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# The Gender Wage Gap and Sample Selection via Risk Attitudes

SEEUN JUNG\*

## 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 5% points, by applying the Switching Regression Model and Dubin & McFadden's selection correction. Self-selection based on risk attitudes therefore explains, in part, what is popularly perceived as gender discrimination.

***JEL Classification:*** J24; J31; D81; C52

***Keywords:*** Occupational Choice; Gender Wage Gap; Risk Preference; Selection Bias

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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 et al. \(1999\)](#)), 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 gender different in risk attitudes.

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

We assume that individuals can have two types of risk attitudes: risk averse and less risk averse (or risk neutral, risk loving). We then assume two types of firms. First, there is the competitive firm (private sector), where the job-separation rate is higher (and job security is lower, since workers are more likely to be fired). Second, there is the non-competitive firm (public sector) with a lower job separation rate. We assume that the competitive firms offer a wage premium  $p > 0$  to offset the job-security risk. We say that workers in non-competitive firms receive a risk-free wage  $w_{pu}$  while workers in competitive firms obtain the risk-free wage plus a risk premium  $p$  (i.e.  $w_{pr} = w_{pu} + p$ ). The assumption here is that the job-separation rate is higher for competitive than non-competitive firms  $r_{pu} < r_{pr}$ . In the extreme case, we could set  $r_{pu} = 0$  with no risk of being fired and  $r_{pr} = r > 0$ . Taking the basic *CRRA* utility function with different risk aversion factors  $\rho$ :  $u(c) = \frac{c^{1-\rho}}{1-\rho}$ , we consider different attitudes to risk (i.e.  $\rho_{RA}$  (risk-averse individuals)  $>$   $\rho_{RN}$  (less risk averse individuals) ). If a worker is fired, s/he receives a basic government subsidy of  $b$ , with  $b < w_{pu} < w_{pr}$ . If we take the non-competitive firm wage as  $w_{pu} = w$ , the competitive firm wage would be  $w + p$  and the basic subsidy  $b$  could

also be rewritten as  $w - p'$  for a given positive value  $p'$ . Provided that the risk premium is greater than  $\frac{r}{1-r}p'$ , expected earnings are higher in competitive than non-competitive firms. We now turn to expected utility. Workers with greater risk aversion would choose to work in non-competitive firms even though the wage is lower from the *CRRA* utility function. Given the same wage premium and job-separation ratio, expected utility varies with the level of  $\rho$ . We are interested here in finding the condition that satisfies the following:

- $EU(w_{pu}) > EU(w_{pr})$  for risk-averse workers with  $\rho_{RA}$
- $EU(w_{pu}) < EU(w_{pr})$  for less risk-averse workers with  $\rho_{RN}$

This is the case when the following condition holds:

$$r \in \left[ \frac{(w+p)^{1-\rho_{RA}} - w^{1-\rho_{RA}}}{(w+p)^{1-\rho_{RA}} - (w-p')^{1-\rho_{RA}}}, \frac{(w+p)^{1-\rho_{RN}} - w^{1-\rho_{RN}}}{(w+p)^{1-\rho_{RN}} - (w-p')^{1-\rho_{RN}}} \right]$$

Given this range of job-separation rates for competitive firms  $r$ , risk-averse workers are better off choosing the non-competitive firms with lower wages. In addition, the market clears within this range, so that both risk-averse and less risk-averse workers maximize their utility. If the ratio is greater than the upper (less than the lower) bound, both workers choose to work in non-competitive (competitive) firms with lower wages (higher risks). This range of job-separation rates broadens as the difference between  $\rho_{RA}$  and  $\rho_{RN}$  grows,  $p'$  grows (unemployment income falls), and the wage premium  $p$  shrinks.

Figure 1 shows the results of the simulated incentives to work in the public sector, where these incentives are simply the difference between the expected utilities of working in the public and private sectors. This incentive rises with risk aversion for any concave utility function. More risk-averse workers (with a parameter close to 1) prefer the public sector. Analogously, Figure 2 shows the simulated incentives to work in the public sector by the job-separation rate. The solid line represents a risk-averse worker (with  $\rho = 0.99$ ), while the dashed line corresponds to a risk-neutral worker ( $\rho = 0.001$ ). When the job-separation rate lies inside the brackets which satisfy the condition above<sup>1</sup>, we see that

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<sup>1</sup>In our calculation using the parameter we use for the simulation, the range of the job-separation rate  $r$  is in between 0.223 and 0.375.

