The Gender Wage Gap and Sample Selection via Risk Attitudes

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Abstract

This paper investigates a new way to decompose the gender wage gap with the introduction of individual risk attitudes using representative Korean data. We estimate the wage gap with correction for the selection bias, which latter results in the overestimation of this wage gap. Female workers are more risk averse. They hence prefer working in the public sector, where wages are generally lower than in the private sector. Therefore, our observation of the gender wage differential based on the normal Mincerian wage equation is overestimated. Our (corrected) wage differential is significantly reduced (by from 3% to 8% points) by applying the Switching Regression Model and Lee's polychotomous selection correction. Self-selection based on risk attitudes therefore explains, in part, what is popularly perceived as gender discrimination.

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1 Introduction

Many factors can affect an individual's decisions about economic issues. In human-capital theory, risk is involved when students make education decisions, such as weighing random future income against an additional year of education. In the labor market, some people choose to endure longer periods of unemployment in order to obtain better wages and working conditions, while some prefer to exit unemployment sooner despite lower wages. Others prefer lower wages and safer public-sector pension and social security plans to higher wages and riskier private-sector pension and social security plans.
A number of reasons may underlie these choices. First, markets might not clear such that firms do not offer the same wage profiles to identical workers. Second, there could be individual heterogeneity in the decision-making process. Even when all observable factors are controlled for - such as gender, age, wealth, region, etc - there are still significant differences in outcomes. This suggests the presence of unobservable factors behind individual heterogeneity and firm behavior.

Murphy et al. (1987) and Moore (1995) show that job sectors with higher unemployment and greater risk tend to have higher wages. Hence, job-sorting decisions may well vary with individuals' attitudes to risk. More recent work such as Hartog et al. (2003) also shows that jobs with greater risk are paid higher wages, contributing to the theory of compensating wage differentials. Workers who are more willing to accept a certain number of dollars for a given increase in risk are more likely to choose to work in riskier jobs than those who are less inclined to make a trade-off between wages and risk. While job-sector choice is sensitive to differences in risk attitudes, it is *a priori* also strongly correlated with education decisions.
Measuring attitudes to risk is, however, a delicate task, and there have been various attempts to find the right kind of subjective self-reported variables which accurately reflect risk aversion. Feinberg (1977) and Hersch and Viscusi (1990) study the use of seatbelts and smoking behavior. Ekelund et al. (2005) use a psychometric variable measuring harm avoidance as an indicator of risk attitudes. They find that agents with a higher harm-avoidance score (i.e. less risk averse) are more likely to become self-employed, which is considered riskier than being employed as a wage earner. In an experimental study, Dohmen et al. (2005) show that measures of subjective risk attitudes, such as self-reported risk aversion and lottery questions, provide a valid predictor of actual risk behavior. Dohmen and Falk (2011) build upon these results and use self-reported risk aversion in the German Socioeconomic Panel to see whether risk preferences explain how individuals are sorted into occupations with different earnings variation. Furthermore, Luechinger

et al. (2007) and Pfeifer (2011) analyze selection in public-sector employment, and Grund and Sliwka (2006) and Cornelissen et al. (2011) study pay-for-performance schemes. All conclude that risk-averse workers have a greater preference for non-competitive working environments. Pissarides (1974) presents a theoretical model explaining that risk-averse workers have lower reservation wages. This relationship is demonstrated empirically by Pannenberg (2007). Similarly, Goerke and Pannenberg (2008) show that there is a negative relationship between risk aversion and union membership.

Given that job sorting matters in terms of the position actually held in the labor market, there is good reason to wonder whether the job-sorting decision interacts with the gender disparity observed on the labor market. Although the gender bias in education has been reduced and the education gap between men and women has narrowed in recent decades Arnot and Weiner (1999), there is still concern over the considerable wage gap and other kinds of gender-based discrimination on the labor market. In a move to explain these findings, Croson and Gneezy (2009) and Bertrand (2011) argue that women may be more risk averse and less competitive than men. More interestingly for our question, Gneezy et al. (2003), Niederle and Vesterlund (2007) and Croson and Gneezy (2009) all suggest that differences in risk attitudes might partly explain the gender gap in labor-market outcomes. Similarly, Barsky et al. (1997), Dohmen and Falk (2011) and Bonin et al. (2007) show that job-sector selection and wages are correlated with risk attitudes.

Here, then, lies our centre of interest. The gender wage gap is still an interesting issue for labor economists and policymakers. In many countries, even developed countries like Sweden where gender rights are believed to be the most equal in the world, gender wage differentials are often observed. Labor economists analyze this phenomenon and define the gender wage gap as "discrimination" if it occurs for equally-productive workers (Becker (1993)). A huge body of literature has been produced in this field to examine the wage gap and discrimination following the seminal paper of Oaxaca (1973). The raw wage gap is decomposed into two parts: one explained by human capital and endowments, and the other unexplained, which is often deemed to be discrimination. Empirical estimations of wages with human capital commonly use a Mincerian wage equation (Mincer (1974)), in which the logarithm of wage is regressed on observable socio-demographic variables such as gender, schooling, age, etc. In this model, however, concerns may arise in the event of selection issues or omitted variable bias: what would the level of wages have been in the absence of discrimination? A number of contributions have attempted to correct this selection bias, mainly based on the selection of labor-market participation (Newman and Oaxaca (2004)). We here instead consider sector selection (followed by participation selection) to decompose the gender wage gap, considering selection via individual risk

attitudes.

This paper shows how female workers appear to choose to work in the lower-paid public sector, and how individual risk attitudes can play a role in this decision-making process. It goes on to explain the reduced gender wage gap by developing an appropriate sample-selection model. The remainder of the paper is organized as follows. Section 2 introduces the simple conceptual framework behind the idea, and then presents the analytical framework with the data description in Section 3. Section 4 shows the empirical results obtained from testing the impact of risk aversion on job sorting and the gender wage gap with corrected selection bias. Last, Section 5 concludes.

2 Conceptual Framework

Public-sector jobs are often considered to be safer in terms of their associated benefits, job stability and security. However, they also pay less than private-sector jobs, where workers obtain a wage premium for taking risks such as higher job separation rates and fewer or lower-quality benefits. For this reason, we might expect risk-averse workers to prefer public-sector stability over private-sector wage volatility and a greater probability of unemployment. In addition, female workers are more sorted into the public rather than the private sector, which might be explained by different risk-attitudes by gender.

This section introduces some simple occupational self-sorting concepts in terms of attitudes towards risk.

2.1 Risk-Averse Workers' Preference for the Public Sector

Here, we present a simple conceptual framework about risk averse workers' preference of working in the public sector. Let's start with a risk neutral agent. The agent can decide whether to work in the private sector with high wage $W1$ and high risk of getting fired, or to work in the public sector with lower wage $W2$ but low risk. The wage with risk premium to offset the job-security risk in the private sector is greater than the wage in the public sector. Then, in the private sector, the agent is facing the risk of getting fired with the job separation rate λ , in which case he/she will earn the unemployment benefit $W3$ which is lower than the wage of the public sector. We assume that in public sector there is no risk to be fired once a worker is hired.

