) 708–725. School of Economics and Management, Tsinghua University, Beijing 100084, China.

1. Introduction

In contrast to the narrowing gender wage gap in the United States,[1] China has experienced a widening gender pay gap in recent decades.[2] China also provides an interesting contrast to other transition countries, such as Poland, Hungary, Russia, Estonia, and Slovenia, where the relative wages for women were unchanged or even improved during the transition from a centrally-planned to a market economy.[3]

In theory, the gender wage gap could widen during the transition from a planned economy to a market economy, as a result of deregulation of wage setting and rising discrimination in the labor market. On the other hand, increasing market forces could punish employers with discriminatory tastes and reduce the gender pay gap (Becker, 1957). This mechanism has been confirmed in Hungary, where both the overall gender wage gap and the gap due to different returns to the endowments of men and women have declined (Jolliffe and Campos, 2005). The improved economic status for women in

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[1] Blau and Kahn (2006, 1997) and Blau (1998).

[2] Gustafsson and Li (2000), Appleton et al. (2005), Ng (2007), and Chi and Li (2008).

[3] Glinskaya and Mroz (2000) and Reilly (1999) found that the gender pay gap in Russia did not change during the transition from 1992 to 1996. Adamchik and Bedi (2003) found no change in women's relative wages in Poland during their transition years. Jolliffe and Campos (2005) showed that the gender wage gap declined in Hungary from 1986 to 1988. Improvement in women's economic welfare was also found for Estonia and Slovenia by Orazem and Vodopivec (2000).

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a transition country might also be explained by the change in the composition of the female labor force. Hunt (2002) showed that the gender wage gap fell by 10 points in East Germany during the economic transition, but a large part of this fall was due to the withdrawal of low-wage women from the labor market.

China has the world's largest labor force, with an estimated 0.78 billion actively working people as of 2010.[4] The male–female pay gap is one of the key issues concerning the vast number of workers in China. Although prior research has examined the gender wage gap, occupation segregation, and discrimination in China,[5] most studies have used samples of working individuals to estimate gender pay gaps, with very few addressing male and female employment rates or how the gender employment gap affects the pay gaps.

According to Chi and Li (2008), employment rates declined from 1987 to 2004 for both men and women, but more so for women. With only 3 years of data, they could not show a trend in the employment rate or gap. We extend Chi and Li (2008) by using 20 years of data to study the trend in gender employment and pay gaps. Appleton et al. (2005) proposed that the gender pay gap in China has stopped widening and has remained relatively static in recent years, suggesting that China may have "crossed the river". We found a similar trend for the raw gender pay gap, but we argue that this finding may be overly optimistic since it does not consider the decline in female employment rates in China.

This paper studies formal sector employment of men and women, similar to the work of Chi and Li (2008). As a transition country, China has a large informal employment sector, which has grown rapidly and has absorbed a large number of rural migrants and urban unemployed workers. However, informal employment is often excluded from official employment statistics. Therefore, little is known about the gender composition of workers in the informal sector. Zhang et al. (2006), Meng (2001), and a recent study by the International Labor Organization (ILO),[6] showed that there were fewer women than men working in urban China's informal employment sector, especially among the self-employed. Meng (2001) found that for both wage-earners and the self-employed, migrants had higher incomes in the urban informal sector than those in the formal sector. Although we could not provide a formal estimate because of a lack of data, our study speculates that the estimate of the gender pay gap would likely be even larger if we had taken informal employment into account, since more men are employed in the informal sector and men earn higher wages than women in the informal sector.

From a methodological perspective, our study applies both Heckman's selection-correction (Heckman, 1979) and the bound method (Manski, 1994; Manski and Pepper, 2000; Blundell et al., 2007) to correct for employment selection in estimating gender pay gaps. Heckman's selection-correction method is based on stringent parametric/semi-parametric assumptions. It is more restrictive, and is potentially subject to misspecification error. The bound method lies within the large and expanding literature of partial identification. It requires minimal assumptions. Although it fails to point-identify the interested parameters, it may still give informative bounds for the parameters of interest, and is generally more robust than Heckman's selection-correction method. However, the bound method may sometimes produce loose and uninformative results, making it difficult to draw a conclusion from the data. In summary, the two methods complement each other. By using both methods, we can check the robustness of our results.

Our main findings are that the employment rates in China have generally decreased since 1989, and have declined more for women than for men, which has contributed to a widening gender gap in the employment rate. Our data also shows widening gender pay gaps among working people. Using Heckman's selection-correction method, we find evidence that the raw gender pay gap has been underestimated for recent years. The bound results, however, are less conclusive.

The remainder of this article is organized as follows: Related studies are introduced in Section 2. We describe the data and present descriptive results in Section 3. Empirical methods are discussed in Section 4. Heckman's selection-correction and bound results are reported in Section 5. Finally, we discuss the results and conclude the article in Section 6.

2. Related studies

While many studies of the Chinese gender earnings gap show the gap widening since economic reform began in 1978, results vary as to the amount of this increase.[7] However, the cause of the increase is relatively well established. The discrimination effect, which is the portion of the gender pay gap that cannot be explained by gender differences in productivity, has accounted for a larger portion of the gender gap and has been increasing (Chi and Li, 2008; Ng, 2007; Gustafsson and Li, 2000). Since previous studies have relied on cross-sectional data covering only a few years, the long-term trend in the gender pay gap remains unclear.

Regarding the gender employment gap, Chi and Li (2008) showed that both male and female employment rates had fallen from 1996 to 2004 for all age groups. Participation in work is influenced by one's own characteristics such as education and experience, as well as family characteristics such as marital status, the presence of a young child in the household, and

[4] Data source: China Statistical Yearbook 2011, Table 4-1. http://www.stats.gov.cn/tjsj/ndsj/2011/indexch.htm.

[5] Gustafsson and Li (2000), Appleton et al. (2005), Ng (2007), Meng and Miller (1995), Meng (1998a,b), Rozelle et al. (2002), Dong et al. (2003), Maurer-Fazio and Hughes (2002), and Maurer-Fazio et al. (1999).

[6] International Labor Organization, "Women and men in the informal economy – Statistical picture". http://laborsta.ilo.org/informal_economy_E.html.

[7] Gustafsson and Li (2000) found that the gender wage gap in urban China had increased from 1988 to 1995, while Ng (2007) showed that the urban gender pay gap had decreased from the 1980s to the early 1990s, but had increased since the mid-1990s. Chi and Li (2008) found that gender earnings differentials in the urban labor market increased for both periods, from 1987 to 1996 and from 1996 to 2004, but the increase was more pronounced in the later period. Appleton et al. (2005) showed that the raw gender pay gap had increased from 1988 to 1999 but decreased from 1999 to 2002.

spousal income. In China, the education level of urban workers has increased rapidly in the past two decades. The presence of a young child in the household reduces labor force participation, especially for women. However, this relationship decreases as the availability and affordability of childcare services increases.[8] The decline in publicly-funded childcare centers and the increase in childcare costs in recent years have had a negative impact on the labor force participation, particularly for women.

Spousal income should have a negative impact on an individual's labor force participation because of the income effect. However, for Chinese urban women, this effect was small and insignificant (Xu, 2011). Culture also influences the decision to work. In the pre-reform period, Chinese women were encouraged to work the same jobs as men, and work was guaranteed by the state. After the reform, the ideology of "women holding up half the sky" became less common and a patriarchal value system re-emerged, which led to an increase in the number of women withdrawing from the labor market (Croll, 1995; Maurer-Fazio et al., 2007). Additionally, women may be discriminated against in the workforce, denied employment and promotions, and be laid off more quickly, contributing to their lower employment rate. For example, it has been found that urban Chinese women are more likely to be discharged and less likely to be re-employed during labor retrenchment (Dong and Pandey, 2012; Giles et al., 2006; Appleton et al., 2002).

In summary, a number of factors influence participation in the labor market, and each has a different impact. Increases in education levels and childcare costs are likely to be associated with positive selection into work. On the other hand, the income effect suggests a negative employment selection, especially for women. The non-random employment selection implies that the gender wage gap estimated based on the employment sample could be biased. Recent research has begun to pay great attention to this bias.