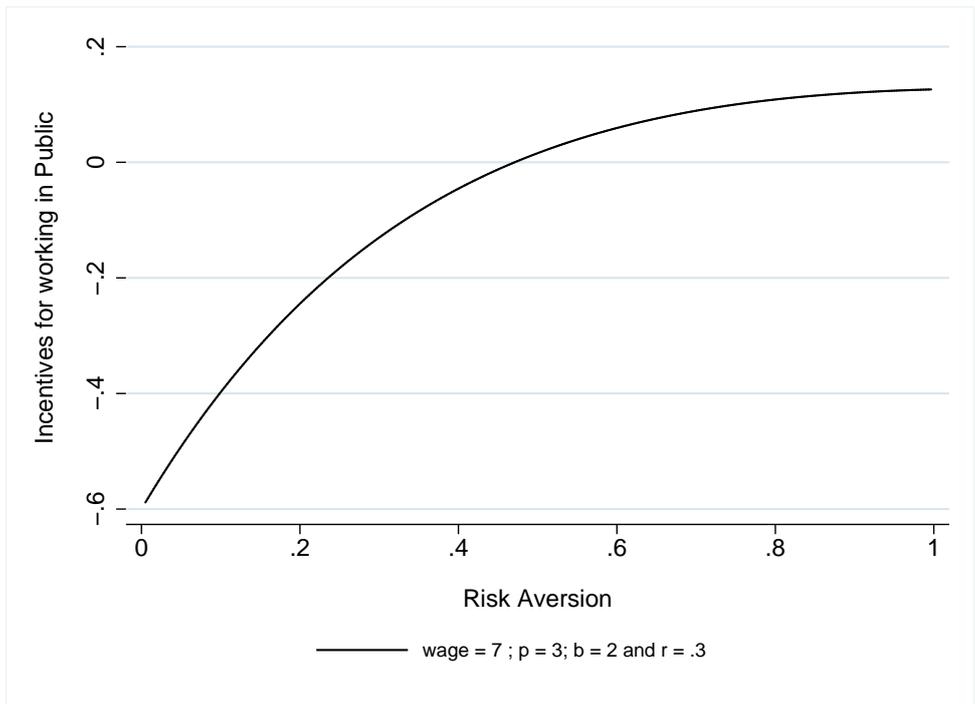


Figure 1: Incentives to Work in the Public Sector by Risk Aversion

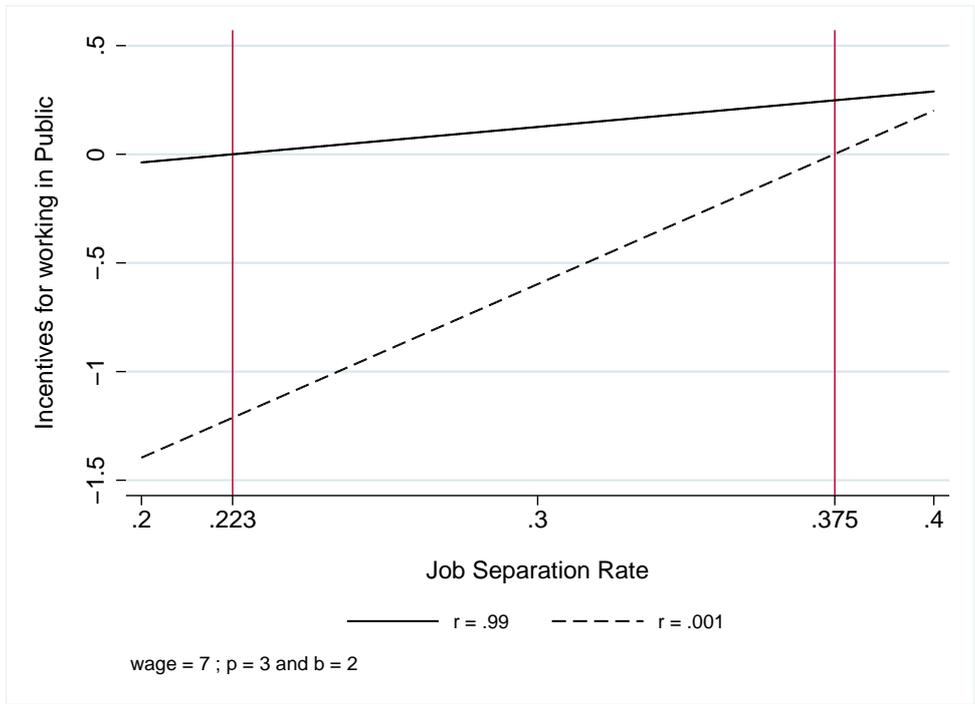


Figure 2: Incentives to Work in the Public Sector by Job Separation Rate

the risk-averse worker has positive incentive to work in the public sector, while the risk-neutral worker is better off working in the private sector.