Then, now we can get the optimal job separation rate where the agent switch his/her decision between the public sector and the private sector. Taking the risk neutral agent first, as his/her utility function is linear to the wage, the job separation rate where the

agent would switch from the private sector to the public sector would be:

$$\lambda^* = \frac{W1 - W2}{W1 - W3}$$

calculated from the indifferent condition of the expected utility between working in the public sector and working in the private sector

$$U[W2] = \lambda U[W3] + (1 - \lambda)U[W1]$$

$$W2 = \lambda W3 + (1 - \lambda)W1$$

Now, we define the optimal job-staying rate which is simply the probability of not getting fired for risk neutral agent is:

$$P^* = 1 - \lambda^* = 1 - \frac{W1 - W2}{W1 - W3} = \frac{W2 - W3}{W1 - W3}$$

Figure **??**Fig:sector1 illustrates the risk neutral agent's utility function. At the optimal level of job-staying rate (P^* = 1- job separation rate λ), the agent switch the job sector. Risk Neutral Agent's optimal strategy with respect to P variation

- $0 \leq P < P^*,\ \lambda^* < \lambda \leq 1 : U[W2] > \lambda U[W3] + (1 - \lambda)U[W1]$: Always Prefers Working in the Public

- $P = P^*, \lambda = \lambda^* : U[W2] = \lambda U[W3] + (1 - \lambda)U[W1]$: Indifferent between the Public Sector and the Private Sector

- $P^* < P \leq 1,\ 0 \leq \lambda < \lambda^* : U[W2] < \lambda U[W3] + (1 - \lambda)U[W1]$: Always Prefers Working in the Private

The incentives to work in the public can be found in the lower triangle, where the agent always decides to work in the public sector, while the incentives to work in the private sector are in the upper triangle, where he/she always prefers working in the private sector.

Now, we introduce two different types of agents-risk averse and risk seeking- in addition to the risk neutral agent. Figure **??**Fig:sector2 draws the utility functions for each agent: risk neutral agent has linear utility function, risk averse agent has concave utility function, and risk seeking agent has convex function with respect to wealth. Given that we now know the optimal level of job-staying rate $P^* = P(RN)^*$ for risk neutral agent, we can graphically get the optimal level of job-staying rate for risk seeking agent $P(RS)^*$ and risk averse agent $P(RA)^*$. Due to its concavity (convexity) of the utility function for risk averse (seeking) agent, the optimal job-staying rate of switching from working in the public sector to working in the private is higher (lower) than that of risk neutral

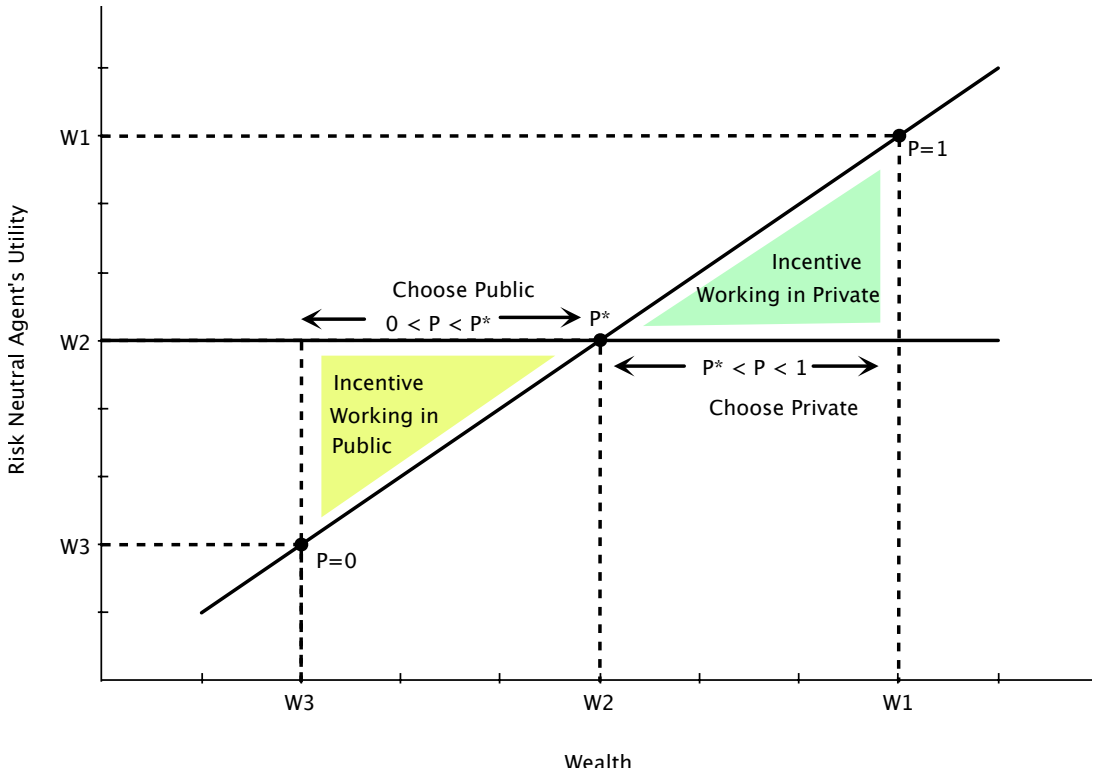

Figure 1: Public or Private? for Risk Neutral Agent

agent. In other words, risk averse agent needs to have lower job separation rate (higher job-staying rate) to bear the potential risk of getting fired in the private sector than the risk neutral agent, whereas risk seeking agent can take higher risk of getting fired at the higher monitoring rate as he/she would value more on higher wage. Therefore, the switching job-staying rate for each agent is $0 < P(RS)^* < P(RN)^* < P(RA)^* < 1$, and hence, we can infer the relationship between the optimal switching rate P^* and the risk parameter r (the higher r, more risk averse) :

$$\frac{\partial P^*}{\partial r} > 0 \ \rightarrow \frac{\partial \lambda^*}{\partial r} < 0$$

which means, as getting more risk averse, the agent switch from the private sector to the public sector at lower job separation rate.

2.2 Gender Difference in Expected Returns

Imagine again that there are two types of firms: public and private. The private firm pays higher wages, but the atmosphere is highly competitive and the job is not secure. The public firm is relatively relaxed and the job is more secure, but pays a lower wage than the private firm. Looking at the private firm, we show below that this firm pays