Since the 1980s, both the labor force participation rate and mean wages of women in the United States have been rising, while gender pay differentials have been narrowing. However, several studies have suggested that the narrowing gender pay gaps in the United States may have been overestimated as a result of overlooking changes in the composition of female workers. Mulligan and Rubinstein (2008) showed that selection of women for employment shifted from being negative in the 1970s to positive in the 1980s. As more skilled women joined the labor force, women's relative wages increased. The researchers showed that most of the narrowing of the wage gap between genders was due to this change in the skill composition of female workers. Blau and Kahn (2006) found that the gender pay gap decreased more rapidly in the 1980s than in the 1990s in the United States, but the differences between the two decades were mostly due to different sample selectivity in the two decades. Machado (2010), however, reached a more positive conclusion: that the gender pay gap in the United States had indeed narrowed substantially, and that the improvement in gender wage equality was not entirely a result of the selection effect.

Similar studies in Europe include Blundell et al. (2007), Albrecht et al. (2009), Picchio and Mussida (2011), and Beblo et al. (2003). Blundell et al. (2007) used the UK. Family Expenditure Survey data to estimate the non-parametric bounds to gender pay differentials for different age and education groups. Albrecht et al. (2009) extended the Machado and Mata (2005) method to account for employment selectivity in gender pay gaps in the Netherlands. They found that if all the non-working women were employed, the gender pay gap would be much larger. Picchio and Mussida (2011) adapted the hazard function estimator proposed by Donald et al. (2000) to estimate the gender wage gap in Italy. Their results also suggested an underestimation of gender pay gaps without selection correction, especially at the bottom of the wage distribution. Beblo et al. (2003) found that accounting for self-selection into work had an impact on gender wage estimates and wage gap decomposition in their study of five EU countries.

Employment selectivity is also useful to explain cross-country differences in the gender pay gap. Olivetti and Petrongolo (2008) showed that both the gender employment gap and the gender pay gap varied significantly across OECD countries, and that there was a negative relationship between the gender employment and gender pay gaps. Their analysis suggests that international variation in the gender pay gap would be smaller if the employment-rate differences across countries were taken into consideration.

3. Data

3.1. China's urban household surveys

This study uses data collected from China's Urban Household Surveys from 1988 to 2009. The Urban Household Survey has been conducted by China's National Bureau of Statistics (NBS) every year since 1987.[9] The survey gathers information from a large random sample of urban households through interviews. The NBS uses this data to produce aggregate statistics on employment and income, which are published in China Statistical Yearbooks.[10] The surveys use a stratified random sampling

[8] Maurer-Fazio et al. (2011) found that the labor force participation rate of Chinese urban women with pre-school children had fallen considerably from 1990 to 2000, and that living with grandparents helped keep the women in the labor market. Kilburn and Datar (2002) and Du (2008) showed that the availability of child care centers or an informal childcare arrangement (such as co-residence with grandparents) had a positive impact on the labor force participation of working-age women. However, the transition from a centrally-planned economy to a market economy has led to a significant decline in publicly-funded childcare centers (Du and Dong, 2010), and the cost of childcare centers has risen dramatically. According to a recent newspaper article, kindergarten is more expensive than college in China (Peter Ford, Christian Science Monitor, February 23, 2010). http://www.csmonitor.com/World/Asia-Pacific/2010/0223/In-China-kindergarten-costs-more-than-college.

[9] We do not use 1987 data because data quality is poor in the first year of the survey.

[10] The overview of the survey methodology can be found in the yearbooks.

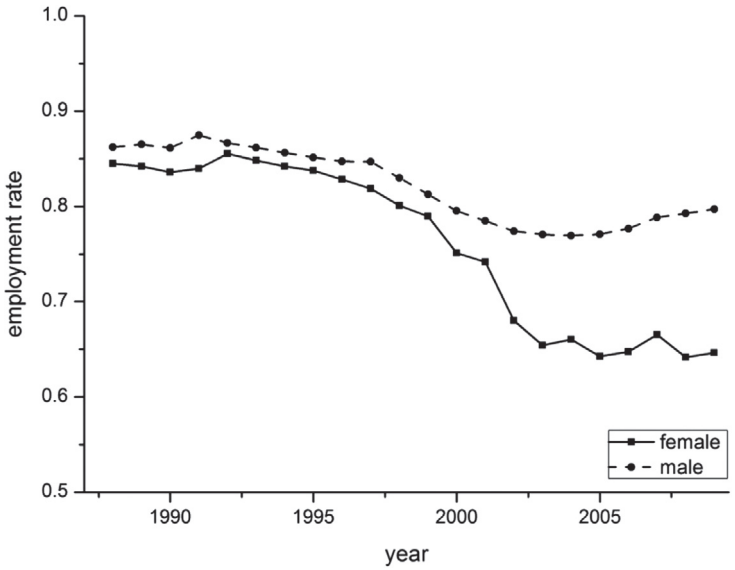

Fig. 1. Male and female employment rates. *Source:* NBS Urban Household Survey data 1989–2009; author's own calculation.

method. To ensure that the sample is representative, each year one-third of the households are rotated out and replaced by new households. Thus the household sample is completely renewed every three years.[11]

The survey begins with a monthly accounting of an individual's basic information on demographics, education, employment status, industry, and occupation, as well as the total monthly income, earnings, and other income components. The survey then asks a set of questions about household living arrangement, housing type, and all kinds of household expenditures. The monthly data are then aggregated into yearly data and reported to the NBS. We used this yearly data provided by the NBS.

3.2. Sample and variables

Our study focuses on individuals of primary working age. The original sample size was 618,041. We selected men aged 16–60 and women aged 16–55. The upper limit was set to exclude retired people; the normal retirement age is 60 for men and 55 for women in China. Because of the lower retirement age for women, many older women who are still capable of working begin temporary or part-time work or care for grandchildren or older parents, while men of the same age continue to work full-time. As a result, average income is significantly reduced for older women, and the gender pay gap widens in this age group. If the older age group was included in our analysis, our estimates of the gender pay gap would be even higher.

As the result of age restriction, 181,370 observations were excluded from the study, of which five were deleted because information on the age was unavailable. Individuals with missing information for gender, education, labor force status or earnings were also excluded, resulting in a further reduction in the sample size by 132. The final sample consisted of 214,296 women and 222,243 men. Table A1 shows the number of observations for each survey year.

The survey asks about the relationship between the respondent and the household head, such as whether the respondent is the household head herself, or if it is her spouse, child, or parent. Based on this question, we generate a dummy indicator of whether an individual has a young child aged $\leqslant$6 years. Table A2 shows the percentage of men and women who have a young child. Those with a young child are mostly aged 25–35 years.[12] Based on the family relationship code, we are also able to identify a household head and her/his spouse. For all years, we identify a total of 152,788 couples.

Although the hourly wage rate would have been ideal to examine gender pay differentials, only annual earnings were available in our dataset. However, information on the number of hours worked was available in the 2003–2006 surveys. Thus, we calculated the hourly wage rate using annual earnings and hours of work, then calculated the gender gap in both the hourly wage and annual earnings for 2003–2006. The results are shown in Table A3. Women, on average, worked 2–3 h fewer per month than men. The gender pay gap was larger when annual earnings were used in the calculation, suggesting that the gender earnings gap is to some extent caused by difference in the number of working hours.

[11] Potentially we could identify individuals in multiple waves of surveys and generate a 3-year set of panel data, but unfortunately we were not given access to the unique household and individual identifier, and thus were unable to match individuals over time.

[12] Since the early 1980s, China has enforced its one-child policy in urban areas. Most couples have only one child, except for those having twins. Therefore, the difference between whether a couple has a young child and the number of young children is small.

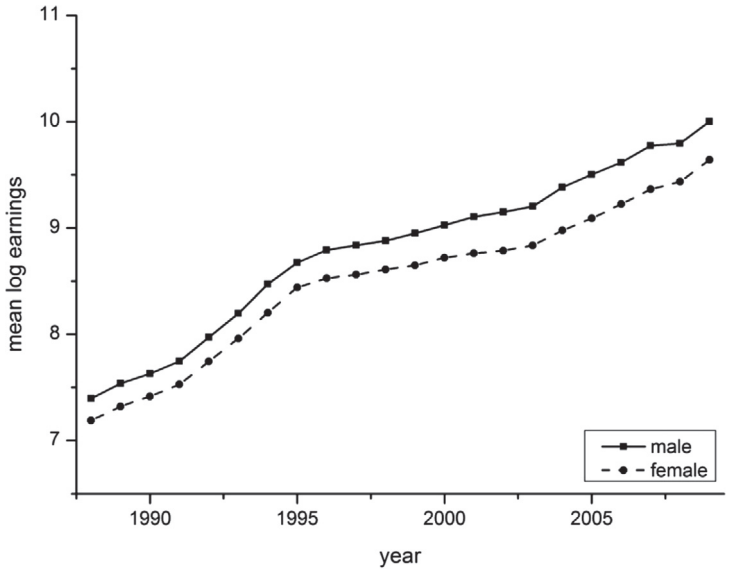

Fig. 2. Male and female mean earnings. *Source:* NBS Urban Household Survey data 1989–2009; author's own calculation. *Note:* Earnings are annual earnings in RMB Yuan. The logarithm is taken for earnings. The figure shows the mean log (earnings) for men and women.