## 2.2 Gender Difference in Expected Returns

Imagine again that there are two types of firms. One pays higher wages, but the atmosphere is highly competitive and the job is not secure. The other firm is relatively relaxed and the job is more secure, but pays a lower wage than the competitive firm. Looking at the competitive type of firm, we show below that this firm pays 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 competitive firms are higher than men's due to their child bearing, following which the competitive firms 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 competitive 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 competitive 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 competitive firms. Therefore, among female workers in the competitive firm, risk-averse workers earn lower wages. This idea ties in with the "statistical discrimination"<sup>2</sup> literature, in that there are different wage profiles emanating from the demand side (firms).

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<sup>2</sup>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 \(1972\)](#)).

### 3 Analytical Framework

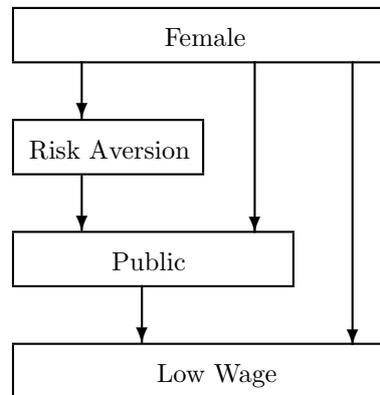
Bearing in mind the two scenarios in the previous section, we now set up an analytical framework in order to test them empirically. A number of pieces of work have investigated whether the gender gap in risk-taking preferences and competitiveness is significantly different and even innate. [Apicella 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 \(2010\)](#) examine the compensation choices of 1,000 Austrian children and teenagers aged 3 to 18, and find that the gender gap in competitiveness is already present by age 3. In this paper, therefore, we write risk aversion (showing individuals' risk attitudes in general) as a function of being female ( $F$ ) :  $RA = RA(F, \dots)$ . 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 risk aversion  $Pub = Pub(F, RA(F), \dots)$ . Last, we extend the Mincerian wage equation to  $w = w(F, Pub(F, RA(F)), \dots)$ .

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

$$\begin{aligned} \frac{\Delta w}{\Delta F} &= \frac{\partial w}{\partial F} + \frac{\partial w}{\partial Pub} \frac{\Delta Pub}{\Delta F} \\ &= \frac{\partial w}{\partial F} + \frac{\partial w}{\partial Pub} \left( \frac{\partial Pub}{\partial F} + \frac{\partial Pub}{\partial RA} \frac{\Delta RA}{\Delta F} \right) \end{aligned}$$

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 due to women's higher risk aversion. The following

figure 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, gender, and sector selection. If we do not control for this selection, the results from the wage equations will not only be biased, but also coefficients will be inconsistent. Here we use a risk-attitude variable to correct for selection and obtain adjusted estimates of the gender wage gap, as risk aversion which is correlated with gender, could determine workers' employment sector choices.<sup>3</sup>

#### 3.1.1 Switching Regression Model

Roy (1951), Maddala (1983), and 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-

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<sup>3</sup>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.

sector workers and private-sector workers separately.

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

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

The sector-selection function is:

$$Pub_i^* = \delta RA_i + Z'_i\gamma + u_i : \text{Sector Choice}$$

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

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);  $RA_i$  is the variable that captures individual risk attitudes (hereafter risk aversion) and  $Z_i$  is a vector of characteristics influencing the employment-sector decision.

We use direct Direct Maximum-Likelihood estimation ([Lokshin and Sajaia \(2006\)](#)) for the two-stage approach in this paper. The log-likelihood for this model is, then,

$$\begin{aligned} \ln L = \sum_i (Pub_i [\ln\{\Phi(\eta_{pub,i})\} + \ln\{\phi(\epsilon_{pub,i}/\sigma_{pub})/\sigma_{pub}\}] + \\ (1 - Pub_i) [\ln\{1 - \Phi(\eta_{pri,i})\} + \ln\{\phi(\epsilon_{pri,i}/\sigma_{pri})/\sigma_{pri}\}]) \end{aligned}$$

where  $\Phi$  is a cumulative normal distribution function,  $\phi$  is a normal density distribution function, and

$$\eta_{ji} = \frac{\delta RA_i + Z'_i\gamma + \rho_j\epsilon_{ji}/\sigma_j}{\sqrt{1 - \rho_j^2}}, \quad j = pub, pri$$

where  $\rho_{pub}$  is the correlation coefficient between  $\epsilon_{pub,i}$  and  $u_i$ ,  $\rho_{pri}$  is the correlation coefficient between  $\epsilon_{pri,i}$  and  $u_i$ ,  $\sigma_u^2$  is a variance of the error term in the selection equation, and  $\sigma_{pub}^2$  and  $\sigma_{pri}^2$  are variances of the error terms in the wage equations. We also assume that  $(\epsilon_{pub,i}, \epsilon_{pri,i}, u_i)$  is trivariate normal,  $\sigma_{\epsilon_{pub},u} = Cov(\epsilon_{pub,i}, u_i)$  and  $\sigma_{\epsilon_{pri},u} = Cov(\epsilon_{pri,i}, u_i)$ .