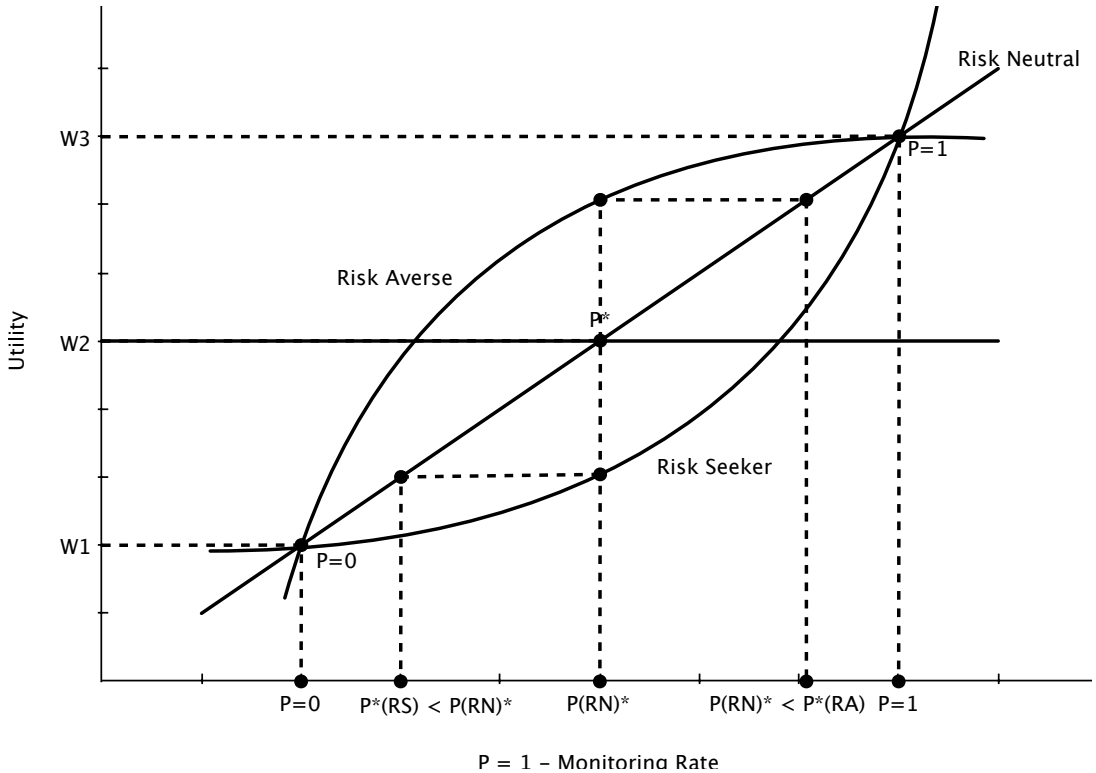

Figure 2: Optimal job-staying rate to switch sectors for Risk Averse, Risk Neutral, and Risk Seeking Agents

male workers higher wages than female workers.

There is less guarantee that a woman will return to the job in the competitive firm after child bearing than to a job in the public sector, where maternity leave is better-accepted. Assuming that women's quitting rates from the private firm are higher than men's due to their child bearing, following which the private firm may not guarantee keeping their job positions open (i.e. $q_f > q_m$), the expected return for a given period after hiring by gender with productivity a and hiring cost of c, $a > c > 0$ (both identical by gender) in the private firms is the following: $\Pi_f = a(1-q_f) - cq_f < \Pi_m = a(1-q_m) - cq_m$. Therefore, it makes sense for the private firm to prefer to hire male workers (i.e. male workers' probability of being hired is greater than that of female workers). More risk-averse workers set their reservation wages lower in order to be hired (Pissarides (1974)), whereas less risk-averse workers have a lower probability of being hired albeit keeping their reservation wage higher. This leads more risk-averse female workers to accept lower wage offers in the private firms. Therefore, among female workers in the private firm, risk-averse workers earn lower wages. This idea ties in with the "statistical discrimination"[1] literature, in that there are different wage profiles emanating from the demand side (firms).

3 Analytical Framework

Bearing in mind the two scenarios in the previous section, we now set up an analytical framework in order to test them empirically. A number of pieces of work have investigated whether the gender gap in risk-taking preferences and competitiveness is significantly different and even innate. Apicella et al. (2008) show that risk-taking in an investment game with potential real monetary pay-offs correlates positively with salivary testosterone levels and facial masculinity. More recently, Buser (2011) finds that women are less competitive both when taking contraceptives that contain progesterone and estrogen and during the phase of the menstrual cycle when the secretion of these hormones is particularly high. Hormone studies aside, Sutter and Rutzler (2010) examines the compensation choices of 1,000 Austrian children and teenagers aged 3 to 18, and finds that the gender gap in competitiveness is already present by age three. In this paper, therefore, we write risk aversion (showing individuals' risk attitudes in general) as a function of being female (F) : $RA = RA(F, ...)$. Based on Section 2.1, the probability of choosing to work in the public sector can be written as a function of being female and

[1]Statistical discrimination is a theory of inequality between demographic groups based on stereotypes that do not arise from prejudice or racial or gender bias (Phelps (1972))

risk aversion $Pub = Pub(F, RA(F), ...)$. Last, we extend the Mincerian wage equation to $w = w(F, Pub(F, RA(F, ...)), ...)$.

Therefore, the wage gap across gender can be written as follows.

$$\frac{\Delta w}{\Delta F} = \frac{\partial w}{\partial F} + \frac{\partial w}{\partial Pub}\frac{\Delta Pub}{\Delta F}$$

$$= \frac{\partial w}{\partial F} + \frac{\partial w}{\partial Pub}\frac{\partial Pub}{\partial F} + \frac{\partial w}{\partial Pub}\frac{\partial Pub}{\partial r}\frac{\Delta RA}{\Delta F}$$

Female workers' lower wages derive from three factors: (1) purely being female (this could be interpreted as pure market discrimination); (2) female workers' preference for work in the public sector irrespective of their risk attitudes or private firms' preference for hiring male workers, which prompts women to work in the public sector (section 2.2), and (3) choosing to work in the public sector and get lower wage due to women's higher risk aversion. The sign of each term would be the following:

- $\frac{\partial RA}{\partial F} > 0$: Women are more risk averse.
- $\frac{\partial Pub}{\partial RA} > 0$: Risk averse workers prefer to work in the public sector.
- $\frac{\partial Pub}{\partial F} > 0$: Due to non-pecuniary benefit (guaranteed maternal leave, child care service), female workers prefer working in the public sector irrespective of risk attitudes. Or private firms prefer to hire male workers for their higher expected returns.
- $\frac{\partial w}{\partial Pub} < 0$: Risky firms compensate their risk with the risk premium, paying higher wage to workers.

Therefore, gender wage gap $\frac{\Delta w}{\Delta F}$ that we observe in the labor markets is the composition of pure female discrimination $\frac{\partial w}{\partial F}$, the gap from female workers' preference on working in the public sector $\frac{\partial w}{\partial Pub}\frac{\partial Pub}{\partial F}$, and the gap from their being risk averse which leads to work in the public sector and also to get lower wage $\frac{\partial w}{\partial Pub}\frac{\partial Pub}{\partial r}\frac{\Delta RA}{\Delta F}$. In this paper, we attempt to disentangle the impact of risk aversion on the wage gap, and get the corrected gender wage gap which comes from market discrimination. The following Figure **??**Fig:scheme illustrates these three factors.

3.1 Selection

The concern often raised with the Mincerian wage equation is that the employment sector is wage-endogenous. There are omitted variables which could influence both wages and sector selection. If we do not control for this selection, the results from the wage equations

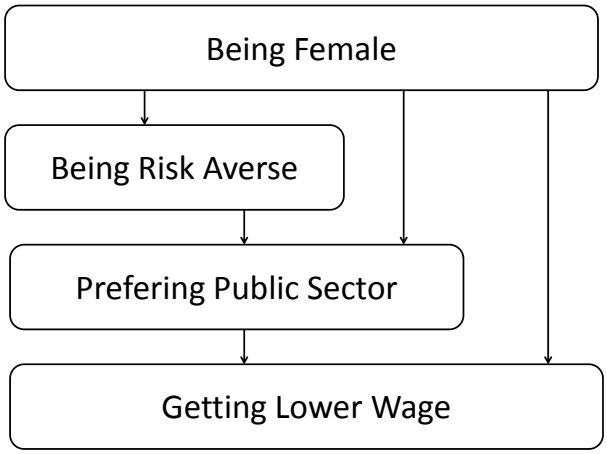

Figure 3: Graphic Illustration of Female Worker's Path towards Lower Wage

could be biased. Here we use a risk-attitude variable to correct for selection and obtain adjusted estimates of the gender wage gap, as risk aversion could determine workers' employment sector choices.[2]

3.1.1 Switching Regression Model

Nakosteen and Zimmer (1980) propose a model to address the earnings of migrants and non-migrants (the move stay model). In our paper, we apply their method to deal with self-selection. We estimate the earnings for public-sector workers and private-sector workers separately.

$$w_{pub,i} = \alpha_{pub} + X'_{pub,i}\beta_{pub} + \epsilon_{pub,i} \ : \ Public\ Wage\ Equation$$

$$w_{pri,i} = \alpha_{pri} + X'_{pri,i}\beta_{pri} + \epsilon_{pri,i} \ : \ Private\ Wage\ Equation$$

The sector-selection function is:

$$Pub_i^* = \delta RA_i + Z_i'\gamma + u_i \ : \ Sector\ Choice$$

$$Pub_i = 1 \ if \ Pub_i^* > 0 \ : \ In\ Public$$

where Pub_i^* is a latent variable such that if $Pub_i^* > 0$ then Pub_i takes the value of 1 (choice of the public sector), otherwise Pub_i takes the value of 0 (choice of the private sector);

[2]Regarding the exclusion restriction, Korean labor market wages are quite rigid once people are employed and are often not negotiable on entering the market. Therefore, risk aversion can be assumed to affect wages only in terms of sector selection. However, we will appeal to polychotomous choice sample-selection models to discuss this issue in the following section.