Since hourly wages are available only for a few years, to study the long-term trend in the gender pay gap, we used annual earnings in RMB for our analysis. We took the logarithm of annual earnings, and estimated the gender pay gap by calculating the differences in the log earnings between men and women.

Two measures of employment can be generated from the survey data. One is the self-reported employment status, and the other is the dummy indicator of positive earnings. In the survey, self-reported employment status takes a value from 1 to 15, with 1–7 indicating employment in a state-owned, foreign, or private company, or in the government or other sectors, and 8–15 indicating non-working individuals, including retired and disabled persons, enrolled students, etc. Because the employment status question has non-standard phrasing,[13] we could not identify unemployed individuals. Therefore, we focus on the employment rate instead. We define employment as equal to 1 if the self-reported status takes the value of 1–7. Alternatively, we define employment equal to 1 if an individual reported positive earnings. These two measures of employment are significantly correlated with a correlation coefficient of 0.80.[14] We report results based on the second measure – an individual is employed if her earnings are positive.[15]

3.3. Gender employment gap and raw gender pay gap

Fig. 1 shows that both male and female employment rates declined during the 20-year period. The female employment rate dropped by 20% points between 1988 and 2009, whereas the male employment rate fell by 12% points. Since 2000, the female employment rate decreased rapidly while the male employment rate was stagnant and even increased slightly after 2005. As a result, the gender employment gap has widened notably since 2005. By 2009, the gender employment gap had risen to 10% points, as compared to only 2% points in 1988. The decline in overall employment rates in urban China is related to economic restructuring and large-scale layoffs by state-owned enterprises in the 1990s and 2000s. Furthermore, the lower female employment rate and widening gender employment gap are caused by increasing childcare costs, diminishing availability of publicly-funded childcare centers, income effects, and the resurrection of the traditional division of work between men and women.

[13] Usually a labor force survey asks whether a person is out of job, and if yes, whether he is actively looking for a job.

[14] Because self-reported employment status pertains to status in the last month of the survey year, typically December, while positive earnings indicate that an individual has done some work during the year, the two measures are not always consistent. For people who did not change work status during the year, the two measures give the same value.

[15] We calculated the employment rate by the same method with another household survey dataset, the Chinese Household Income Project (CHIP). CHIP data are provided by ICPSR, University of Michigan (www.icpsr.umich.edu), and are only available for three years; 1988, 1995, and 2002. Moreover, official statistics on the urban registered unemployment rate from 1988 to 2009 were taken from the China Statistical Yearbooks. This rate refers to the ratio of urban registered unemployment to total urban employment. Urban registered unemployment includes people aged above 16 years and below the official retirement age who are unemployed, are willing to work and have registered at the local employment service agency to apply for a job. These rates are shown in Fig. 7. The trend for the urban registered unemployment rate is almost the reverse of that in the employment rate calculated with our data. The employment rate calculated with CHIP data in the years 1988, 1995, and 2002 is close to our estimate. This comparison provides some evidence for the reliability of our measurement.

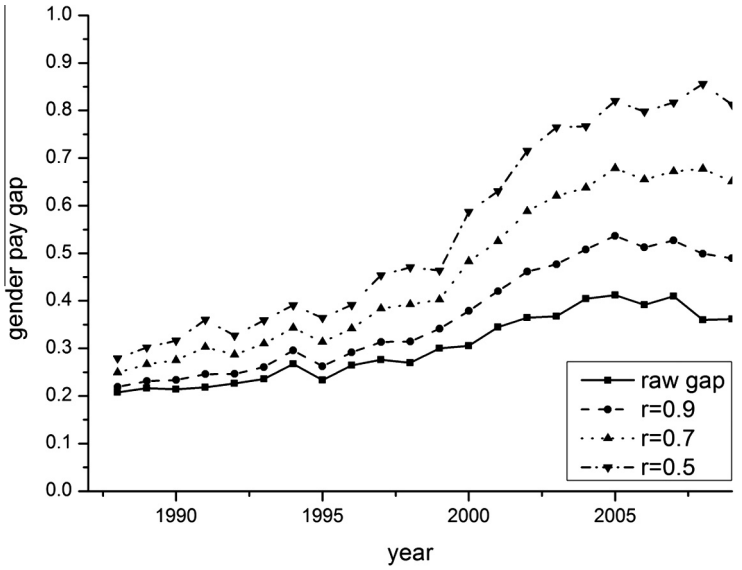

Fig. 3. Raw and simulated gender pay gaps. *Source:* NBS Urban Household Survey data 1989–2009; author's own calculation. *Note:* The figure shows the raw gender pay gap (denoted as "raw gap") and simulated ones based on Eq. (1). The gender pay gap is measured by male–female differences in mean log earnings. Earnings are annual earnings in RMB Yuan. Positive employment selection is assumed. r = 0.9, 0.7, and 0.5 assumes that non-workers would earn 90%, 70%, or 50% of the observed earnings of workers. The employment rate and observed wages used in the simulation are from data.

Table 1
Employment rates of women and men with and without young children in the 1990s and 2000s. *Source:* NBS Urban Household Survey data 1989–2009; author's own calculation.

	1990s	2000s	All years
Panel A			
Employment rates			
Women with young children	96.64	79.75	85.80
Women without young children	96.79	81.01*	86.65*
Men with young children	99.26	89.67	93.86
Men without young children	96.74*	83.95*	87.62*
Panel B			
Log earnings			
Women with young children	7.74	7.40	7.52
Women without young children	7.80	7.48	7.58
Men with young children	8.11	8.62	8.40
Men without young children	7.95*	7.91*	7.92*

Note: Calculation is based on men and women 25–35 years old.
* Indicates that Pearson Chi^2 test is significant at the 1% level.

Fig. 2 demonstrates average log earnings for men and women from 1988 to 2009 based on the sample of employed individuals. Although both male and female log earnings increased significantly during this period, the gender pay gap also increased. Fig. 2 shows that the raw gender pay gap, measured by male–female differences in mean log earnings, increased from 0.2 to the maximum of 0.4 log points during the mid-2000s, then decreased to 0.35 log points in 2008 and 2009. We also calculated the gender earnings gap as the ratio of average female earnings to male earnings. The ratio decreased from 82% in the late 1980s and early 1990s to a low of 71% in the mid-2000s, then rose back up to 75% in 2009.

4. Empirical methods

4.1. Simulation

Similar to Olivetti and Petrongolo (2008), we conduct simulations to show potential bias in the gender earnings gap, given positive employment selection. Let W and X denote the logarithm of wage and the conditional vector (including gender, age, education, and year). When W is observed, the indicator variable employment (E) equals 1, and when W is not observed, E equals 0. Assume that non-employed individuals earn a wage equal to a proportion (r) of the wage of employed individuals.