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:

$$\begin{aligned}
E(w_{pub,i}|x_{pub,i}, Pub_i = 1) &= \alpha_{pub} + X'_{pub,i}\beta_{pub} + E(\epsilon_{pub,i}|u_i > -\delta RA_i - Z'_i\gamma) \\
&= \alpha_{pub} + X'_{pub,i}\beta_{pub} + \sigma_{pub}\rho_{pub} \frac{\phi(-\delta RA_i - Z'_i\gamma)}{1 - \Phi(-\delta RA_i - Z'_i\gamma)} \\
&= \alpha_{pub} + X'_{pub,i}\beta_{pub} + \sigma_{pub}\rho_{pub} \frac{\phi(\delta RA_i + Z'_i\gamma)}{\Phi(\delta RA_i + Z'_i\gamma)}
\end{aligned}$$

This correlation coefficient determines the effect of selection on the conditional income of workers in the public sector. If  $\rho_j$  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:

$$\begin{aligned}
E(w_{pri,i}|x_{pri,i}, Pub_i = 0) &= \alpha_{pri} + X'_{pri,i}\beta_{pri} + E(\epsilon_{pri,i}|u_i \leq -\delta RA_i - Z'_i\gamma) \\
&= \alpha_{pri} + X'_i\beta_{pri} + \sigma_{pri}\rho_{pri} \left[ -\frac{\phi(-\delta RA_i - Z'_i\gamma)}{\Phi(-\delta RA_i - Z'_i\gamma)} \right] \\
&= \alpha_{pri} + X'_{pri,i}\beta_{pri} - \sigma_{pri}\rho_{pri} \frac{\phi(\delta RA_i + Z'_i\gamma)}{1 - \Phi(\delta RA_i + Z'_i\gamma)}
\end{aligned}$$

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).

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

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

### 3.1.2 Polychotomous Choice Sample Selection Model

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.<sup>4</sup> The selection correction models based on the multinomial logit have been developed by Lee (1983), Dubin and McFadden (1984), and more recently Bourguignon et al. (2007). Consider the following polychotomous choice model with three categories:

$$w_j = \alpha_j + x_j\beta_j + \rho_j u_j$$

$$s_j^* = \delta R A_j + Z_j \gamma_j + v_j$$

where  $j = 1, 2, 3$  and  $u_j \sim N(0, 1)$ . If we assume that  $v_j$  is *i.i.d* with a Gumbel distribution, the probability of individual  $i$  choosing  $j$  is

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

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

where  $\eta_{ij} = \max_{k=1,2,3, k \neq j} (s_k^* - v_j)$ .

The bias-corrected wage equation by Dubin and McFadden (1984) is then

$$w_1 = \alpha_1 + x_1\beta_1 + \sigma \sum_{j=2,3} \rho_j \left( \frac{P_j \ln(P_j)}{1 - P_j} + \ln(P_1) \right) + \epsilon_j$$

where  $P_j$  is the probabilities to choose  $j$  and  $(\sigma\rho)$  is the coefficient term for the polychotomous correction of the selectivity bias;  $\epsilon_j$  is an orthogonal error parameter towards the rest of terms, which allows us to use directly OLS in the estimation.

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<sup>4</sup>See Pissarides (1974).

## 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, 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 4 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 5). Figure 6 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, 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),<sup>5</sup> 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<sup>6</sup> 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.

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<sup>5</sup>1 U.S. dollar is approximately 1,100 Korean Won.

<sup>6</sup>We discuss the construction of our risk-aversion measure in the following section.

## 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 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 three questions that we use for this study are shown below:

Nane	Lottery characteristics	Expected Value	Indifferent
LottoM	1/2: KRW200,000, 1/2: KRW0	KRW100,000	Risk Neutral
LottoL	3/5: KRW200,000, 2/5: KRW0	KRW120,000	Risk Averse
LottoH	2/5: KRW200,000, 3/5: KRW0	KRW80,000	Risk Seeking

Here, the three choices - denoted LottoM, LottoL, and LottoH - differ in their degree of riskiness. Taking LottoM as the baseline, LottoL is less risky than LottoM while LottoH is riskier. By comparing the cash KRW100,000 with the expected value of lotteries, we could identify the individual to be risk neutral, risk averse, or risk seeking if she is indifferent between the lottery and the cash.

We use the answers to these three questions to construct a risk-aversion variable, which may well explain a part of individual heterogeneity. We follow the method first introduced by [Barsky et al. \(1997\)](#), categorising individuals into several groups which differ in risk aversion. The mechanism of categorising individuals into different risk-attitude groups is presented in Figure 3.