RA_i is the variable that captures individual risk attitudes (hereafter risk aversion) and Z_i is a vector of characteristics influencing the employment-sector decision. If we take the condition $Pub_i = 1$ (i.e. workers in the public sector), the earning equation for workers in the public sector is as follows:

$$E(w_{pub,i}|x_{pub}, Pub_i = 1) = \alpha_{pub} + X'_{pub,i}\beta_{pub} + E(\epsilon_{pub,i}|u_i > -\delta RA_i - Z'_i\gamma)$$

$$= \alpha_{pub} + X'_{pub,i}\beta_{pub} + \sigma_{\epsilon_{pub},u}\frac{\phi(-\delta RA_i - Z'_i\gamma)}{1 - \Phi(-\delta RA_i - Z'_i\gamma)}$$

$$= \alpha_{pub} + X'_{pub,i}\beta_{pub} + \sigma_{\epsilon_{pub},u}\frac{\phi(\delta RA_i + Z'_i\gamma)}{\Phi(\delta RA_i + Z'_i\gamma)}$$

$$= E(y_{pub,i}|x_i) + \sigma_{\epsilon_{pub},u}\lambda$$

where $(\epsilon_{pub,i}, u_i)$ is joint normal and $\sigma_{\epsilon_{pub},u} = Cov(\epsilon_{pub,i}, u_i)$. This covariance determines the effect of selection on the conditional income of workers in the public sector. If $\rho_{\epsilon_{pub},u}$ is significantly different from zero, we cannot ignore the unobservable characteristics that could affect both selection and earnings. The wage equation for workers in the private sector can similarly be written as:

$$E(w_{pri,i}|x_i, Pub_i = 0) = \alpha_{pri} + X'_{pri,i}\beta_{pri} + E(\epsilon_{pri,i}|u_i \leq -\delta RA_i - Z'_i\gamma)$$

$$= \alpha_{pri} + X'_{pri,i}\beta_{pri} + \sigma_{\epsilon_{pri},u}[-\frac{\phi(-\delta RA_i - Z'_i\gamma)}{\Phi(-\delta RA_i - Z'_i\gamma)}]$$

$$= \alpha_{pri} + X'_{pri,i}\beta_{pri} - \sigma_{\epsilon_{pri},u}\frac{\phi(\delta RA_i + Z'_i\gamma)}{1 - \Phi(\delta RA_i + Z'_i\gamma)}$$

Furthermore, we can calculate the hypothetical expected log wage (i.e. public-sector workers' expected wages if they worked in the private sector and private-sector workers' expected wages if they worked in the public sector).

$$E(w_{pub,i}|x_{pub}, Pub_i = 0) = \alpha_{pub} + X'_{pub,i}\beta_{pub} - \sigma_{\epsilon_{pub},u}\frac{\phi(\delta RA_i + Z'_i\gamma)}{1 - \Phi(\delta RA_i + Z'_i\gamma)}$$

$$E(w_{pri,i}|x_i, Pub_i = 1) = \alpha_{pri} + X'_{pri,i}\beta_{pri} + \sigma_{\epsilon_{pri},u}\frac{\phi(\delta RA_i + Z'_i\gamma)}{\Phi(\delta RA_i + Z'_i\gamma)}$$

3.1.2 Polychotomous Choice Sample Selection Model (Lee (1983))

We now consider the case where people choose from three alternatives; (1) employment in the public sector, (2) employment in the private sector, and (3) otherwise (unemployed, inactive, or self-employed). This factors in the possibility that risk aversion could affect

wages via one more channel: the reservation wage associated with entering employment.[3] Consider the following polychotomous choice model with three categories:

$$w_k = \alpha_k + x_k\beta_k + \rho_k u_k$$

$$s_k^* = \delta RA_k + Z_k\gamma_k + v_k$$

where $k = 1, 2, 3$ and $u_k \sim N(0, 1)$. McFadden (1974) shows that if v_k is $i.i.d$ with a Gumbel distribution, the probability of individual i choosing j is

$$Pr(s_{ij} = 1) = \frac{exp(\eta_{ij})}{1 + \sum_{k=1}^{3} exp(\eta_{ik})} \; if \; j > 1$$

$$or \; = \frac{1}{1 + \sum_{k=1}^{3} exp(\eta_{ik})} \; if \; j = 1$$

where $\eta_{ij} = max_{k=1,2,3k\neq j} s_k^* - v_j$.
If we denote $J = \Phi^{-1}F$, the transformed random variable $\eta_j^* = J\eta_s$ is standard normal. The bias-corrected wage equation is then

$$w_j = \alpha_j + x_j\beta_j - \sigma_j\rho_j\phi(J_j(\delta RA_j + Z_j\gamma))/F_j(\delta RA_j + Z_j\gamma) + \epsilon_j$$

under the assumption that u_k and η_j^* are joint normally distributed, $E(\epsilon_j|j\text{is chosen}) = 0$, ϕ is a standard normal density function, σ_j is the standard deviation of the disturbance u_j, and ρ_j is the correlation coefficient of u_j and η_j^*. The conditional variance of ϵ_j is

$$Var(\epsilon_j|l = j) = \sigma_j^2 - (\sigma_j\rho_j)^2[J_j(\delta RA_j + Z_j\gamma) + \phi(J_j(\delta RA_j + Z_j\gamma)/F_j(\delta RA_j + Z_j\gamma)]$$

$$\times\phi(J_j(\delta RA_j + Z_j\gamma)/F_j(\delta RA_j + Z_j\gamma)$$

4 Data and Results

4.1 Data

This paper uses data from Korea where the gender gap is still an important labor market issue. Even though Korea's economy has grown remarkably over the past few decades, its gender wage gap remains the largest among member countries of the Organization for Economic Co-operation and Development (OECD). Data from the OECD's 2009 Annual Report show that male workers in Korea are paid 40 percent more than their female counterparts. This is the widest gender wage gap of the 30 OECD member economies,

[3]See Pissarides (1974)

being over twice the OECD average of 18.8 percent.