Table 2
Gender employment and pay gaps for subgroups, 1992, 2002, and 2009. *Source:* NBS Urban Household Survey data 1989–2009; author's own calculation

	1992						2002						2009					
	Male		Female		Differentials		Male		Female		Differentials		Male		Female		Differentials	
	Employment rate (%)	Mean lgearn	Employment rate (%)	Mean lgearn	Employment gap	Gender pay gap	Employment rate (%)	Mean lgearn	Employment rate (%)	Mean lgearn	Employment gap	Gender pay gap	Employment rate (%)	Mean lgearn	Employment rate (%)	Mean lgearn	Employment gap	Gender pay gap
All	86.67	7.97	85.54	7.74	1.12	0.23	77.41	9.15	68.01	8.79	9.41	0.36	79.73	10.00	64.61	9.64	15.12	0.36
Marital status																		
Married		88.38	9.21	75.48	8.81	12.90	0.40	83.60	10.05	70.26	9.65	13.34	0.40					
Not married		37.44	8.67	40.24	8.63	−2.80	0.04	39.03	9.58	42.21	9.55	−3.18	0.02					
Education																		
Primary	90.52	7.93	84.39	7.63	6.13	0.29	70.42	8.86	55.10	8.31	15.32	0.55	65.17	9.61	49.29	9.11	15.88	0.50
Secondary	83.25	7.92	84.69	7.78	−1.44	0.13	73.55	9.08	71.61	8.83	1.94	0.25	69.77	9.88	60.60	9.50	9.17	0.38
College	94.62	8.13	93.01	8.01	1.61	0.12	87.40	9.48	83.36	9.27	4.04	0.22	85.66	10.31	83.59	10.05	2.07	0.26
Age																		
18–22	56.28	7.32	61.50	7.26	−5.22	0.06	17.80	8.17	21.50	8.23	−3.70	−0.05	13.10	9.02	15.94	8.87	−2.84	0.15
23–27	95.21	7.70	94.19	7.55	1.02	0.14	72.88	8.78	74.70	8.68	−1.82	0.10	71.63	9.71	72.53	9.62	−0.90	0.09
28–32	98.61	7.93	98.54	7.78	0.07	0.16	84.49	9.04	79.16	8.81	5.33	0.23	86.56	10.05	80.27	9.80	6.29	0.25
33–37	100.00	8.02	99.54	7.87	0.46	0.15	90.88	9.20	83.31	8.88	7.57	0.32	86.50	10.14	79.57	9.75	6.93	0.39
38–42	99.90	8.07	98.05	7.94	1.85	0.13	92.41	9.26	84.99	8.91	7.42	0.35	85.79	10.09	78.90	9.68	6.89	0.41
43–47	99.33	8.14	96.38	7.92	2.95	0.22	92.97	9.26	83.08	8.86	9.89	0.41	87.00	10.09	75.99	9.63	11.01	0.47
48–52	99.20	8.18	77.89	7.70	21.31	0.48	90.31	9.23	66.34	8.69	23.97	0.54	87.28	10.02	57.80	9.50	29.48	0.52

Note: "lgearn" denotes the logarithm of earnings. Earnings are annual earnings in RMB Yuan. Gender employment gap is calculated as male–female differentials in the employment rate, and is in percentage points. Gender pay gap is calculated as the male–female differentials in mean log earnings, and is in log points. "College" indicates college and above education; "Secondary" denotes high school education; and "primary" denotes junior high or below education.

Table 3
Spousal income and men and women's employment selection, 1992, 2002, and 2009. *Source:* NBS Urban Household Survey data 1989–2009; author's own calculation.

	Spousal income quintiles				
	1	2	3	4	5
Panel A					
Female employment rate (%)					
1992	85.22	93.88	91.14	90.91	91.97
2002	67.98	79.95	80.42	77.90	79.88
2009	60.03	71.23	74.70	74.87	77.34
Panel B					
Male employment rate (%)					
1992	91.50	97.73	99.21	98.18	99.43
2002	86.41	91.11	94.00	95.11	93.89
2009	83.42	89.64	91.08	93.03	92.81

Note: The calculation is based on a matched set of husbands and wives. The number in each cell shows married women or men's employment rate by spousal income quintile. Spousal income is annual labor income in RMB Yuan, and is divided into 5 quintiles, with 1–5 indicating the lowest to the highest 20% of income earners.

If there is a positive selection into employment, non-workers would earn a lower wage than workers even if they worked. In such a case r is less than 1. The actual average wage for each subgroup with characteristics x can be calculated from the observed average wage via the following equation:

$$E(W|x) = E(W|x, E = 1)[r + (1 - r)P(x)] \tag{1}$$

Here $P(x) = P(E = 1|x)$ is the employment rate for the subgroup.

The true gender pay gap can be derived from Eq. (1):

$$E(W_m) - E(W_f) = [E(W_m|E_m = 1) - E(W_f|E_f = 1)] - (1 - r)[(1 - P_m)E(W_m|E_m = 1) - (1 - P_f)E(W_f|E_f = 1)] \tag{2}$$

If both the employment rate and observed mean wage are higher for men than women, i.e., $P_m > P_f$ and $E(W_m|E_m = 1) > E(W_f|E_f = 1)$, which is a common case, the sign of $(1 - P_m)E(W_m|E_m = 1) - (1 - P_f)E(W_f|E_f = 1)$ is, thus, not determined.

We simulate three scenarios where $r = 0.9$, 0.7, and 0.5, using male and female employment rates and earnings of workers from our data. Fig. 3 shows the simulated gender pay gaps from 1988 to 2009. The results support that the raw gender pay gap is underestimated. In addition, as the gender employment gap rises over time, the extent to which the gender pay gap is underestimated increases. For a given year, the smaller r is (i.e., the lower the shadow wage for the non-working), the greater the extent to which the gender pay gap would be underestimated.

4.2. Estimating gender pay gaps with Heckman's selection-correction method

We adopt two parallel approaches to correct for non-random employment selection in estimating gender pay gaps: Heckman's selection-correction method; and the bound method. Instrumental variables (IV) are needed in Heckman's sample-selection model (Heckman, 1979; Mulligan and Rubinstein, 2008; Beblo et al., 2003). The instrumental variables should be able to predict the employment probability but are uncorrelated with wages after counting for observables. The IV we use is a dummy variable indicating whether an individual has a young child aged $\leqslant$6 years. This variable is widely used in the relevant literature as an IV for employment selection (Mulligan and Rubinstein, 2008). However, the validity of this IV has not been fully tested in China.

To demonstrate the validity of this IV for our sample, we report the employment rate for men and women both with and without a young child (Table 1 and Fig. A2). Our calculation is based on the sample of men and women aged 25–35 years.[16] Table 1 shows that among those in that category, women without a young child have a higher employment rate than those with a young child. The difference is less than 1% point, but is statistically significant at the 1% level, based on the data from all years. We also divide the data into two periods, the 1990s and 2000s, and find that the impact of having a young child on females' employment is more evident in the 2000s.

For men, having a young child had a different impact on the employment probability and earnings than for women. The calculations show that men with a young child are more likely to work and have higher earnings than those without a young child. This finding indicates that having a young child may motivate men to work harder in China. Fig. 8 shows further

[16] Pooling people of all ages in the calculation could confound the result. Because individuals with a young child are mostly aged 25–35 years, while those without a young child are older, the employment rate differences between them could be due to age rather than having a young child.

Table 4
Probit model of employment selection, 1992, 2002, and 2009 dependent variable: employment = 1 or 0. *Source:* NBS Urban Household Survey data 1989–2009; author's own calculation.

	Full sample						Married sample					
	1992		2002		2009		1992		2002		2009	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Age	0.023***	0.068***	0.105***	0.161***	0.095***	0.154***	−0.0004*	−0.005**	0.022***	0.048***	0.021***	0.053***
Age squared	−0.0003	−0.001	−0.001	−0.002	−0.001	−0.002	0.0001	−0.002	−0.028***	−0.069***	−0.027***	−0.079***
Married			0.045***	−0.050**	0.071***	0.026						
Education												
Primary	−0.004	−0.051***	−0.112***	−0.213***	−0.114***	−0.169***	0.001***	−0.049***	−0.018***	−0.154***	−0.051***	−0.135***
College	−0.001	0.021**	0.078***	0.137***	0.144***	0.247***	0.001	0.046***	0.042***	0.143***	0.063***	0.232***
Young child	0.003	0.009	0.029**	−0.023***	0.031**	−0.012*	−0.015***	−0.126***	0.011	−0.061***	−0.013	−0.099***
Log (spousal income)							−0.001	−0.002	−0.006	−0.042	0.040**	−0.202***
Log likelihood	−983.78	−1434.87	−5041.78	−6471.85	−7385.62	−8287.51	−287.11	−886.29	−1808.19	−4212.83	−2570.69	−5234.00
Number of obs.	6285	6108	14,424	13,875	17,795	16,754	4407	4734	7985	9525	8969	11,272

Note: The estimation is based on both the full sample (men 16–60 years old and women 16–55 years old) and the married sample (a matched set of husbands and wives). We calculate and report the marginal effect for probit coefficient estimate. For brevity, standard errors are not reported, but are available from authors upon request. Marital status is not available for 1992. The default category for education is "secondary", denoting high school education. "Young child" is a dummy variable that indicates whether a person has a young child with age equal to or lower than 6 years, and the default group is those without a young child. "Log (spousal income)" denotes the logarithm of spousal annual labor income in RMB Yuan.