Starting with LottoM in the first stage, we can make the following three categories: (1) choosing the cash, (2) being indifferent, and (3) choosing the lottery. As being indifferent in this lottery corresponds to risk neutrality, we can sort individuals who prefer the cash into the risk-averse group, while those who prefer the lottery are sorted into the risk-seeking group. If their choice of LottoM is either the lottery or the cash, then we can subdivide those individuals into two groups. If the choice of LottoM is the cash, we

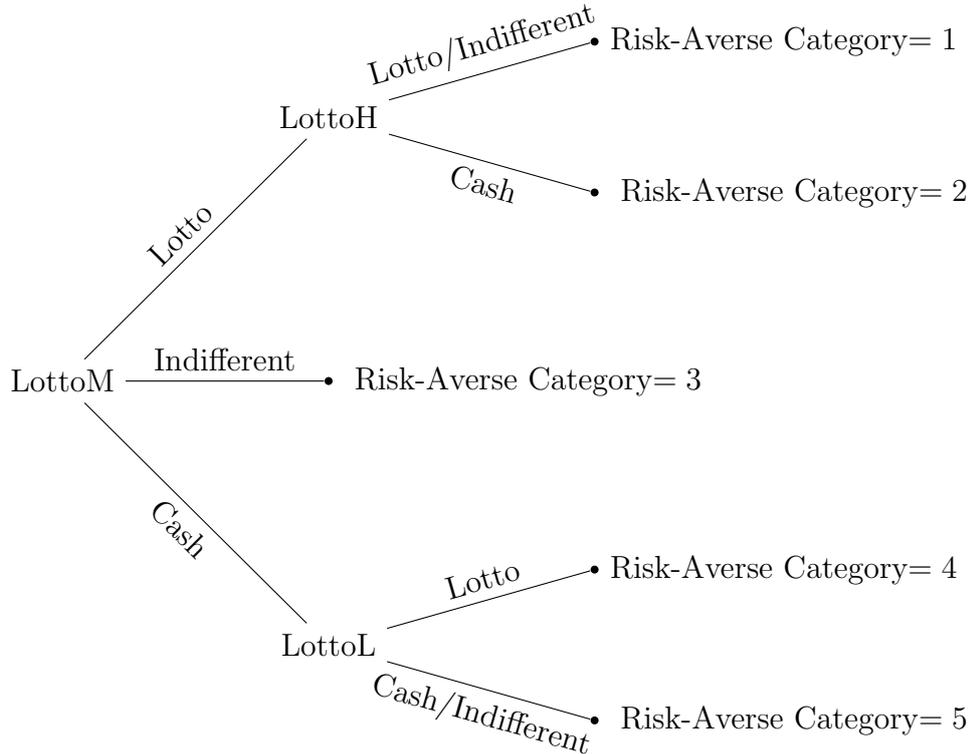


Figure 3: Categorising Risk-Attitude Groups by Choices of Lotteries  
 consider LottoL which is less risky. If the choice of LottoM is the lottery, we consider LottoH which is riskier. In LottoL, being ‘indifferent’ also means ‘risk averse’ as the expected value is less than KRW100,000, because the distance between the expected value and KRW100,000 could be seen as a risk premium from choosing the lottery. Similarly, being indifferent in LottoH means ‘risk seeking’. Based on these answers, we create 5 categories in ascending order of risk-averse level. We divide each risk-averse categorical value by 5 in order to get a risk aversion variable that is ranged between 0 and 1.

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 7 shows the relationship between risk 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. 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 shows the results of selection steps using Maximum Likelihood, Ordered Logit, and Multinomial Logit models. In these selection steps, we consider being woman, the number of children, being mother, and risk aversion as the main explanatory variables for sector choices. First column estimates the Maximum-Likelihood estimation (hereafter abbreviated to ML) in order to investigate what factors explain the decision to work in the public sector; the binary dependent variable is public-sector employment. The subjects who choose to work in the public sector are as expected more risk averse. Second column presents the results from the Ordered Logit analysis. We consider three choices namely working in the private sector ( $= 2$ ), working in the public sector ( $= 1$ ), and

other status including being inactive (= 0). Considering that situations become riskier ( $0(\textit{inactive or etc.}) \rightarrow 1(\textit{public}) \rightarrow 2(\textit{private})$ ), we find that the risk aversion is negatively correlated with sectoral choices. Columns 3 and 4 show the Multinomial Logit Model results for: (1) working in the public sector (in Column 3); and (2) working in the private sector (in Column 4); 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 is, the less likely they are to be found in the private sector.

Overall, mothers tend to choose (or to be pushed to choose) the public sector. Education is positively correlated with selection into private sector. Health<sup>7</sup> is positively and significantly correlated with working in the private sector; workers who are confident in their health may prefer to work in the private sector. Our variable of interest, risk aversion is, indeed, negatively correlated with private-sector choice: workers with greater risk aversion are more often found in the public sector. Therefore, the selection correction reveals the differences in the gender wage gap in both sectors.