Our data comes from the Korean Labor & Income Panel Study published by the Korean Labor Research Institute. This survey was first launched in 1998 and now has more than 10 waves, being carried out once a year. It covers 5,000 households and their members (11,855 individuals in all) who currently live in Korea. These panel data are interesting in that they contain questions on risk attitudes and many different elements of job and life satisfaction. For this paper, we restrict the sample to 4,208 individuals in the one wave (2007) in which the risk questions are available, and also only consider individuals who are currently employed as wage earners in order to deal with labor-market sector selection. In the Korean sample, the occupational shares for the 11,855 individuals are as follows:

Mainly Working (Public, Private, and Self-Employed)	5,927	50.0%
Domestic Work (childcare and family duties)	2,649	22.3%
Students	1,396	11.8%
Other economically inactive	1,883	15.9%
Total	11,855	100.0%

We retain wage earners only (sample size 4,208) for the switching regression model in order to look at selection between the public and private sectors. The full sample is then used for the polychotomous selection model when estimating sector selection including the labor market participation decision. For individual risk attitudes, we construct a measure from the answers to five lottery-type questions.

Table 1 presents the simple descriptive statistics on wage earners. The proportion of female workers in the wage-earning segment of the Korean labor market is about 40%. Figure 3 shows the percentage of women among wage earners in different cohorts. In Korea, women tend to enter the labor market earlier than men, since men have to serve two years of national service before entering the labor market. Women's labor market participation drops sharply however by the age of 30. This is the age at which they often get married (Figure 4). Figure 5 depicts the log wage difference between genders in the different cohorts. There appears to be no difference in terms of wages on entering the labor market. There is a break point at which male workers start to earn more at the age of 25-30, which might be the age of 'marriage', and the gap grows with age. Marital status in Korea may therefore be one factor in explaining women's labor market behavior, including wages and sectoral choice. However, our data here only covers employees and not the self-employed, in which sector where there are generally more men. Therefore, our dataset here does not cover all labor market participation. We can first look at

the gender wage differential. On average, women have lower wages (KRW130.61million monthly),[4] fewer years of schooling (12.39 years), and are younger (age 39) than men (KRW227.57 million, 13.34 years education, age 41). This lower wage could be the result of both gender discrimination and female workers' characteristics, such as less education and a higher proportion of women in the public sector (47% of public-sector workers are women as opposed to 36% in the private sector), where wages are generally lower (KRW207 million in the private sector and KRW140 million in the public sector). In addition, public-sector workers' risk aversion[5] is higher on average than it is for workers in the private sector. Women are also found to be more risk averse. We now describe how risk aversion is measured in our data.

4.2 Measuring Risk Aversion

The Korean Labor & Income Panel Study recently added in a number of pilot questions on individual risk attitudes. We use the 2007 wave, which contains five lottery questions that we can use to summarize individual risk-taking attitudes. Each individual is asked whether they would accept the given lottery or take KRW100,000 (USD 82) in cash, or whether they are indifferent between the two. The details of the five questions are shown below:

Number	Lottery characteristics	Expected Value	$[N_i]$	Weight$[\alpha_i]$
1	1/2: KRW150,000, 1/2: KRW50,000	KRW100,000	363	0.155
2	1/2: KRW200,000, 1/2: KRW0	KRW100,000	314	0.179
3	1/5: KRW500,000, 4/5: KRW0	KRW100,000	226	0.249
L	3/5: KRW200,000, 2/5: KRW0	KRW120,000	389	0.145
H	2/5: KRW200,000, 3/5: KRW0	KRW80,000	207	0.272

Here, the first three choices - denoted risk1, risk2, and risk3 - have the same expected value as the fixed amount of KRW100,000, but differ in their degree of riskiness. Taking risk2 as the baseline, risk1 is less risky than risk2 while risk3 is riskier. Meanwhile, RiskL and RiskH have different expected values (KRW80,000 and KRW120,000 respectively). We use the answers to these five questions to construct a risk-aversion variable, which may well explain a part of individual heterogeneity. Each question is assigned a value of 0 if the respondent prefers the lottery, which is regarded as risk-taking, a value of 0.5 if the respondent is 'indifferent', and a value of 1 if the lottery is not chosen. Higher numbers therefore indicate greater risk aversion. Different weights can be assigned to

[4] 1 U.S. dollar is approximately 1,100 Korean Won

[5] We discuss the construction of our risk-aversion measure in the following section.

these choices depending on the lottery's expected value. For example, in riskL, saying 'indifferent' could also mean 'risk averse' as the expected value is less than KRW100,000, because the distance between the expected value and KRW100,000 could be seen as a risk premium from choosing the lottery. Equally, choosing the lottery in risk1, 2, and 3 would be assigned the same value of 1 above, but this does not mean that those lotteries have the same associated levels of risk. We therefore weight each risk variable according to the inverse of the fraction of people choosing the lottery in order to take this into account.

$$ra_i = \sum \alpha_i Risk_i, i = 1, 2, 3, L, and H^6$$

where $Risk_i$=0 (prefer lottery: less risk averse), 0.5 (indifferent: risk neutral), 1 (prefer cash: risk averse), and α_i is an ad-hoc weight, which is higher for a riskier lottery choice if that lottery is chosen by fewer people, $\alpha_i = b_i / \sum b_i$, where b_i is the inverse of the proportion of the number of lotteries chosen in each case (i.e. $b_i = \sum N_i / N_i$, N_i in the table shows the number of respondents who prefer each lottery i). The risk aversion measure therefore has the range of $[0, 1]$.[7] Each lottery has its own weight, which is calculated as the inverse of the proportion of people who choose the lottery.[8] The ascending order of risk amongst the five lotteries as subjectively perceived by workers is $L(the\ least\ risky) \rightarrow 1 \rightarrow 2 \rightarrow 3 \rightarrow H(the\ most\ risky))$.[9]

Table 2 shows risk aversion in the different sub-samples: by gender, job sector, education, age, and marital status. Female workers are more risk averse than male workers, and workers in the public sector are more risk averse than those in the private sector. Employed workers (both in the public and the private) tend to be less risk averse than those who are in other status (self employed or inactive). In addition, highly-educated workers tend to be less risk averse than workers who have a high-school diploma. Older workers (aged over 45) are more risk averse, while marital status is also significantly linked with risk aversion. We do indeed find a gender difference in attitude towards risk, which is the basis for the work we carry out here. Figure 6 shows the relationship between risk

[6]This method was introduced by Sung and Ahn (2007)

[7]A simple aggregation using the same weights for each question was also tested and yielded a fairly similar picture to that produced by the method used above; these results are available on request. Alternatively, the Barsky et al. (1997) method could be used. The first three questions would yield 27 categories of different risk attitude-groups.

[8]For example, $\alpha_1 = \frac{\frac{1}{363}}{\frac{1}{363}+\frac{1}{314}+\frac{1}{226}+\frac{1}{389}+\frac{1}{207}} = 0.155$, although results are unchanged with the same weight ($\alpha_i = 0.2$ for all i's).

[9]There is an issue regarding the inconsistency of respondent choice. For example, 53 respondents chose to take lottery 2, but not lottery 1, which is less risky. These inconsistency rates are, however, typically below 2.5% in this sample and do not change the results much. We have therefore retained all of the observations regardless of their consistency.

aversion and age by gender. Women have a tendency to be more risk averse than men at all ages. This figure also shows a positive slope, suggesting an age effect on risk aversion. Figure 7 shows risk aversion/age profile by sector. In common with the gender findings, public-sector workers' risk aversion is generally higher than that of private-sector workers across most cohorts. When we compare risk aversion between the public and private sectors, female workers continue to report greater risk aversion. However, the gender difference in terms of risk aversion is larger among private-sector workers (Figure 9) than in the public sector (Figure 8), which might explain the difference in the gender wage gap between sectors. This is what we now set out to evaluate using a regression analysis.