* Indicates the 10% significance level, respectively.

** Indicates the 5% significance level, respectively.

*** Indicates the 1% significance level, respectively.

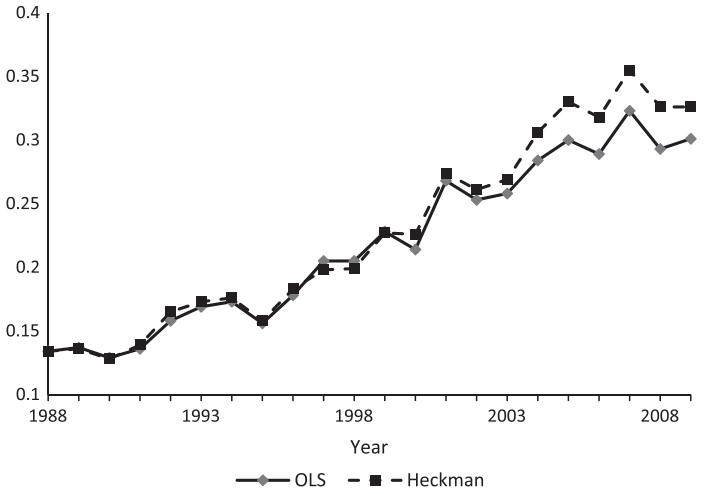

Fig. 4. OLS and Heckman's selection-correction estimates of the gender pay gap. *Source:* NBS Urban Household Survey data 1989–2009; author's own calculation. *Note:* The figure shows the coefficient estimate for male dummy variable in the OLS log earnings regression and in the second-stage Heckman regression. The instrumental variable used in the Heckman regression is whether an individual has a young child under age 6.

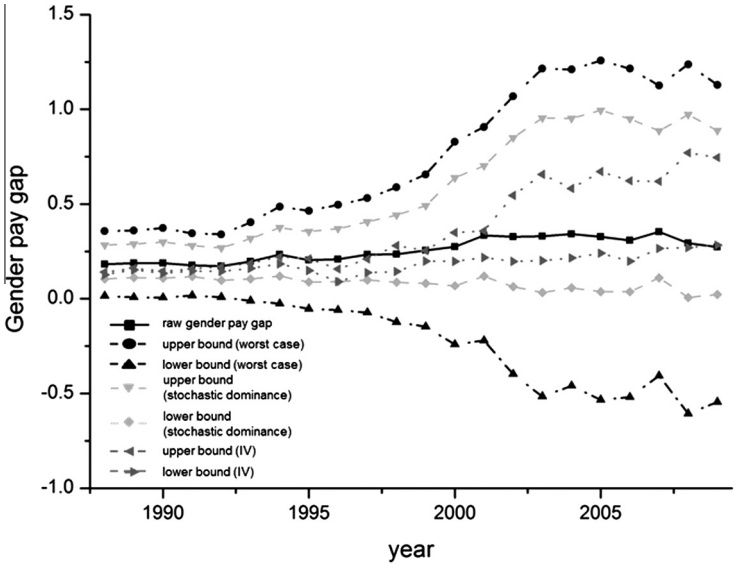

Fig. 5. Employment selection and gender pay gap bounds. *Source:* NBS Urban Household Survey data 1989–2009; author's own calculation. *Note:* The figure shows the raw gender pay gap and estimated upper and lower bounds of the gap with employment selection. The raw gender pay gap is measured by male–female differences in mean log earnings. Earnings are annual earnings in RMB Yuan.

evidence of the lower employment rate for women with young children in some years. We perform statistical tests on the significance of the IV with the first-stage Heckman regression, providing more rigorous support for the relevance of IV.[17]

4.3. Estimating the bounds to the gender pay gap with employment selection

Since non-workers' wages are not observed, we need to estimate the non-workers' shadow wage. Although shadow wages can be estimated, a direct method would generally require restrictive assumptions. However, a series of bounds of the gender pay gap can be estimated with presumably less restrictive assumptions. Instead of obtaining a point estimate to the corrected gender pay gap, the bound method would only provide an upper and lower bound to the gender pay gap

[17] If *F*-statistics on the joint significance of all excluded variables in the first-stage regression is greater than 10, or in the case of a single IV, *t*-statistics is greater than 3.2, the IV is considered to be relevant.

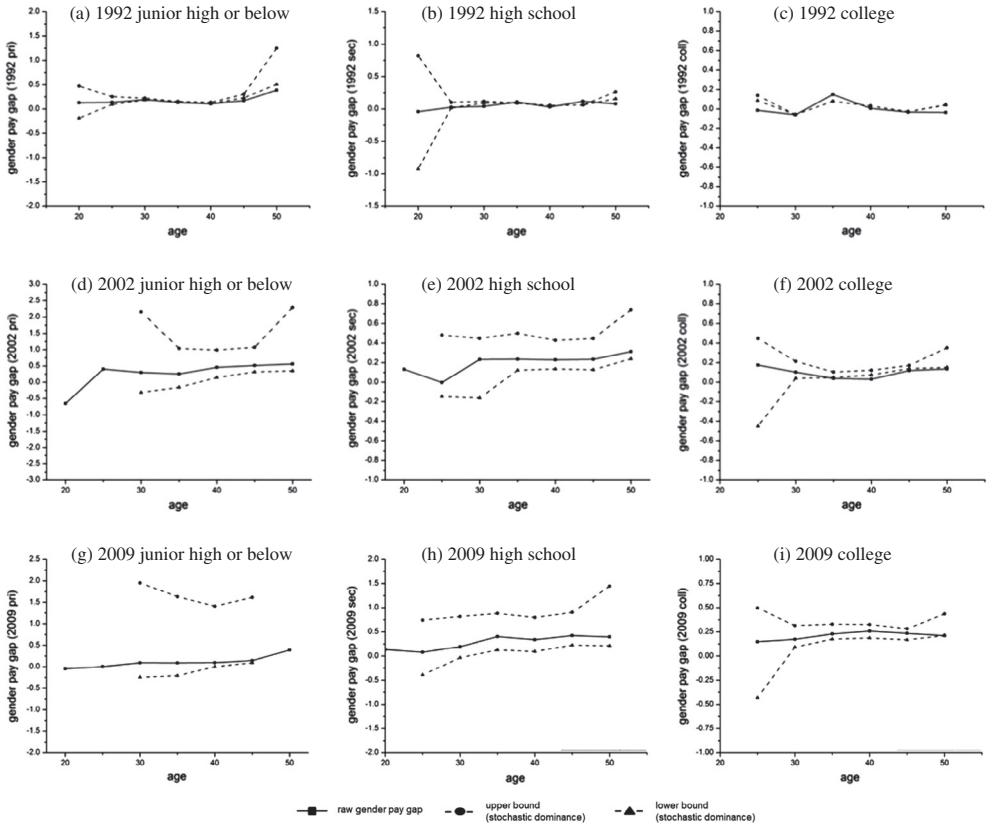

Fig. 6. Raw gender pay gaps and bounds for age–education subgroups, 1992, 2002, and 2009. *Source:* NBS Urban Household Survey data 1992, 1999, and 2002; author's own calculation. *Note:* The figure shows the raw gender pay gap and the upper and lower stochastic-dominance bounds for each subgroup by year. The raw gender pay gap is measured by male–female differences in median log (earnings). Earnings are annual earnings in RMB Yuan.

with non-random employment selection taken into account (Manski, 1994; Blundell et al., 2007). In the following we provide only the heuristics of the bound methods. For the detailed derivation, readers may refer to Blundell et al. (2007).

The worst-case bounds are the bounds that entail no assumption. The rationale is as follows: we notice that the cumulative distribution function (*cdf*) of the complete population, including both working and non-working people, $F(w|x)$, is a weighted average of the *cdf*s of workers $F(w|x, E = 1)$ and non-workers $F(w|x, E = 0)$. The weight is the conditional employment probability, $P(x) = P(E = 1|x)$. That is,

$$F(w|x) = F(w|x, E = 1)P(x) + F(w|x, E = 0)[1 - P(x)] \tag{3}$$

The *cdf* for workers and the conditional employment probability can be estimated from the data, but the *cdf* for non-workers is unidentified. However, since the *cdf* for non-workers is between 0 and 1, we replace $F(w|x, E = 0)$ in Eq. (3) with 1 and get the upper bound to $F(w|x)$. If we replace it with 0, we get the lower bound. As a result, we obtain the following inequality:

$$F(w|x, E = 1)P(x) \leqslant F(w|x) \leqslant F(w|x, E = 1)P(x) + 1 - P(x) \tag{4}$$

Eq. (4) can then be translated to worst-case bounds on the wage quantiles for men and women, respectively, and then the bound to the gender pay gap at each quantile.