Table 5 presents the results of various wage equations using two different selection-correction methods; the Switching Regression Model (Nakosteen and Zimmer (1980)) (hereafter abbreviated to SRM) and Dubin and McFadden (1984)'s polychotomous method (hereafter abbreviated to DMF). In the Korean sample, female workers earn about 37.4% less on average than male workers, controlling for other socio-demographic variables and a public-sector dummy. Returns to education are about 8.4%, which is fairly standard. One interesting point is that public workers earn 26% less than do private-sector workers.<sup>8</sup> Columns 2 and 3 show the wage equations for private-sector workers and public-sector workers respectively. Female workers in the public sector are still paid less (30.7%), but the gap is narrower than in the private sector (40.3%). This could show that discrimination is harder to effect in the public sector due to policy and also the less competitive

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<sup>7</sup>Health is self-reported.

<sup>8</sup>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.

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 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: 3.583 vs 3.276).

We now consider the selection model. We first use SRM.<sup>9</sup> Columns 4 and 5 display the wage equation results with selection correction. In the public sector, the gender gap not explained by other socio-demographic features falls from 30.7% to 28.4%. In the private sector, the gender gap also drops by 4% (40.3% to 36.5%). 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 6 and 7 then present the wage equation results corrected using DMF.<sup>10</sup> Noting that the rhos in Table 5 are significantly different from zero, we can now look at the corrected wage equations. The DMF correction in the public sector (Column 7) actually reduces the gender gap by 3% points. 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

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<sup>9</sup>We use the 'movestay' stata command developed by [Lokshin and Sajaia \(2006\)](#) to estimate the switching regression.

<sup>10</sup>We use the 'selmlog' stata command developed by [Bourguignon et al. \(2007\)](#) to estimate the polychotomous choice selection model.

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 also narrows the gender wage gap by 5.6% points, more than in SRM (from 40.3% to 34.7%).

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 37.4% to 34.3%<sup>11</sup> using SRM, and to 32.8%<sup>12</sup> using DMF to correct for selection bias.

Given that  $\rho_0$  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. Yet as  $\rho_1$  is 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. In other words, if those who entered the public sector were placed in the private sector, they would do better than those who actually entered the private sector. Then, from the result we could explain why the gender wage gaps in both sectors reduced. There are more productive women who chose to work in the public sector than productive men, who would have had higher wage if they were placed in the private sector. Similarly, there are more unproductive men who chose to work in the private sector than unproductive women, who would have had lower wage if they were placed in the public sector. Then this reduces wage gaps in both sectors.

This result confirms that selection is indeed not marginal. It also suggests that the gender wage gap is substantially overestimated without correction. Selection across labor-market sectors depends then on risk-aversion. In particular, the results using sample correction models 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.

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<sup>11</sup> $0.27(\text{in public}) \times 28.4\% + 0.73(\text{in private}) \times 36.5\% \approx 34.3\%$

<sup>12</sup> $0.27(\text{in public}) \times 27.6\% + 0.73(\text{in private}) \times 34.7\% \approx 32.8\%$

## 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 public-private sector choice. The switching regression model narrows the gender gap in both sectors by about 3% points. In addition, when we extend our model to the multinomial choice model for the selection step taking into account that individual risk attitudes are an important determinant of labor-market participation choices, the gender gap drops by 5% points.