4.3 Results

Table 3 presents the results of pairwise correlation matrices for the variables in which we are interested. The main risk-aversion variable is significantly correlated with wage, gender, employment, sector selection, education, being married, health, and father's education. Female, working in the public sector, and being married are all positively correlated with risk aversion, while the correlation with wage, employment, education, health, and father's education is negative. The signs and significance are in line with human-capital theory and the literature on risk. Wages are lower for women and in the public sector, and women are found more in the public sector. These correlations are the starting point of our analyses.

Table 4 presents the results of various wage equations using two different selection-correction methods; the Switching Regression Model (Nakosteen and Zimmer (1980)) and Lee (1983)'s polychotomous method. In the Korean sample, female workers earn about 38% less on average than male workers, controlling for other socio-demographic variables and a public-sector dummy. Returns to education are about 8%, which is fairly standard. One interesting point is that public workers earn 26% less than do private-sector workers.[10] Columns 2 and 5 show the wage equations for public-sector workers and private-sector workers respectively. Female workers in the public sector are still paid less (32%), but the gap is narrower than in the private sector (41%). This could show that discrimination is harder to effect in the public sector due to policy and also the less competitive atmosphere, which makes for more equal wage conditions for men and women. On the other hand, private firms are more competitive and profit-seeking, which

[10]However, the picture changes slightly when considering skilled and unskilled work. The private sector pays higher wages for skilled work, whereas the public sector tends to pay higher wages for unskilled work. Even so, the private sector still pays more on average than the public sector

leads workers to work harder. Female workers tend to be left behind in this working environment due to childcare and less competitive characteristics, which widens the gender gap. Private firms' preferences for male workers may contribute to this wider gender wage gap by offering higher wages to men. Returns to education are also higher in the private sector. Given a set of individual characteristics, wages are higher in the private- relative to the public-sector (from a comparison of the two constants: 3.636 vs 3.35).
We now consider the selection model. We first use the Switching Regression Model (Nakosteen and Zimmer (1980)).[11] The results of the selection step are presented in Column 3 in the second panel. The binary dependant variable is public-sector employment. As expected, women tend to choose (or to be pushed to choose) the public sector. Education is positively correlated with selection into public sector. Being married is negatively correlated with the public sector, but not significantly so. Health[12] is negatively and significantly correlated with working in the public sector; workers who are confident in their health may prefer to work in the private sector. Our variable of interest, risk aversion is, indeed, positively correlated with public-sector choice: workers with greater risk aversion are more often found in the public sector. The selection correction reveals the differences in the gender wage gap in both sectors. Columns 3 and 6 display the wage equation results with selection correction. In the public sector, the gender gap not explained by other socio-demographic features falls from 32% to 30%. In the private sector, the gender gap also drops by 3% (41% to 38%). This correction is meaningful as the estimated value of rho is significantly different from zero, which proves that there is indeed a selection issue in the main wage equation. Controlling for risk aversion helps correct women's self-selection into the public sector and reduces the pure gender gap that cannot be explained and is often defined as market gender discrimination. Columns 4 and 7 then present the wage equation results corrected using Lee's method.[13] The second panel shows the multinomial logit model results for: (1) working in the public sector (in Column 4); and (2) working in the private sector (in Column 7); with (3) self-employed or inactive as the reference point. Risk aversion no longer has a significant impact on working in the public sector. However, it becomes a significant determinant of working in the private sector: the more risk averse the individual, the less likely they are to be found in the private sector.

[11]We use the 'movestay' stata command developed by Lokshin and Sajaia (2006) to estimate the switching regression.

[12]Health is self-reported.

[13]We use the 'selmlog' stata command developed by Bourguignon et al. (2007) to estimate the polychotomous choice selection model.

Noting that all of the rhos in Table 4 are significantly different from zero, we can now look at the corrected wage equations in the first panel. The Lee correction in the public sector (Column 4) actually widens the gender gap by 9% points, as compared to column 2. This underlines the importance of considering participation as a third element in labor-market choices, and how this participation decision is related to risk aversion. The results of the three-category choice model show how the two employment sectors compare with the reference point: the public-sector estimation results show the comparison to self-employment and inactivity, and not to the private sector. When individuals compare the public sector with self-employment or inactivity, the coefficient on risk aversion is insignificant so that the corrected wage gap will not necessarily fall. What is more significant here is the private sector. In the selection step, risk aversion is a key determinant of this choice. This correction in the private sector narrows the gender wage gap even more than in the Roy switching regression model (from 41% to 24%). This result confirms that selection is indeed not marginal in the private sector. It also suggests that the gender wage gap in the private sector is substantially overestimated without correction. Selection across labor-market sectors depends then on risk-aversion. In particular, the Lee results suggest that selection into the private sector produces women who are on average less risk-averse than are the men who choose the private sector. As risk-aversion is negatively correlated with wages, the correction for selection via risk reduces the female wage penalty in the private sector.

The selection bias makes the gap wider as women are more risk averse in general. The gender wage gap in the Korean labor market is then reduced from 38% to 35.5%[14] using Roy's method, and to 28.4%[15] using Lee's method to correct for selection bias.

Table 5 shows the prediction of the expected log wage based on the sample correction method. Expected wages are calculated for the following: unconditional in the public sector, unconditional in the private sector, conditional in the public sector with workers currently working in the public sector, conditional in the private sector with workers currently working in the public sector, conditional in the public sector with workers currently working in the private sector, and conditional in the private sector with workers currently working in the private sector. Given that rho1 is positive and significantly different from zero, the model suggests that individuals who intentionally choose to work in the private sector earn lower wages than a random individual from the sample (or currently working in the other sector) would earn (Row 4 vs Row 6). Yet as rho0 is

[14] $0.27(\text{in public}) \times 0.302 + 0.73(\text{in private}) \times 0.376 \approx 0.355$

[15] $0.27(\text{in public}) \times 0.412 + 0.73(\text{in private}) \times 0.237 \approx 0.284$

also positive and significantly different from zero, individuals who intentionally choose to work in the public sector earn higher wages than a random individual from the sample (or currently working in the other sector) would earn (Row 3 vs Row 5).

5 Concluding Remarks

This paper provides some evidence on the impact of risk aversion on labor market behavior. We control for risk attitudes based on hypothetical lottery questions from Korean labor surveys. We especially look at private-public job sector choice, assuming that the public sector provides more incentives than the private sector in terms of stability and job security. The results show that risk aversion is a significant and positive determinant of public-sector employment choice. That women are more risk averse than men hints that there could be a link between women's self-selection and the gender wage gap. We explain labor market gender discrimination partly by risk aversion using a decomposition into three channels: (1) being female by itself (this could be interpreted as pure market discrimination); (2) female workers' preference for working in the public sector regardless of their risk attitudes or private firms' preference for hiring male workers, prompting women to work in the public sector (Section 2.2); and (3) choosing to work in the public sector due to women's higher risk aversion. We then need to correct the wage equation for selection bias. We show that individual risk attitudes are an important determinant of labor-market participation choices and also public-private sector choice. The switching regression model narrows the gender gap in both sectors by about 5% points. In addition, when we extend our model to the multinomial choice model for the selection step, the gender gap drops sharply in the private sector while it surprisingly increases in the public sector. This opposite direction, however, could be explained by the different mechanism at work when we use the multinomial model with self-employment and inactivity as the reference category. These findings indicate that the wage gap is not simply a product of the labor market environment, but also the choices made by women themselves based on their risk aversion and other preferences. In other words, the wage gap is not only a result of pure discrimination in the labor market, but also of intrinsic sorting based on preferences formed by risk attitudes. This could be a new way to explain why female workers in Korea are paid so much less than their male counterparts.