The preceding worst-case bounds are universally correct, but could be too crude and hence uninformative. To tighten the bounds, one can impose a positive selection assumption. The positive selection assumption can be translated to a *stochastic dominance* premise, which suggests that the *cdf* of workers would dominate that of non-workers. However, we need to point out that while the assumption of positive selection is generally plausible, it is not incontrovertible and can fail for certain subgroups. For instance, if more capable 20-year-old persons choose to study in schools (i.e., positive selection into education), the shadow wages for this particular age subgroup will be higher than the observed wages.[18] Thus, the empirical results following the stochastic dominance assumption need to be embraced with caution. In the case that this assumption holds, we can deduce:

[18] We thank a referee for his/her insightful point.

$$F(w|x,E=1) \leqslant F(w|x) \leqslant F(w|x,E=1)P(x) + [1 - P(x)] \tag{5}$$

The left bound is tighter than the previous worst-case version. This transcends to tighter bounds to the gender pay gap.

IVs can be employed to tighten the bounds as well. IVs are determinants of the employment, which, on the other hand, are conditionally independent of the wage, i.e., $F(w|x,z) = F(w|x)$ The intuition of IV bounds is that we can deduce similar inequalities to (4) with respect to $F(w|x,z)$ In general, the bounds for $F(w|x,z)$ derived in this way will depend on z. But, because of the IV assumption, $F(w|x,z)$ does not depend on z per se. Thus, the maximum of the lower bounds of $F(w|x,z)$ over z will give a tighter lower bound to $F(w|x,z)$ (equivalently, $F(w|x)$) than the worst-case bound. Similarly, the minimum of the upper bounds of $F(w|x,z)$ over z will give a tighter upper bound to $F(w|x)$.

The same IV variable, the presence of young children, is used in the IV bounds estimation as in Heckman's selection-correction model. While the Heckman method assumes the specific functional form for how the IV affects endogenous employment variables, the IV bounds do not assume any functional form and thus are more robust.

So far our focused parameter is the conditional *cdf* $F(w|x)$ from which (conditional) quantiles can be calculated. This will give us results about the gender pay gap for various subgroups corresponding to particular values of x. When x is averaged over the entire sample, we obtain the gender pay gap bounds to the unconditioned *cdf*.

5. Results

5.1. Evidence of employment selection

Table 2 shows the gender employment gap and the gender pay gap by marital status, age, and education. Our focus is to compare male–female employment rates and earnings across groups. Therefore, we show the detailed results only for three years – 1992, 2002, and 2009. Figs. A3–A5 show the trend for subgroups for additional years.

We discover the following patterns from Table 2. First, more educated individuals had a higher employment rate than less educated individuals. This is true for both men and women. This pattern became more pronounced in recent years.[19] For each of the three years, the gender employment gap and the gender pay gap were narrower for the better educated. This finding may be related to labor market conditions in China. Although college enrollment has increased dramatically in recent years, resulting in a significant increase in the supply of college-educated workers, there is still a shortage of highly skilled professionals.[20] Under such labor market conditions, skilled female workers may be less likely to face employment and wage discrimination, since employers may find it difficult to replace them with enough skilled male workers.

Second, we find an interesting pattern with respect to marital status. In general the employment rate was lower for singles. This is likely because of their young age and student status. However, single women had a higher employment rate than single men. Single women also had relatively higher pay, so that the gender pay gap was markedly smaller for singles.

Third, regarding age, we find that the employment rate generally increased with age for both men and women. For the youngest group (aged 18–22 years), the employment rate was fairly low and became even lower in recent years. This is also likely due to increasing college availability and enrollment. Interestingly, both gender employment and pay gaps were the smallest for the youngest group; women from this age group actually had a higher employment rate than their male counterparts, even though this pattern attenuated over time, and for this group female earnings were close to male earnings. Over time, the second youngest group (aged 23–27 years) started to show a similar pattern.

The finding that young single women have a higher employment rate than their male counterparts while older married women have a significantly lower employment rate than their male counterparts, suggests that women's employment decision is more likely to be impacted by their family characteristics. While younger single women are equally likely to participate in the labor market as men of their age, the decision of older married women to work is more likely to be affected by the situation of their spouse and the presence of young children. Appendix Figs. A3–A5 confirm that both the gender employment and pay gaps are wider for the less-educated, and narrower for the young unmarried group.

To further provide evidence for employment selection, we use the matched set of husbands and wives to show the relationship between the employment rate and spousal income. We calculate the employment rate for men and women by spousal income quintile. Spousal income is divided into five quintiles: the bottom 20%; 20–40%, 40–60%, 60–80%, and the top 20%. Table 3 shows that the employment rate of married men is not negatively affected by higher spousal income. Likewise, we do not find that women with a relatively wealthier husband are less likely to work.

Tables 2 and 3 show descriptive results regarding employment selection. For more rigorous evidence, we performed a probit regression of employment selection (Table 4). The dependent variable is a dummy variable that indicates whether one works. Explanatory variables include age, education, the presence of young children in the household and spousal income. The regression results support our conclusions that the employment rate is higher for those with higher education levels. The presence of young children in the household affects the employment probability of women more negatively than men. The regression results also suggest that, when all other factors have been controlled for, the impact of spousal income on employment probability was negative, but was statistically insignificant for both men and women during the earlier

[19] The only exception is for men in 1992, when men with a primary education had a 90% employment rate while those with a secondary education had a 83% employment rate, and the earnings of the two groups were similar.

[20] "China's looming talent shortage", Diana Farrell and Andrew J. Grant, McKinsey Quarterly, November 2005.

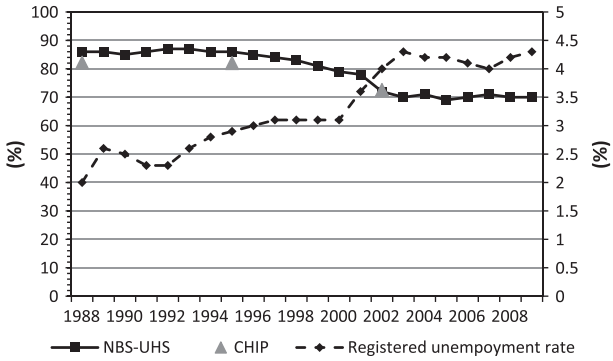

Fig. A1. Employment rates based on different datasets. *Source:* NBS Urban Household Survey data, 1988–2009; China Statistical Yearbooks, 1988–2009; and Chinese Household Income Project data, 1988, 1995, and 2002. *Note:* "NBS-UHS" denotes the employment rate calculated with the NBS Urban Household Survey data. "CHIP" refers to the employment rate calculated by the same method with the Chinese Household Income Project (CHIP) data. "Registered unemployment rate" is official statistics sourced from China Statistical Yearbooks (right axis is used).

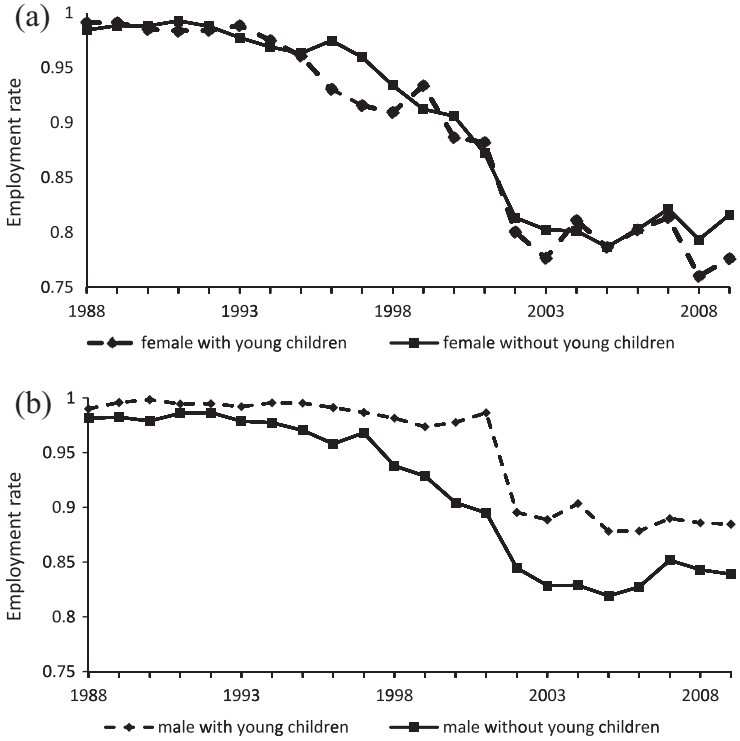

Fig. A2. Employment rates for men and women with or without young children. Panel A: Employment rates of women 25–35 years old. Panel B: Employment rates of men 25–35 years old. *Source:* NBS Urban Household Survey data 1989–2009; author's own calculation.

period under study. However, the effect of spousal income has become significantly negative for women in recent years. This suggests that the income effect has increasingly affected married women's decision to work in urban China.[21]

5.2. Heckman's selection-correction results

We estimate Heckman's selection-correction model for each year, using the presence of young children in a household as an IV. A test for significance of the IV in the first-stage regression suggested that it is relevant for most of the years after 2000.