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

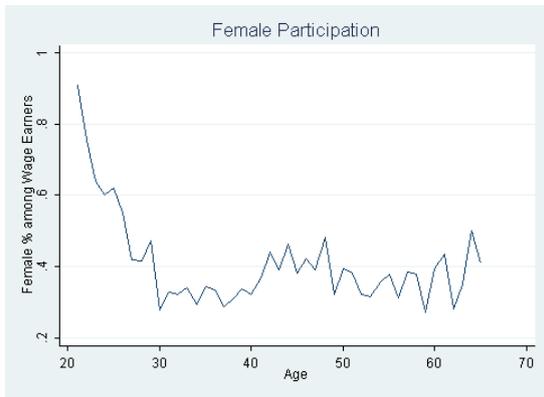


Figure 4: Female Participation

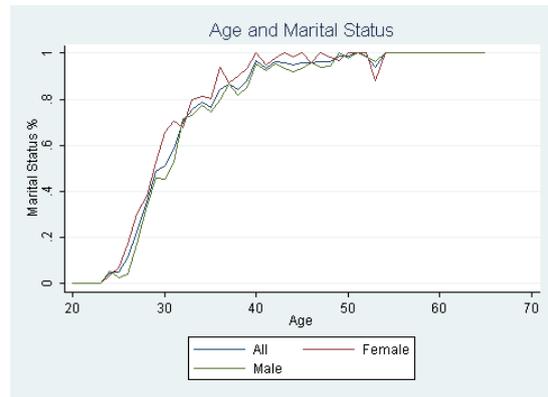


Figure 5: Marital Status by Age



Figure 6: Gender Wage Gap by Age



Figure 7: Risk Aversion Age Profile

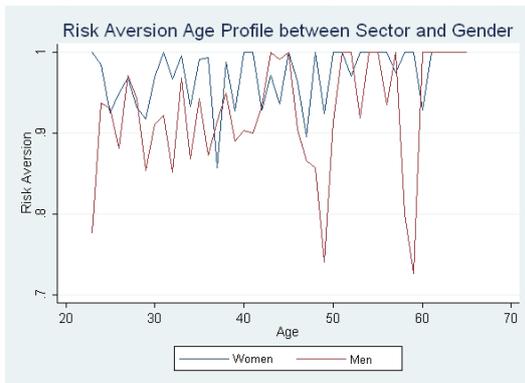


Figure 8: RA in Public

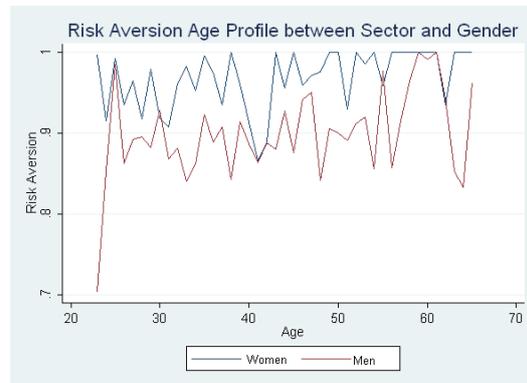


Figure 9: RA in Private

# Tables

Table 1: Descriptive Statistics

	Full Sample	Male	Female	Diff	Private	Public	Diff
Age	40.00 (11.50)	40.76 (11.11)	38.81 (12.01)	-1.95***	41.18 (10.96)	36.74 (12.31)	-4.43***
Yrs of Schooling	12.95 (3.19)	13.31 (3.01)	12.38 (3.37)	-0.94***	12.97 (3.25)	12.88 (3.01)	-0.09
Woman (=1)	0.39 (0.49)				0.36 (0.48)	0.47 (0.50)	0.11***
Wage(mil won)	189.37 (189.20)	227.15 (220.92)	130.58 (99.44)	-96.57***	207.57 (208.56)	139.26 (105.80)	-68.31***
Public (=1)	0.27 (0.44)	0.23 (0.42)	0.32 (0.47)	0.09***			
Married (=1)	0.74 (0.44)	0.76 (0.43)	0.71 (0.45)	-0.05***	0.79 (0.41)	0.61 (0.49)	-0.17***
Risk Aversion	0.952 (0.17)	0.929 (0.20)	0.973 (0.13)	0.044*** (0.007)	0.932 (0.20)	0.951 (0.17)	0.020** (0.008)
<i>N</i>	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	0.929	0.21	11453
Male	0.929	0.21	5546
Female	0.973	0.13	5907
Diff Male-Female	-0.044***	0.013	
Private	0.932	0.20	1123
Public	0.951	0.17	3085
Diff Private-Public	-0.019**	0.008	
Inactive or SE	0.960	0.16	7245
Diff Employed-Non emp	-0.023***	0.003	
Edu > 12yrs	0.935	0.20	7362
Edu ≤ 12yrs	0.961	0.16	4091
Diff	-0.026**	0.003	
Age < 45	0.935	0.20	6419
Age ≥ 45	0.973	0.13	5034
Diff	-0.038***	0.003	
Not married	0.936	0.19	2931
Married	0.957	0.16	8522
Diff	-0.021***	0.004	

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

Table 3: Pairwise Correlation of Variables

	RA	LW	W	E	P	E	M	H	F
Risk Aversion	1.000								
Log Wage	-0.103*	1.000							
Woman (=1)	0.127*	-0.410*	1.000						
Employed	-0.065*	0.000*	-0.191*	1.000					
In Public	0.042*	-0.256*	0.099*	0.000*	1.000				
Education	-0.112*	0.441*	-0.213*	0.238*	-0.014	1.000			
Married	0.054*	0.121*	0.097*	-0.009	-0.177*	-0.294*	1.000		
Health	-0.061*	0.163*	-0.116*	0.138*	-0.037*	0.339*	-0.218*	1.000	
Father Edu	-0.023*	0.036*	-0.021*	0.101*	-0.145*	0.027*	0.004	0.007	1.000