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Figures

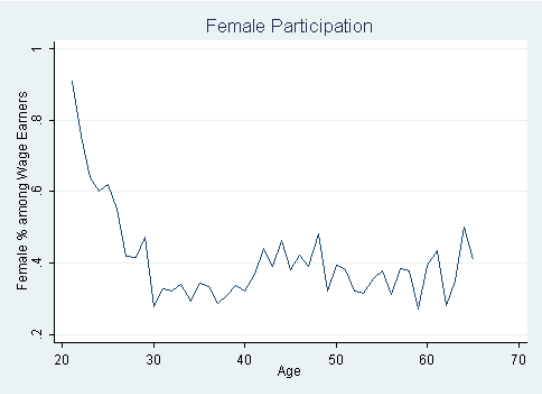

Figure 4: Female Participation

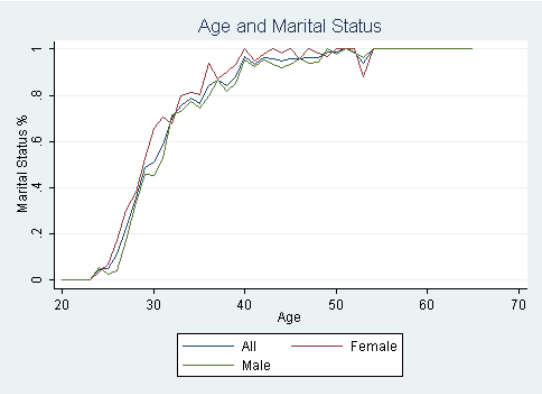

Figure 5: Marital Status by Age

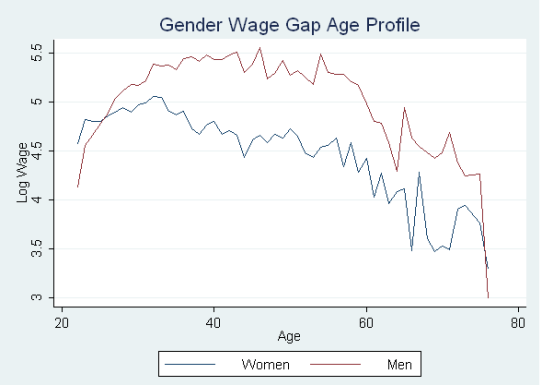

Figure 6: Gender Wage Gap by Age

Figure 7: Risk Aversion Age Profile

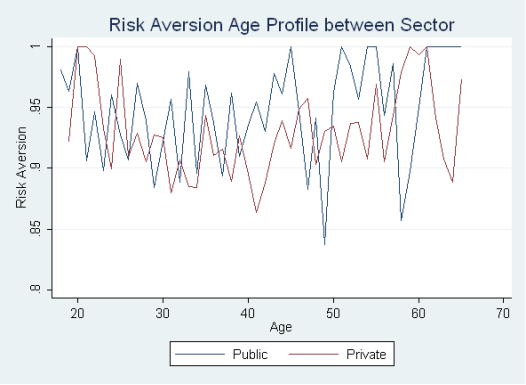

Figure 8: Risk Aversion Age Profile by Sector

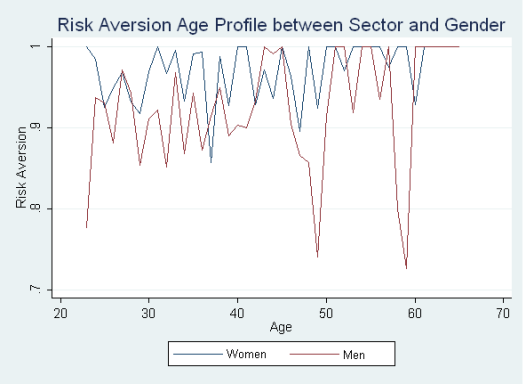

Figure 9: Risk Aversion Age Profile by Gender in the Public Sector

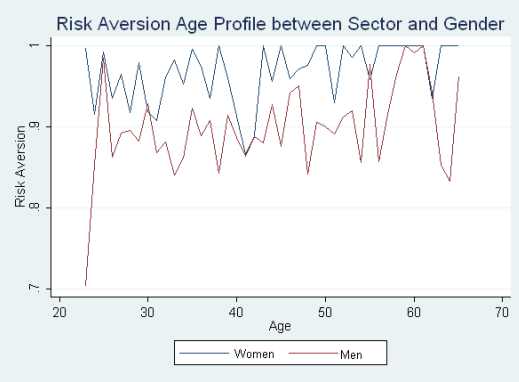

Figure 10: Risk Aversion Age Profile by Gender in the Private Sector

Tables

Table 1: Descriptive Statistics

	Full Sample	Male	Female	Diff	Private	Public	Diff
Age	40.00	40.76	38.81	-1.95***	41.18	36.74	-4.43***
	(11.50)	(11.11)	(12.01)		(10.96)	(12.31)	
Education	12.95	13.31	12.38	-0.94***	12.97	12.88	-0.09
	(3.19)	(3.01)	(3.37)		(3.25)	(3.01)	
Female	0.39				0.36	0.47	0.11***
	(0.49)				(0.48)	(0.50)	
Wage(mil won)	189.37	227.15	130.58	-96.57***	207.57	139.26	-68.31***
	(189.20)	(220.92)	(99.44)		(208.56)	(105.80)	
Public	0.27	0.23	0.32	0.09***			
	(0.44)	(0.42)	(0.47)				
Married	0.74	0.76	0.71	-0.05***	0.79	0.61	-0.17***
	(0.44)	(0.43)	(0.45)		(0.41)	(0.49)	
Risk Aversion	0.927	0.904	0.963	0.06***	0.923	0.943	0.020**
	(0.25)	(0.15)	(0.25)	(0.007)	(0.24)	(0.18)	(0.008)
N	4208	2563	1645		3085	1123	

Notes. Standard errors in parentheses

*: $p < 0.10$, ** : $p < 0.05$, *** : $p < 0.01$

Table 2: Risk Aversion Measures

	Mean	SE	Obs
Full Sample	837	0.168	11453
Male	0.814	0.204	5546
Female	0.860	0.122	5907
Diff	0.045***	0.003	
Private	0.816	0.204	3085
Public	0.833	0.171	1123
Diff Public-Private	0.017**	0.007	
Inactive or SE	0.847	0.149	7245
Diff Employed-Non emp	-0.027***	0.003	
Edu $> 12yrs$	0.847	0.153	7362
Edu $\leq 12yrs$	0.820	0.192	4091
Diff	-0.027**	0.003	
Age < 45	0.821	0.192	6419
Age ≥ 45	0.859	0.130	5034
Diff	0.038***	0.003	
Not married	0.825	0.182	2931
Married	0.841	0.163	8522
Diff	0.017***	0.004	

Notes. *: $p < 0.10$, ** : $p < 0.05$, *** : $p < 0.01$

Table 3: Pairwise Correlation of Variables

	Risk Aversion	Log Wage	Female	Employed	In Public	Education	Married	Health	Father Edu
Risk Aversion	1.000								
Log Wage	-0.112*	1.000							
Female	0.135*	-0.410*	1.000						
Employed	-0.077*	0.000*	-0.191*	1.000					
In Public	0.037*	-0.256*	0.099*	0.000*	1.000				
Education	-0.117*	0.441*	-0.213*	0.238*	-0.014	1.000			
Married	0.045*	0.121*	0.097*	-0.009	-0.177*	-0.294*	1.000		
Health	-0.064*	0.163*	-0.116*	0.138*	-0.037*	0.339*	-0.218*	1.000	
Father Edu	-0.026*	0.036*	-0.021*	0.101*	-0.145*	0.027*	0.004	0.007	1.000