[21] The regression result regarding the impact of spousal income (Table 4) differs from the descriptive results in Table 3. The differences are likely because the education level of women was not controlled for in the descriptive analysis. Women with spouses that have higher incomes are also likely to have a higher education level, which leads to a higher employment probability. Women of the same education level are less likely to work when their spouses have higher incomes.

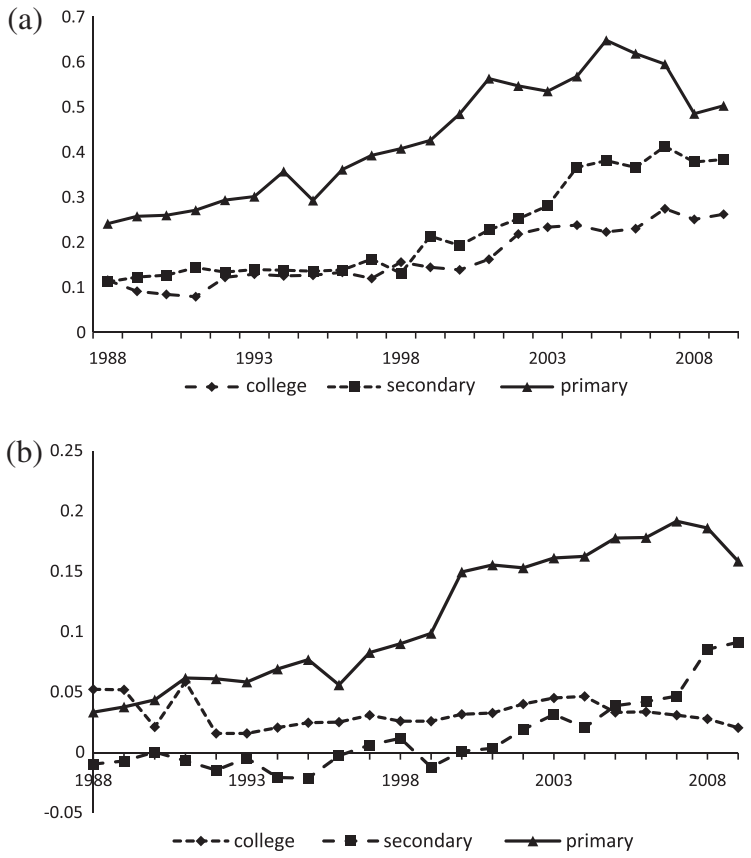

Fig. A3. Gender pay gap and gender employment gap by education. (a) Raw gender pay gap and (b) gender employment gap. *Source:* NBS Urban Household Survey data 1989–2009; author's own calculation. *Note:* Gender pay gap is measured by male–female differential in mean log earnings. Earnings are annual in RBM Yuan. Gender employment gap is measured by the differences in male–female employment rates. "College" indicates college and above education; "Secondary" denotes high school education; and "primary" denotes junior high or below education.

The Likelihood Ratio test of non-selectivity in the Heckman regression was rejected for most of the years, suggesting that selectivity is present and the OLS estimates are biased.

To compare the OLS and Heckman models, we plotted the coefficient estimate for the gender dummy variable in both the OLS regression and the second-stage Heckman regression (Fig. 4). The Heckman method provides a point estimate to the corrected gender pay gap. Fig. 4 shows that the OLS regression underestimates the gender pay gap after the year 2000. Since we used the logarithm of earnings as the dependent variable, the OLS estimate suggests that after 2005 men earned 34–38% more than women. However, results from the second-stage Heckman regression indicate that men earned 38–43% more. Thus, the OLS estimate is lower than the Heckman estimate by 4–5% points.[22]

5.3. The bounds of the gender pay gap

Fig. 5 shows the raw gender pay gap and the bounds estimates for 1988–2009. The worst-case bounds are the least informative, as the lower bound crosses zero for most of the years from 1995 to 2009. To tighten the bounds, we assume the positive selection into employment. Including this assumption tightens the lower bound of the gender pay gap significantly, making it above zero for all years. Before 1995, male and female employment rates were high and the gender employment gap was small; hence the bounds were rather tight. After 2000, the gender employment gap widened significantly, and the bounds became loose. As can be seen, however, the lower bound remained steady while the upper bound increased. In 2009, the lower and upper bounds with the assumption of stochastic dominance were 0.02 and 0.88, respectively, in contrast with the raw gender pay gap, 0.27.

We then use the IV bounds of women's earnings and the stochastic dominance bounds of men's earnings to create the gender pay gap bounds. These estimated bounds are shown in Fig. 5 as the "IV bounds". The IV bounds are tighter than the stochastic dominance bounds. After 2000, the lower IV bound almost overlaps with the raw gap. For example, in 2009 the IV lower and upper bounds are 0.28 and 0.75, respectively, while the raw gender pay gap is 0.27.

[22] That is 12–14% by calculation, e.g., (38 − 34)/34 = 12%.

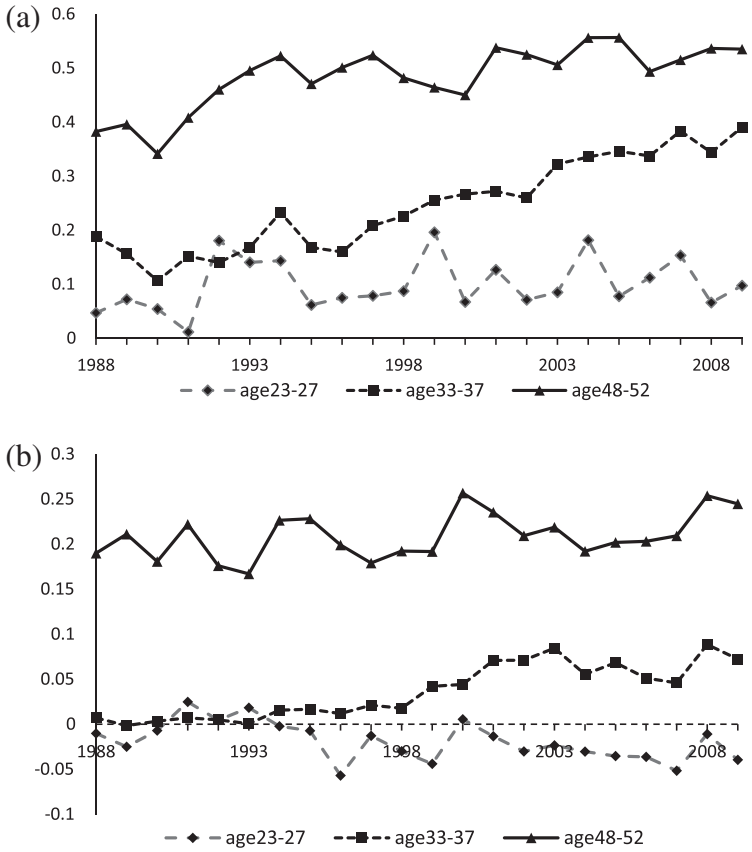

Fig. A4. Gender pay gap and gender employment gap by age. (a) Raw gender pay gap and (b) gender employment gap. *Source:* NBS Urban Household Survey data 1989–2009; author's own calculation. *Note:* Gender pay gap is measured by male–female differential in mean log earnings. Earnings are annual in RBM Yuan. Gender employment gap is measured by the differences in male–female employment rates. "age 23–27" Indicates age 23–27 years; "age 33–37" denotes age 33–37 years; and "age 48–52" denotes age 48–52 years.