Notes. \*:  $p < 0.10$

Table 4: Selection Step

	<u>ML</u>	<u>Ordered Logit</u>		<u>Multinomial Logit</u>		
	Public (=1)	Ref(=0)	Pub(=1)	Pri(=2)	Public (=1)	Private (=2)
Woman (=1)	-0.210*** (0.06)		-0.783*** (0.06)		-0.625*** (0.09)	-0.904*** (0.07)
Age	-0.025*** (0.00)		-0.006** (0.00)		-0.016*** (0.00)	-0.005* (0.00)
Yrs of Schooling	-0.041*** (0.01)		0.078*** (0.01)		0.053*** (0.01)	0.083*** (0.01)
Married (=1)	-0.495*** (0.05)		0.982*** (0.06)		0.368*** (0.10)	1.170*** (0.07)
Health Status	-0.128*** (0.03)		0.151*** (0.03)		-0.008 (0.05)	0.187*** (0.03)
Number of Child	-0.025 (0.03)		-0.283*** (0.03)		-0.356*** (0.05)	-0.294*** (0.03)
Mother (=1)	0.658*** (0.07)		0.129* (0.07)		0.527*** (0.12)	0.137 (0.08)
Risk Aversion	0.214** (0.10)		-0.211* (0.11)		0.211 (0.19)	-0.264** (0.12)
Constant	1.333*** (0.21)				-1.650*** (0.31)	-1.944*** (0.21)
Observations	4208		11453		11453	
Log Likelihood	-5144.08		-9296.80			-9230.29

Notes. Standard errors in parentheses

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

Table 5: Estimates of the Wage Equations

	<u>Without Correction</u>			<u>With Correction</u>			
	Full Sample	<u>OLS</u>		<u>Switching Regression</u>		<u>Polychotomous Selection</u>	
		Private	Public	Private	Public	Private	Public
Woman (=1)	-0.374*** (0.02)	-0.403*** (0.02)	-0.307*** (0.03)	-0.365*** (0.02)	-0.284*** (0.03)	-0.347*** (0.04)	-0.276*** (0.06)
Yrs of Schooling	0.084*** (0.00)	0.090*** (0.00)	0.064*** (0.01)	0.078*** (0.00)	0.038*** (0.01)	0.075*** (0.01)	0.055*** (0.01)
Experience	0.332*** (0.02)	0.330*** (0.02)	0.288*** (0.03)	0.274*** (0.03)	0.196*** (0.03)	0.172*** (0.05)	0.217*** (0.05)
Experience sq.	-0.061*** (0.00)	-0.058*** (0.00)	-0.059*** (0.01)	-0.055*** (0.01)	-0.059*** (0.01)	-0.050*** (0.01)	-0.068*** (0.01)
Hours of Work	0.063*** (0.01)	0.037*** (0.01)	0.121*** (0.01)	0.033*** (0.01)	0.121*** (0.01)	0.037*** (0.01)	0.120*** (0.01)
Public	-0.260*** (0.02)						
Constant	3.523*** (0.07)	3.583*** (0.08)	3.276*** (0.12)	4.005*** (0.09)	3.333*** (0.13)	4.925*** (0.39)	4.098*** (0.75)
rho0				0.719*** (0.03)		0.104 (0.18)	1.732*** (0.26)
rho1				0.671*** (0.05)		2.088*** (0.05)	0.703*** (0.18)
rho2						-0.119* (0.07)	0.857*** (0.34)
sigma0				0.572*** (0.03)			
sigma1				0.550*** (0.01)			
sigma2						2.827** (1.14)	2.687** (1.12)
Observations	4208	3085	1123	4208		11453	
R sq.	0.431	0.407	0.389				
Log Likelihood				-5144.08		-9230.29	

Notes. Standard errors in parentheses

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

# 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

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

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

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

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

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

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

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

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

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

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

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

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

$$\begin{aligned}
& +(\Pr(Pu = 1|RA, f = 0) - \Pr(Pu = 1|RA, f = 1))[E(w|RA, Pu = 1, f = 1) - E(w|RA, Pu = 0, f = 1)] \\
& \quad + [E(w|RA, Pu = 0, f = 0) - E(w|RA, Pu = 0, f = 1)] \\
& = \Pr(Pu = 1|RA, f = 0)[E(w|RA, Pu = 1, f = 0) - E(w|RA, Pu = 1, f = 1)] \\
& \quad + (1 - \Pr(Pu = 1|RA, f = 0))[E(w|RA, Pu = 0, f = 0) - E(w|RA, Pu = 0, f = 1)] \\
& + (\Pr(Pu = 1|RA, f = 1) - \Pr(Pu = 1|RA, f = 0))[E(w_f|RA, Pu = 0) - E(w_f|RA, Pu = 1)] : \text{positive term}
\end{aligned}$$

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