Notes. *: $p < 0.10$

Table 4: Switching Regression and Polychotomous Selection Model

	Full Sample		Public		Private		
Wage							
Correction	No	No	Roy	Lee	No	Roy	Lee
Female	-0,382***	-0,323***	-0,302***	-0,412***	-0,406***	-0,376***	-0,237***
	(0,016)	(0,03)	(0,032)	(0,093)	(0,019)	(0,021)	(0,041)
Education	0,08***	0,060***	0,045***	0,175***	0,085***	0,076***	0,060***
	(0,003)	(0,007)	(0,008)	(0,031)	(0,004)	(0,004)	(0,008)
Experience	0,234***	0,189***	0,057	0,218***	0,238***	0,135***	0,237***
	(0,023)	(0,042)	(0,057)	(0,041)	(0,028)	(0,031)	(0,033)
Experience2	-0,049***	-0,047***	-0,031***	-0,052***	-0,047***	-0,033***	-0,046***
	(0,004)	(0,007)	(0,008)	(0,007)	(0,005)	(0,005)	(0,006)
Married	0,171***	0,161***	0,142***	-0,716***	0,172***	0,150***	0,010
	(0,023)	(0,044)	(0,046)	(0,252)	(0,027)	(0,029)	(0,045)
Working Hour	0,063***	0,121***	0,127***	0,122***	0,037***	0,036***	0,035***
	(0,005)	(0,009)	(0,010)	(0,014)	(0,006)	(0,007)	(0,009)
In Public	-0,256***						
	(0,017)						
Constant	3,585***	3,35***	3,346***	-4,056**	3,636***	4,044***	4,602***
	(0,066)	(0,126)	(0,131)	(1,915)	(0,077)	(0,088)	(0,252)
Selection							
Female			0,093**	-0,294***			-0,758***
			(0,045)	(0,066)			(0,046)
Education			-0,068***	0,113***			0,133***
			(0,010)	(0,010)			(0,007)
Health			-0,141***	0,082*			0,249***
			(0,028)	(0,043)			(0,030)
Married			-0,097	-0,285***			0,699***
			(0,064)	(0,071)			(0,055)
Risk Aversion			0,202**	-0,138			-0,485***
			(0,102)	(0,191)			(0,124)
rho0			0,545***				
			(0,116)				
rho1			0,653***	-0,440***			
			(0,040)	(0,012)			
rho2							0,587***
							(0,048)
wald/LR chi2			627,74	1250,54			1250,54
Adj R 2	0,4375	0,3930			0,4133		
Obs	4208	1123	4208		3085		

Notes. Standard errors in parentheses

*: $p < 0.10$, ** : $p < 0.05$, *** : $p < 0.01$

Table 5: Expected Log Wage with Selection

Expected lwage	Full Sample	Men	Women
Uncond in Pub	4,46	4,62	4,20
	(0,369)	(0,295)	(0,325)
Uncond in Pri	5,25	5,44	4,95
	(0,372)	(0,272)	(0,304)
Cond in Pub w/ pub workers	4,75	4,97	4,51
	(0,386)	(0,301)	(0,322)
Cond in Pri w/ pub workers	5,58	5,83	5,31
	(0,387)	(0,280)	(0,299)
Cond in Pub w/ pri workers	4,35	4,51	4,06
	(0,380)	(0,296)	(0,334)
Cond in Pri w/ pri workers	5,12	5,31	4,78
	(0,402)	(0,295)	(0,335)
Prob to Choose Pub	0,27	0,24	0,32
	(0,121)	(0,105)	(0,127)

Notes. Standard errors in parentheses

Appendix

Wage Decomposition with Sectoral Choice

$E(w|RA,Pu,f=0)-E(w|RA,Pu,f=1)$: Normal Wage Equation Controlling for RA, Gender, and Sector

$= Pr(Pu=1|RA,f=0)E(w|RA,Pu=1,f=0)+(1-Pr(Pu=1|RA,f=0))E(w|RA,Pu=0,f=0)$

$-Pr(Pu=1|RA,f=1)E(w|RA,Pu=1,f=1)-(1-Pr(Pu=1|RA,f=1))E(w|RA,Pu=0,f=1)$

$$= Pr(Pu=1|RA,f=0)[E(w|RA,Pu=1,f=0) - E(w|RA,Pu=0,f=0)]$$

$$-Pr(Pu=1|RA,f=1)[E(w|RA,Pu=1,f=1) - E(w|RA,Pu=0,f=1)]$$

$+[E(w|RA,Pu=0,f=0) - E(w|RA,Pu=0,f=1)]$: Wage Gap in the Private Sector

$= Pr(Pu=1|RA,f=0)E(w|RA,Pu=1,f=0)-Pr(Pu=1|RA,f=0)E(w|RA,Pu=0,f=0)$

$[+Pr(Pu=1|RA,f=0)E(w|RA,Pu=1,f=1)-Pr(Pu=1|RA,f=0)E(w|RA,Pu=1,f=1)]$

$-Pr(Pu=1|RA,f=1)E(w|RA,Pu=1,f=1)+Pr(Pu=1|RA,f=1)E(w|RA,Pu=0,f=1)$

$[+Pr(Pu=1|RA,f=0)E(w|RA,Pu=0,f=1)-Pr(Pu=1|RA,f=0)E(w|RA,Pu=0,f=1)]$

$$+[E(w|RA,Pu=0,f=0) - E(w|RA,Pu=0,f=1)]$$

$$= Pr(Pu=1|RA,f=0)[E(w|RA,Pu=1,f=0) - E(w|RA,Pu=1,f=1)]$$

$$-Pr(Pu=1|RA,f=0)[E(w|RA,Pu=0,f=0) - E(w|RA,Pu=0,f=1)]$$

$$+[Pr(Pu=1|RA,f=0) - Pr(Pu=1|RA,f=1)]E(w|RA,Pu=1,f=1)$$

$$-[Pr(Pu=1|RA,f=0) - Pr(Pu=1|RA,f=1)]E(w|RA,Pu=0,f=1)$$

$$+[E(w|RA,Pu=0,f=0) - E(w|RA,Pu=0,f=1)]$$

$$= Pr(Pu=1|RA,f=0)[[E(w|RA,Pu=1,f=0) - E(w|RA,Pu=1,f=1)]$$

$$-[E(w|RA,Pu=0,f=0) - E(w|RA,Pu=0,f=1)]$$

$+(Pr(Pu=1|RA,f=0)-Pr(Pu=1|RA,f=1))[E(w|RA,Pu=1,f=1)-E(w|RA,Pu=0,f=1)]$

$$+[E(w|RA,Pu=0,f=0) - E(w|RA,Pu=0,f=1)]$$

$$= Pr(Pu=1|RA,f=0)[E(w|RA,Pu=1,f=0) - E(w|RA,Pu=1,f=1)$$

$$+(1 - Pr(Pu=1|RA,f=0))[E(w|RA,Pu=0,f=0) - E(w|RA,Pu=0,f=1)$$

$+(Pr(Pu=1|RA,f=0)-Pr(Pu=1|RA,f=1))[E(w_f|RA,Pu=1)-E(w_f|RA,Pu=0)]$: positive term

Therefore, when we observe the wage gap conditional on sector and risk aversion (RA, Pu), we overestimate the gap with the additional positive term $(P_m - P_f)[E(w_f|Pu=1)-E(w_f|Pu=0)]$, which reflects the selection preference.