The bound method provides useful information in two ways. First, the bound estimates are consistent with the simulation results presented in Section 4, indicating that as the employment rate falls and the gender employment gap widens, non-random employment selectivity becomes a more important factor affecting the gender pay gap estimate. Second, although the bound method does not provide a point estimate to the true gender pay gap, which can be achieved by Heckman's selection-correction method under more stringent model assumptions, it still produces useful range estimates of the focus parameters under certain assumptions.

5.4. Bounds for subgroups

Furthermore, we estimate the gender pay gap bounds for age–education subgroups for 1992, 2002, and 2009 (Fig. 6). In 1992, the bounds are quite tight for most of the groups, except for age 20 and age 50 groups with an education of junior high or below, and the age 20 group with a high school education. For 2002 and 2009, the bounds are still relatively tight for college-educated individuals aged 30–50 years. The bounds are generally loose for the groups with no more than high school education.

Before the mid-1990s, employment in urban areas was concentrated in the state sector. Employment was secured and layoffs were rare. The employment rate was high across many age groups and education levels, except for the young, who enrolled in college, or older groups, who retired. The employment rate was high for both men and women. Thus, non-random selection into employment was not an important factor affecting the gender wage gap before 1995. Since this time, state sector employment has been significantly reduced, and layoffs have increased. The employment rate has fallen for both men and women. Women are also more likely to selectively withdraw from the labor force. Therefore, employment selectivity has become more significant, leading to the wider bounds of the gender pay gap in the late 1990s and 2000s.

In general, the bounds are tighter for college graduates than for groups with less education. This is because, especially in recent years, the employment rate is higher and the gender employment gap is smaller for college graduates. Although college graduates face increasing difficulty finding employment because of the rising supply of college graduates in recent years

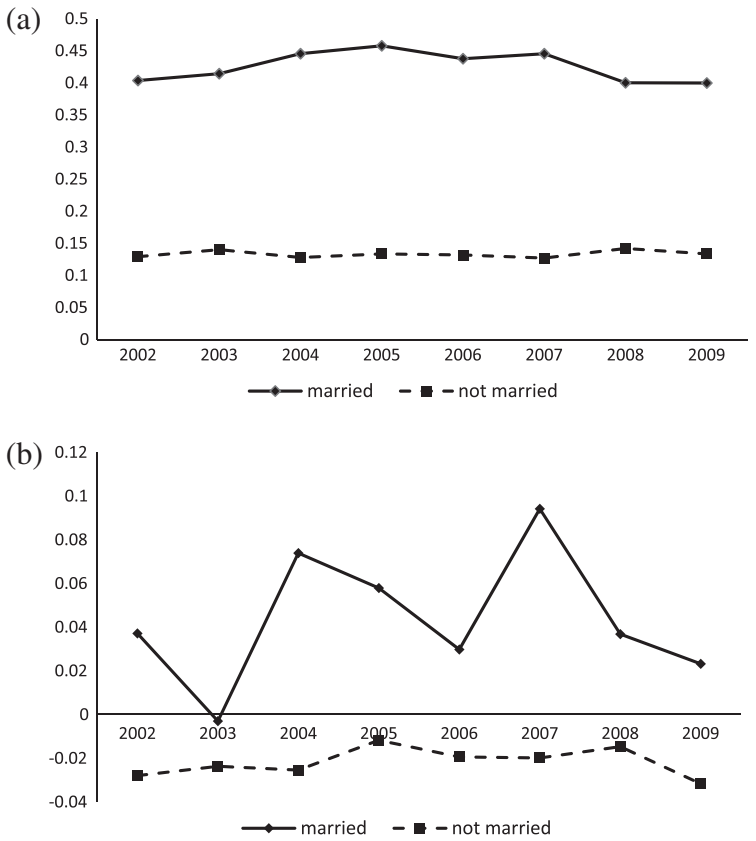

Fig. A5. Gender pay gap and gender employment gap by marital status, 2002–2009. (a) Raw gender pay gap and (b) gender employment gap. *Source:* NBS Urban Household Survey data 1989–2009; author's own calculation. *Note:* Gender pay gap is measured by male–female differentials in mean log earnings. Earnings are annual earnings in RBM Yuan. Gender employment gap is measured by the differences in male–female employment rates. Because marital status was asked in the survey after 2002, the figure shows the results from 2002 to 2009.

Table A1
Sample description. *Source:* NBS Urban Household Survey data 1989–2009; author's own calculation.

	The number of observations
1988	11,286
1989	10,502
1990	11,144
1991	10,967
1992	12,393
1993	11,788
1994	11,854
1995	11,867
1996	11,888
1997	12,058
1998	12,021
1999	12,102
2000	11,884
2001	11,967
2002	28,299
2003	31,930
2004	34,327
2005	36,052
2006	36,306
2007	36,267
2008	35,088
2009	34,549
Total	436,539

Table A2
Having a young child by age. *Source:* NBS Urban Household Survey data 1989–2009; author's own calculation.

Men	Num. of obs.	% Having a young child	Women	Num. of obs.	% Having a young child
<25 Years old	39,597	1.32	<25 Years old	38,427	4.03
25–35	39,347	43.98	25–35	47,200	42.32
>35	143,299	3.66	>35	128,669	1.88

Table A3
Annual earnings, hourly wages, and working hours, 2003–2006. *Source:* NBS Urban Household Survey data 2003–2006; author's own calculation.

Year	Hours worked last month		Log (hourly wage)		Difference in log (wage)	Log (annual earnings)		Difference in log (earnings)
	Men	Women	Men	Women		Men	Women	
2003	180.6	177.2	1.64	1.36	0.28	9.20	8.84	0.36
2004	180.8	177.3	1.82	1.51	0.31	9.38	8.98	0.40
2005	181.4	178.3	1.93	1.62	0.31	9.50	9.09	0.41
2006	180.7	177.8	2.04	1.75	0.29	9.62	9.22	0.40

Note: Hours worked last month is only available for 2003–2006. Since yearly data is collected and reported to NBS in the end of a calendar year, hours worked in last month is referred to hours worked in December. Hourly wages are equal to annual earnings divided by hours worked last month multiplied by 12. Both hourly wages and annual earnings are in RMB Yuan. Logarithm is taken for hourly wages and earnings. The differences in log (hourly wages) and log (annual earnings) between men and women are calculated.

(Whalley and Xing, 2011), our data show that college graduates still have a higher employment rate than less-educated individuals. In particular, female college graduates have a higher employment rate than less-educated women. Therefore, employment selectivity does not influence the gender wage gap as much for college graduates.

6. Conclusion

Men and women often have different employment rates, and because of non-random selection into employment, the gender pay gap estimate is likely to be biased. Our article is motivated by the observation that little is known about the male–female employment rate gap in China, or the extent to which the gender employment gap causes the bias in the gender pay gap.

We show the trend in the gender employment gap and gender pay gap in China during the period 1988–2009, and estimate the gender pay gap using Heckman's selection-correction method. The Heckman results suggest an underestimation of the raw gender pay gap by 12–14% for the years 2005–2009. The worst-case bounds are uninformative because the lower bound crosses zero for many of the years. When stochastic dominance of the earnings of workers over non-workers is assumed, the lower bound is tightened significantly. We further tighten the bound by using the IV – whether an individual has a young child aged less than or equal to 6 years – which is often used to correct employment selection. However, even with these tightened bounds, the raw gender pay gap is between the estimated lower and upper bound for many of the years, which leads to a more modest conclusion that the bounds estimates support a possible mis-estimation, rather than an underestimation, of the raw gender pay gap.

Our article contributes to the growing literature on the gender pay gap in transition countries, specifically in China. Our study has a couple of important policy implications. Labor policies that focus on narrowing the wage gap between men and women should also look at skill composition of the male and female labor force because of employment selectivity. Policymakers should be aware of the implications of such an employment selection for the gender wage gap estimate. Future research is needed to examine the determinants of labor force participation and employment for both men and women, and to identify the causes of the widening gender employment gap. This will lead to a better understanding of changes in the skill levels of men and women in the labor force and the effect that such changes have on the gender wage gap in China.

Acknowledgments

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Appendix A

See Figs. A1–A5. Tables A1–A3.

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